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ITALIAN REAL ESTATE INVESTMENT FUNDS: MARKET STRUCTURE AND RISK MEASUREMENT

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Abstract

This paper describes the Italian real estate investment funds industry, providing an overview of the distinctive features and risk factors of this sector. By using accounting and supervisory data, we: (1) compute the returns of the real estate assets in the portfolio of these funds; (2) construct a price index and a total return index of the real estate assets held by the Italian funds; (3) define a risk assessment process based on three different aspects – their financial profile, income structure and property price behaviour. This analysis allows us to select funds with a weak financial structure, poor returns, and a high probability that in a three-year interval their property portfolio will fall below their net liabilities (defined as the difference between debt and liquid assets). The proposed risk assessment can be seen as the first step towards a more intensive supervisory analysis and can also be useful for investment purposes.

JEL Classification: C15, G10.
Keywords: real estate investment funds, asset management, firm value model, non-normal distributions, Monte Carlo simulation.

Contents

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1 Introduction[1]

Real estate investment funds (REIFs) allow investors to convert real estate assets, which are typically hard to exchange, into units of financial products. In Italy they are established and managed by asset management companies (*società di gestione del risparmio* - SGRs) supervised by the Bank of Italy in cooperation with Consob (Commissione Nazionale per la Società e la Borsa – Companies and Stock Exchange Commission). In particular, the Bank of Italy receives supervisory and statistical reports regarding all the REIFs established by Italian management companies (for more detailed information on these data see the Bank of Italy (2009)).

Italian real estate funds are closed-end funds that give investors the right to redeem the units only at predetermined intervals, under specific circumstances and for limited amounts. This feature reduces the liquidity problems that might otherwise arise if a real estate fund functioned as an open-end fund, by allowing investors to request the redemption of their units at any time (see Bannier et al. (2007) and Schweizer et al. (2011)). In spite of that, Italian real estate funds are exposed to different types of risk: property, economic and liquidity risks are interconnected and associated with the credit market conditions and financial constraints (including debt repayment obligations and capital reimbursements).

In 2009, in addition to the supervisory and statistical reports, the Bank of Italy (see the Bank of Italy (2010a) and the FSB (2011)) requested that all SGRs managing REIFs provide detailed data on the financial structure of funds and conducted an analysis of three aspects: (1) the financial profile; (2) income structure, and; (3) property price behaviour of each REIF. In particular, the analysis of the property price behaviour, the most challenging of the three, allowed us to calculate a three-year probability of default (PD) for each fund under different scenarios for the real estate market. The analysis aimed to detect the riskiest funds, taking into account the interrelations between structural and market risks. The ultimate aim was to select funds for an in-depth examination from a supervisory perspective. In this paper, we update the analysis based on supervisory data to June 2010.

The Italian REIF market has been analyzed in the literature from various perspectives. For example, Maggio and Vivoli (2009) described the evolution of the Italian REIFs, their legal regime together with their regulatory framework and main characteristics. Colombo and Marcelli (2009) presented the results of a survey on asset valuation practices of real estate funds, and explored the methodologies, assumptions and risks considered in the appraisal process, and the way in which an SGR interacts with appraisers (also called *independent experts*). Furthermore, VV.AA. (2009) provided an overview of these products, analyzing the market structure, the risks connected with these instruments and the results of an analysis based on fees, liquidity and risk measures to explain the net asset value (NAV) discount of 22 listed funds.

However, only a handful of research papers have studied with a quantitative approach the Italian REIF market. Morri and Benedetto (2009) studied Italian listed

[1] The authors are grateful to Mario Cappabianca, Carlo Gola and Giuseppe Grande for their comments and suggestions and they would like to thank Alice Chambers and Carla Lucidi for the linguistic revision of the paper. The views expressed in the article are those of the authors and do not involve the responsibility of the Bank of Italy.

REIFs and developed an econometric model to explain the well-known closed-end fund puzzle (see Ross (2002)), i.e. the reason why Italian listed REIFs generally trade at a discount to their NAV. In another paper, Morri and Lee (2009) analyzed the risk-adjusted performance of 17 funds. Giannotti and Mattarocci (2009) identified different factors, principally based on portfolio characteristics and debt policies, for the valuation of the risk exposure. Recently, Biasin et al. (2010) investigated the influence of the Italian listed REIF governance and regulatory structure on the market prices discount to NAV.

This paper sets out to: (1) give a detailed insight into the Italian REIF market; (2) analyze the market structure; (3) construct a price and total return index based on the returns of the property assets held by the funds; (4) define a risk assessment based on their financial profile, income structure and property price behaviour.

The risk assessment process we propose is intended as a tool for the detection of REIFs for which more intense supervision is necessary in order to have a complete understanding of the funds' risk. Supervisors can request ad-hoc information from fund managers to get a better idea of the financial situation of a single fund and the future cash flow behaviour predicted in the business plan.

The remainder of this paper is organized as follows. In Section 2 we briefly describe the Italian REIF market. In Section 3 we compute the return of real estate assets held by the funds and consider some financial indicators connected with these kind of products, as well as the distinctive traits and performance of the Italian market. In Section 4 we propose a risk assessment of three different aspects: (1) the financial profile; (2) income structure, and; (3) property price behaviour of each REIF. Section 5 concludes.

2 Funds data and market structure

In our study we consider supervisory and statistical reports sent by management companies to the Bank of Italy regarding all REIFs. The dataset contains historical balance sheet information, and portfolio and financial data (see the Bank of Italy (2009)). Furthermore, Euribor, daily data of listed REIFs, Scenari Immobiliari (ISI) and Investment Property Databank (IPD) indexes are obtained from Bloomberg. Unfortunately, there are few data providers on the Italian property market and the time series are relatively short. The analysis of residential properties proposed by Muzzicato et al. (2008) cannot be taken into consideration since most of the funds have only a small part of their portfolio invested in residential properties. The most authoritative data provider in this sector is the Italian Territorial Agency, set up as a consequence of the Ministry of Economy and Finance reform. It holds documents and information related to the real properties register. Other data providers include: Il Consulente Immobiliare, ISI, IPD, and Nomisma. However, since the statistical reports do not contain all the information on the properties characteristics, it is difficult to integrate the property register data with the data at the fund level.

In this paper we propose a method for evaluating the risks of the Italian REIF market, but we neither discuss the appraisal methods used in the valuation of the assets nor do we perform a comparison analysis to check if properties are overvalued or undervalued. In particular, we analyze some characteristics of the market mainly based on the data the Bank of Italy receives twice a year. We follow this approach also because it is based only on certified and homogeneous data.

In Italy, REIF activity involves different entities: (1) the asset management company that manages the fund; (2) the external and independent appraiser, who twice a year evaluates the properties held by the funds; (3) the depository bank which is responsible for keeping the securities and ensuring the fund's liquidity and may also be responsible for the periodic valuation of fund units; (4) finally, the Italian stock exchange for listed funds.

In 1994 REIFs were introduced in Italian legislation. A REIF can be established only after the approval of the fund rules by the Bank of Italy. Fund must to comply with a number of rules regarding investment thresholds and risk concentration, portfolio allocation and the maximum permissible debt ratio (the amount of debt cannot exceed 60 per cent of the value of real estate assets and 20 per cent of other investments). However, exceptions to the prudential rules are provided for funds reserved to qualified investors. Further exemptions are envisaged for the so-called *speculative* (or *hedge*) real estate funds that are allowed to exceed the debt limit of 60 per cent of the value of the property; for these funds there is a minimum subscription of €500,000. The main difference between Italian legislation and that of other countries is that real estate products intended for qualified investors are also subject to prudential regulation even if at times they are more similar to separate accounts than to mutual funds, since some of these funds have a small number of investors. Real estate held by funds are evaluated twice a year by external and independent appraisers. Nevertheless, fund managers remain fully responsible for real estate evaluation and they are not obliged to comply with the appraiser's evaluation.

In order to guarantee small investors the possibility of liquidating their investment in the fund, Italian law states that if the unit is less than €25,000, an application for listing on the Italian Stock Exchange (Borsa Italiana) must be filed within 24 months after the closing of the initial offer.

Operational constraints in the legal regime introduced in Italy in 1994 have hampered the growth of these vehicles. However, since 1999 the legal framework has been modified on several occasions, stimulating the development of REIFs, in particular, through the introduction of favourable tax rules. Also for these reasons, in Italy in the last decade there has been significant growth of these products: the number of funds increased from 3 in 1999 to 281 at the end of June 2010. The history of the Italian REIFs can therefore be divided into two main periods: from 2000 to 2004, when the REIF market was dominated by retail products; from 2005 onwards, when the funds intended for qualified investors sharply increased in number.

Italian REIFs are not subject to IRES (corporate income tax) or IRAP (local tax based on productive activities). However, investors (institutional investors, foundations, public agencies, or private investors not holding more than 5 per cent of the shares in the fund) are taxed at a rate of 20 per cent (compared to 12.5 per cent until 2008) on income derived from participation in the funds. The tax is levied on the basis of periodical reports. In 2008 a wealth tax of 1 per cent of net asset value was introduced for a particular subset of funds, that is, for those with a

Italian real estate investment funds data								
	Dec. 03	Dec. 04	Dec. 05	Dec. 06	Dec. 07	Dec. 08	Dec.09	Jun. 10
All REIFs								
Number	19	31	61	119	174	229	267	281
Total assets	5,141	12,309	18,326	27,248	36,058	42,390	47,517	47,771
Real estate assets	3,718	10,520	15,215	22,110	30,434	36,791	40,936	41,678
Debt	573	3,979	6,019	9,890	13,453	16,630	19,517	19,347
NAV	4,414	8,084	11,859	16,384	21,531	24,446	26,306	26,846
Financial leverage	1.16	1.52	1.55	1.66	1.67	1.73	1.81	1.78
Retail funds								
Number	14	19	23	29	30	29	27	27
Total assets	3,836	6,531	8,057	10,168	10,731	10,185	9,461	9,282
Real estate assets	2,847	5,105	6,407	7,949	8,914	8,591	7,985	7,774
Debt	312	1,301	1,797	2,687	2,960	2,983	2,978	2,915
NAV	3,435	5,108	6,065	7,219	7,547	6,976	6,290	6,159
Financial leverage	1.12	1.28	1.33	1.41	1.42	1.46	1.50	1.51
Reserved funds								
Number	5	12	36	78	116	156	176	179
Total assets	1,304	5,778	9,900	13,641	19,762	26,240	31,176	31,128
Real estate assets	872	5,415	8,472	11,537	16,682	22,665	26,654	27,241
Debt	261	2,678	4,015	5,311	6,931	9,636	11,796	11,529
NAV	979	2,977	5,646	8,023	12,143	15,707	18,155	18,608
Financial leverage	1.33	1.94	1.75	1.70	1.63	1.67	1.72	1.67
Hedge funds								
Number			2	12	28	44	64	75
Total assets			369	3,439	5,564	5,964	6,879	7,361
Real estate assets			337	2,624	4,838	5,535	6,297	6,662
Debt			207	1,892	3,563	4,011	4,742	4,903
NAV			148	1,142	1,840	1,763	1,861	2,080
Financial leverage			2.50	3.01	3.02	3.38	3.70	3.54
SGR number	10	14	26	33	48	51	55	54

Table 1: REIF data. Descriptive and balance-sheet data of Italian REIFs at the end of the months considered from 2003 to 2010. Balance-sheet data are in millions of Euro. Real estate assets are the sum of property values and interests in land; the financial leverage is the ratio between total assets and net asset value (NAV).

small number of participants and for the so-called “family” funds. In 2010 this tax rule was repealed. However, a more restrictive fiscal regime remains for investors (other than institutional investors, foundations or public agencies) holding more than 5 per cent of the shares in the fund.

Notwithstanding the financial crisis, the number of REIFs continued to increase between January 2008 and June 2010. The number of active funds at the end of June 2010 amounted to 281 (27 retail, 179 reserved and 75 hedge, as shown in Table 1). The number of asset management companies managing this type of vehicle was 54 at the end of June 2010. These SGRs mainly belong to banking groups but there are also property market operators (Italian and foreign) and private individuals with professional experience in the field. In recent years, the market concentration has significantly decreased, due to the entry of new operators.

Most of the funds buy properties and lease them, sometimes after significant restructuring initiatives and after enhancing the property portfolio to make them more suitable to lease. However, almost one third of the Italian REIFs are focused on real estate development (we refer to them as *development funds*): during the construction or restructuring phase, the funds bear the cost of debt but do not generate incomes. Thus, the riskiness of these funds may be higher, especially during property market downturns. In the following paragraphs we will consider a subset of 131 funds (27 retail, 82 reserved and 22 speculative) composed of non-development funds operating for at least two years, and we refer to them as *classical* REIFs.

Figure 1: *Site.* Geographical distribution of the REIFs properties.

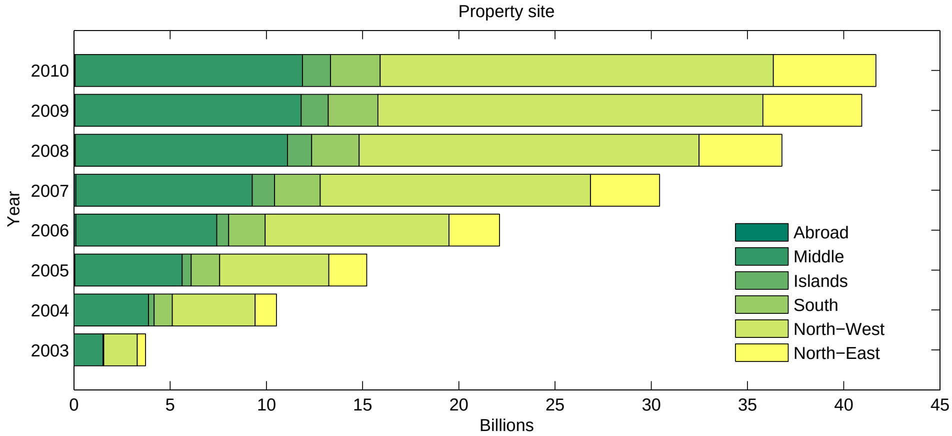


Figure 2: *Destination.* Type of investments of the REIFs properties.

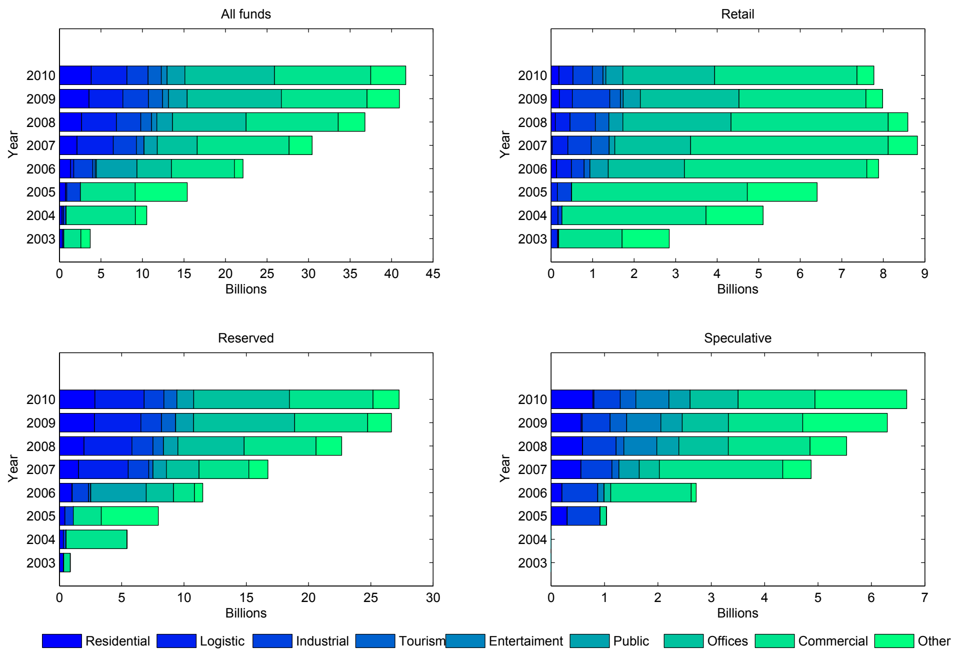
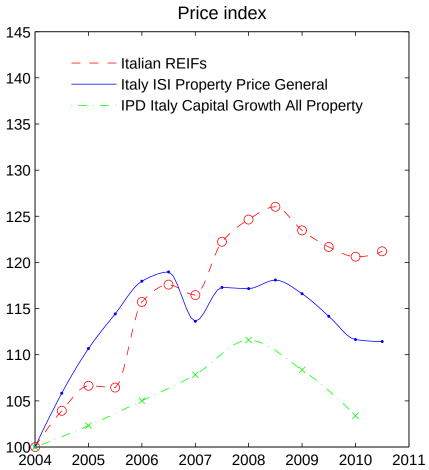


Figure 3: *Property price and total return indexes.* Behaviour of the property price index extracted from the balance-sheet information of all Italian REIFs. The indexes are compared with Scenari Immobiliari (ISI) and Investment Property Databank (IPD) indexes.



In June 2010 the net asset value (NAV) of Italian real estate funds amounted to €26.8 billion (see Table 1),[2] about 10 per cent of the total assets of the Italian mutual funds industry. By size of assets managed, Italy is the fourth European market, after Germany, Holland and Britain, according to Scenari Immobiliari (2010). In recent years, the NAV of the Italian funds has sharply increased (by more than €22 billion from December 2003 to June 2010), mainly reflecting the entry of new funds.

The portfolio of €47.8 billion held by Italian REIFs is mainly invested in properties (87 per cent of the total). These properties are mostly situated in Italy and only a small fraction is in other countries. Figure 1 shows that investments are concentrated in the central areas or in the North-West. Furthermore, over 90 per cent of the value is attributable to property for non-residential use (such as offices and assets for commercial, industrial and logistic use). As far as the sector risk is concerned, there are no discernible differences in terms of characteristics of real estate assets among the different types of real estate funds (retail, reserved and hedge). However, retail funds are highly focused on offices and commercial properties and less so on the residential ones, as shown in Figure 2. In recent years, interest in the tourism and entertainment sector has grown.

Figure 3 shows the behaviour of the price and the total return indexes of Italian REIFs with their basis equal to 100 at the end of 2003. The indexes are computed using REIFs balance-sheet data, according to the procedure described in Section 3.1. The price index is compared with the Italy ISI Property Price General Index developed by Scenari Immobiliari and the IPD Italy Capital Growth All Property Index developed by IPD. We then compare the total return index with the IPD Italy All Property TR developed by IPD. The differences in the trends of the indexes may be due to the composition of the real estate assets in the portfolio

[2] In December 2010 and in December 2011, the NAV increased to €28.6 billion and to €31.8 billion, respectively.

considered in the indexes construction.[3]

2.1 Listed real estate funds in Italy

In this section we briefly describe the secondary market of the Italian listed REIFs. On 31 October 2010 there were 23 retail REIFs traded on the Italian stock exchange (in the *telematic market of investment vehicles* - MIV). Critical aspects of listed real estate funds include their frequent lack of liquidity caused by a small number of trades, which can have a distorting effect on price formation mechanisms; marked differences between bid and ask prices; and situations of extreme volatility when specific events occur. Various liquidity indicators confirm that there is a limited liquidity in the market where these products are traded. A second feature of the market price of the shares of Italian REIFs, strictly related to liquidity, is the difference between market prices and their book values. The market prices are systematically lower than the NAV indicated in the balance-sheet report of the funds: this phenomenon is known as *NAV discount*. This discount usually appears after the fund's listing and tends to decline (and the market price to converge to the NAV) during the winding up before the shares are repaid to subscribers.

If we recall that the net asset value (NAV) is defined as the difference between total assets and total liabilities of the funds, then the NAV discount at time t is defined as

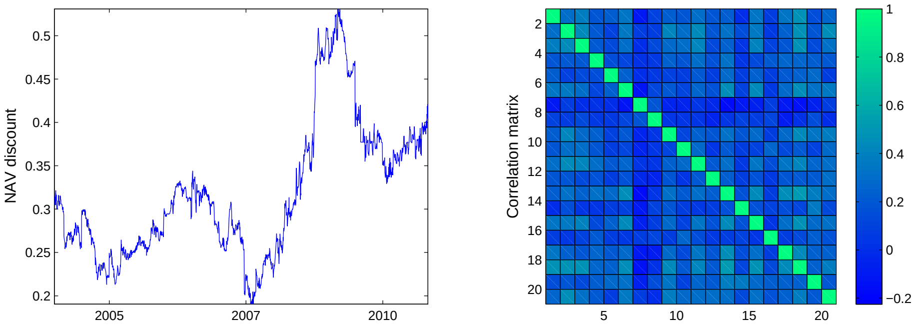
$$D_t = 1 - \frac{M_t}{NAV_t} \tag{1}$$

where M_t and NAV_t indicate the market price and the NAV at time t, respectively. The median of the so called NAV discount from 31 December 2003 to 31 October 2010 is drawn in Figure 4. In Italy the gap between the market price and book value of shares is large on average; during the crisis it widened significantly, reaching levels of above 50 per cent, and at the end of the period considered it was around 40 per cent. During market downturns the REIF market was highly correlated to the stock market: this relation has not been always true in the past. Only a few research papers have studied the Italian market of listed real estate funds, principally in order to explain the NAV discount (see Morri and Benedetto (2009) and Biasin et al. (2010)). Liquidity, operating costs and fees, funds' characteristics, and financial leverage are all factors that drive the dynamics of the discount (see also Schweizer et al. (2011)). However, even if academia has proposed different explanations for this market phenomenon, discussions with financial practitioners as to why this discount exists suggest that there is no general consensus on the matter and it remains a puzzle.

In general, the correlation between REIF returns is positive. Figure 4 shows the heat map related to the correlation matrix estimated by considering weekly REIF returns of 21 funds from 11 December 2006 to 31 October 2010. The figure shows that there are two funds that are less correlated to the market in comparison with all the other remaining funds (see in Figure 4 the darkest vertical lines corresponding to the 7-*th* and 8-*th* fund). A principal component analysis (see Rachev

[3] For more details readers are referred to the Investment Property Databank (2008) and `http://www.scenari-immobiliari.it`.

Figure 4: *Listed Italian REIFs.* The median of the NAV discount is shown on the left side. The correlation matrix is reported on the right side. The correlation is computed by considering weekly total returns of 21 funds from 11 December 2006 to 31 October 2010.



et al. (2007)) on funds' returns[4] shows that the first three principal components account for 49 per cent of the variation, indicating that common drivers govern only half of the variation and other factors specific to each single fund drive the remaining variation.

3 Estimation of returns, costs and risk parameters

Our risk analysis requires the preliminary estimation of certain parameters. As observed in Section 2, the historical time series of property prices available from data providers cannot be used in this context. In order to overcome this lack of data, one solution is to compute the indicators of interest directly from REIF supervisory and statistical reports by considering the methods proposed in the following sections. More precisely, in Section 3.1 we propose a method for extracting price and total property returns, at fund and at sector level, and in Sections 3.2 and 3.3 we consider some useful indicators computed by looking at balance-sheet information.

3.1 Property prices, total returns and volatilities

REIF returns are required to estimate important parameters, such as the real estate price rate of growth as well as price volatility (see Baroni et al. (2007)). In our analysis, they are computed from the time series of property values, purchases and sales, rents and property costs, by considering for each single fund the following criteria

$$r_t \approx \log\left(\frac{P_t + S_{[t-1,t]} + L_{[t-1,t]}}{P_{t-1} + B_{[t-1,t]}}\right) \tag{2}$$

where r_t is the return of a certain fund between time $t-1$ and t, P_t and P_{t-1} are the total value of real estate assets at time t and $t-1$, $S_{[t-1,t]}$ is the value

[4] Returns are computed by considering daily market quotes of funds traded on the Italian stock exchange.

of real estate assets sold between $t-1$ and t, $B_{[t-1,t]}$ is the value of real estate assets bought between $t-1$ and t, and $L_{[t-1,t]}$ are the rents between $t-1$ and t net of all property costs. A similar formula was applied by Investment Property Databank (2008). If one assumes for the numerator of the ratio in equation (2) that the component $L_{[t-1,t]}$ is equal to zero, the price return is obtained, otherwise the total return is computed. In practice, it is possible to calculate both price and total returns.

As a consequence, we can compute a volatility σ_P, related to the price returns, and a volatility σ_{TR} related to the total returns. In the risk assessment process described in Section 4.3.2, we will consider only price returns.

Furthermore, we use the formula in equation (2) to compute a price index of the Italian REIF sector and a total return index (see Figure 3). This means that we use the previously defined variables P_t, P_{t-1}, $S_{[t-1,t]}$, $B_{[t-1,t]}$, $L_{[t-1,t]}$ by considering data on all Italian REIFs, instead of at the single fund level. As done for each single fund, we take into account only the property values in the computation of the price index (indeed, we assume $L_{[t-1,t]} = 0$), and we consider the rents net of all property costs in the computation of the total return index.

3.2 Cash flows and other indicators

In this section we empirically study some indicators useful in describing different aspects of funds' cash flows. Some of the indicators we compute depend strictly on the portfolio trading activity (property purchases and sales), therefore we will consider the mean values of the real assets in the portfolio (NAV and debt, respectively) of each fund between the time $t-1$ and t, and we refer to it as $\overline{P_{(t-1,t)}}$ ($\overline{NAV_{(t-1,t)}}$ and $\overline{Debt_{(t-1,t)}}$, respectively). The subscript $(t-1,t)$ means that the average of the two values at time $t-1$ and t is taken, and, similarly to Section 3.1, the subscript $[t-1,t]$ refers to the flow between $t-1$ and t. The variables we examine are defined as follows:

$$I_{Rent_t} = \frac{Rent_{[t-1,t]}}{\overline{P_{(t-1,t)}}},$$
$$I_{Expenses_t} = \frac{Expenses_{[t-1,t]}}{\overline{P_{(t-1,t)}}}$$

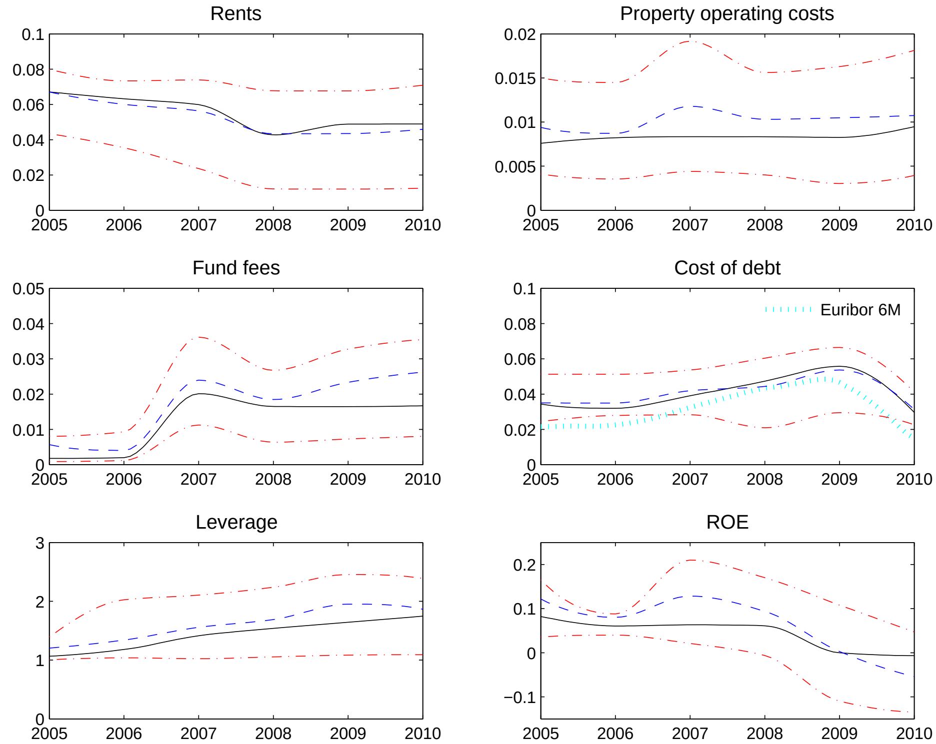
measure the percentage of rents and total property expenses with respect to the mean value of properties between the time $t-1$ and t;

$$I_{Fees_t} = \frac{Fees_{[t-1,t]}}{\overline{NAV_{(t-1,t)}}},$$
$$ROE_t = \frac{Profits_{[t-1,t]}}{\overline{NAV_{(t-1,t)}}},$$

measure the percentage of total fund fees and the *return on equity* (ROE) with respect to the mean value of NAV from $t-1$ to t;

$$I_{CostOfDebt_t} = \frac{CostOfDebt_{[t-1,t]}}{\overline{Debt_{(t-1,t)}}}$$

Figure 5: *Cash flows and other indicators*. Indicators based on rents, expenses, fund fees, cost of debt, leverage and ROE behaviour from the end of 2004 to the end of 2009 (as defined in Section 3.2). The median values are in black, the mean values in blue, and the strips between the red lines contains 70 per cent of the analyzed funds. Non-development funds active for at least two years are considered. One-year moving average of the 6 month Euribor is reported in the chart of the cost of debt.



is the cost of debt defined as the ratio between the interest paid and the average amount of debt between the time $t-1$ and t; finally,

$$Leverage_t = \frac{TotalAssets_t}{NAV_t},$$

is the financial leverage, that is the well-known ratio between the total assets and the net asset value.

These indicators measure the earnings and the expenses, fees and financial costs, the fund's profitability and the level of indebtedness with respect to the invested capital. The indicators dynamics from the end of 2004 to the end of 2009 are shown in Figure 5: the median values are in black, the mean values in blue, and the strips between the red lines contain 70 per cent of the analyzed funds. In these pictures classical REIFs active for at least two years are considered. We point out that the more extreme values (the quantiles) may be affected by the changing financial structure between $t-1$ and t. Retail funds have shown larger and more stable values of I_{Rent_t} with smaller leverages. It is interesting to see the trend of the one-year moving average of the Euribor 6 Months compared to the median cost of debt of REIFs: the spread is not far from constant over time. We also find that the ROE relative to retail products has been in general less volatile, although it has suffered from the negative cycle in recent years. However, in the long-term it remains, in most cases, positive. As expected, the recent financial crisis has affected both the financial drivers and the market value of REIF assets.

3.3 Profitability indicators

In this section we compute the internal rate of return (IRR) of investors as the rate $r_{Investors}$ which satisfies the following equation

$$NAV_0 = \sum_{i=1}^{n} \frac{Div_{t_i}}{(1 + r_{Investors})^{t_i}} + \frac{Asset_T - Liabilities_T}{(1 + r_{Investors})^T}. \qquad (3)$$

where $t_0, t_1, \ldots, t_n = T$ are the time steps (the end of each semester) and Div_{t_i} the dividends received at time t_i. This rate strictly depends on the final value of the total asset $Asset_T$ and on the fund's performance during its life. There are two possible approaches that can be taken in order to evaluate these rates: (1) we can compute a current IRR based on the historical observed data up to time T, $Asset_T$, $Liabilities_T$, and Div_{t_i} (that is, a deterministic or realized IRR); (2) we can use historical observations to simulate future values of the variables of interest $Asset_T$, $Liabilities_T$, Div_t with $t > T$ (that is, a stochastic or expected IRR).[5] In equation (3) it is implicitly assumed that $Asset_T$ is a correct estimate of the property portfolio value, thus, that a cash amount equal to $Asset_T$ can be obtained by selling all properties. For listed funds, the initial investment may not necessarily be equal to NAV_0, since fund shares can be bought at time s (with $s > 0$) at price $M_s < NAV_0$. Furthermore, investors can sell their shares at time t before the fund liquidation at time T with $t < T$, and, thus, in equation (3) the market price M_t has to be considered instead of $Asset_T - Liabilities_T$.

The IRR depends on the fund's capacity to generate positive incomes. In any case, it measures only the profitability of the investment without taking into consideration its risk factors (e.g., leverage, geographical and sector risk). Nor is it a proper performance measure, because it is not adjusted for the risk of the real estate portfolio.

The estimates of the current IRR for all 131 classical REIFs show a median annual value of 2.43 per cent (25^{th} quantile -2.35 per cent and 75^{th} quantile 8.62 per cent) for $r_{Investors}$. We obtain more positive rates with respect to negative ones, indicating, with some exceptions, a positive performance over the observed period. The presence of funds with final NAV much smaller than the initial NAV, mainly due to the impairment of property values, heavily affect the mean values estimate. As shown by the above estimates, the IRR distributions are asymmetric with some negative tail events. Furthermore the IRR value also depends on the market situations when the funds start being operative or when the fund has to be liquidated.

[5] If considered at property level, this second approach can be particularly useful for property valuation, as outlined by Hoesli et al. (2006).

4 Risk measurement

REIFs are exposed to different types of risk. As already observed, property and economic risks, connected with the real estate market, have to be analyzed by taking into consideration the financial structure of the fund and credit market conditions. As far as the financial structure is concerned, one crucial variable is leverage, i.e. the ratio between total assets and NAV. This variable differs among REIFs: at June 2010 leverage was 1.51 for retail REIFs, 1.67 for reserved REIFs and 3.54 for speculative REIFs. Lenders are exposed to high levels of credit risk caused by highly leveraged funds. Moreover, they are exposed to interest rate risk. From the fund's perspective, there are loans that, more then others, could condition the ordinary fund management: short-term loans, which may be not renewed at maturity, and loans with covenants (see Section 4.1). Fund managers must pay attention to these constraints and to the economic and financial equilibrium of the fund both during its life and when it is liquidated (and its units have to be repaid). A REIF may opt to extend its maturity: it is no longer necessary to ask the Bank of Italy for a "grace-period" during which the SGR can complete the sale of the properties but cannot implement new investments. Indeed, before the expiry of the fund, by resolution of the board of directors and with the assent of the committee of subscribers, the SGR can deliberate an extension of the fund not exceeding three years. As we pointed out in Section 2, there are also risks associated with funds' operational features. Developing funds are usually riskier than classical ones and negative real estate cycles may exacerbate their risk. During construction and revaluation phases, a developing fund bears debt costs (the mortgage may depend on the percentage-of-completion of the works) but do not generate revenues; thus, it is more exposed to potential shocks. Revenues are generated when the properties are sold.

In general, the risks of investing in real estate assets are of various kinds and principally depend on:

- the real estate market price volatility;
- the level of liquidity of the market (like the first factor, connected to the type and location of properties);
- the level of indebtedness of the fund;
- the structure of loans (principally their maturity, interest rate type - fixed or variable -, and the existence and type of financial covenants);
- general and local economic conditions;
- credit risk associated with the tenants;
- volatility of interest rates and availability of financing;
- changes in laws and regulations;
- legal risk;

- unforeseen damages.

A proper assessment of REIF risks should take into consideration all of the above. As already discussed, we do not perform a property-by-property analysis, but rather we study the REIF sector as a whole. For this reason, we have defined some financial indicators, which allow us to monitor the trend of the entire market. We do not specify property type in our study since only a small portion of the investments are focused on certain sectors, and we do not directly measure the credit risk associated with tenants. However, part of this risk can be analyzed through data related with rents.

To estimate the intensity of most of these risks and their interrelation, in the following Sections 4.1, 4.2 and 4.3, we analyze: (1) the financial profile of the funds, by focusing our attention on the debt structure; (2) the income structure by looking at inflows and outflows, and finally; (3) the market risk of property values in connection with the fund's liabilities. Based on the results, we can analyze the sustainability of each single fund as well as of the entire REIF sector.

4.1 Financial profile

The analysis of the REIF financial structure must consider three different aspects:

1. short-term financial positions in respect of expected short-term cash flows;

2. short-term loans as a proportion of total loans;

3. loans with covenants in respect of total loans, and, for each fund, analysis of covenants and their possible financial impact.

A covenant is a sort of promise in a debt agreement. A loan agreement may contain covenants that deal with financial ratios. In order to comply with the agreement, the borrower is required to maintain one or more financial ratios above or below a stated threshold. If a covenant is breached lenders can exercise their right to demand repayment before the loan's normal maturity date. The most commonly used financial ratios are the loan-to-value ratio (total loans / property fair value) and debt service coverage ratio (net operating income / debt service). If, on the one hand, covenants mitigate the credit risk borne by lenders, on the other hand in difficult situations the manager may be forced to sell assets in order to obtain liquidity to repay the loan. From this perspective, covenants can be seen as an additional source of risk for the REIF. Moreover, unexpected and protracted contractions of real estate prices may trigger financial covenants in the borrowing agreements between banks and REIFs, and could in theory lead to serious financial difficulties not only for REIFs but also, to some extent, for the lending banks.

Maturity gaps (calculated by considering both balance-sheet data and expected cash flows), a high percentage of short-term loans and loans with financial covenants with respect to total loans weaken the financial structure of a fund and indicate liquidity needs. Liquidity can be obtained in different ways: by restructuring the loans or underwriting new loans (credit capital), by recalling the commitments undertaken by investors (equity capital), or by selling property assets. Especially during market downturns, credit and equity capital is expensive and difficult to find, and, if the property market becomes illiquid, the forced selling of property assets may be particularly disadvantageous.

A weak financial profile does not necessarily indicate a disequilibrium. Consequently, this financial analysis is intended as a tool for the detection of REIFs requiring in-depth supervision, to clarify their real financial situation. An illustration of how this kind of indicators is used by the supervisory authority for Italian REIFs can be found in Bank of Italy (2010a, pp. 229 and 251–252), Bank of Italy (2011a, p. 249) and FSB (2011, pp. 36–38).

4.2 Income structure

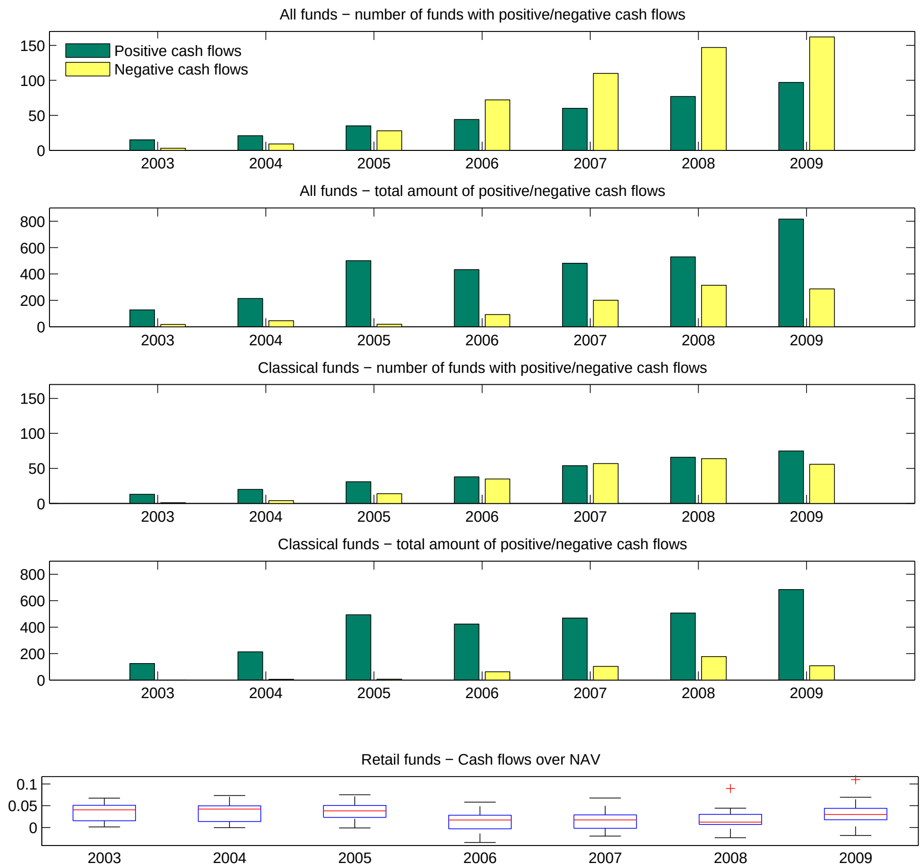
In this section we focus on ordinary cash flows, to measure the funds capacity to generate positive incomes. In practice, we look at the difference between inflows and outflows: for classical REIFs, rents are the major source of inflows, while operating expenses and interest payments are the major source of outflows. For each fund, we extract this difference from the financial statement and check whether it is positive or not. A fund registering a negative value for more than one year shows a weak income structure, and cash flows may be compromised to the extent that the property asset no longer services the debt. We point out that during the start-up of the fund, this difference can be negative and turn to positive as the fund becomes fully operational. In general, a fund with a inflows-outflows mismatch is on the way to encountering financial problems and may need capital.

In Figure 6 we report the number of funds with positive and negative ordinary cash flows and the total amount of these cash flows observed in the period between 2003 to 2009.[6] The sign of the cash flows depends also on the structure of the fund: most retail funds present positive values, while most of the remaining funds present negative values. As shown by some development REIFs, negative values can be compensated by an appreciation of the property portfolio (this can also be true for some classical REIFs). Classical REIFs present better cash flows than the whole sector. However, also for the whole sector the amount of positive cash flows has always been greater than that of the negative ones, showing a positive performance of the Italian REIF market as a whole. In Figure 6 (below) we report the boxplot of the ratio between cash flows and NAV for retail funds: they present, in some cases, a positive performance over time. The same may not be true for those funds having a shorter period of activity and with a different investment strategy with respect to retail funds.

Here we analyze historically observed cash flows. We do not take into consideration future cash flows estimated in the business plan within a time horizon of 12 or 24 months. An analysis of this kind can be conducted only if we have access to prospective property-by-property data. For an application to 2009 data on Italian REIFs, see Bank of Italy (2010a, pp. 229 and 251–252).

[6] The analysis was conducted before the 2010 data became available.

Figure 6: *Cash flow analysis.* Ordinary cash flows are defined as rents minus operating expenses and interest payments. The first four charts (from the top) show the number of funds (all and classical funds) with positive and negative cash flows and the total amount (in millions of Euro) of these cash flows. On the bottom the box-plot of the ratio between cash flows and NAV for retail funds is shown: on each box, the central mark is the median, the edges of the box are the 25th and 75th percentiles, the whiskers extend to the most extreme data points not considered outliers, and outliers are plotted individually.



4.3 Property analysis

4.3.1 Default probabilities using Monte Carlo methods

The forecasting of the future behaviour of the price of financial instruments is an essential activity in the implementation of risk management and portfolio allocation. Monte Carlo methods are a widely used tool to forecast the future dynamics of these instrument: the risks of an investment are usually inferred from past observed patterns. Even if the limitations of this method have been well documented in the academic literature, as well as among regulators and risk managers, in most cases it is the only way to proceed. Monte Carlo methods, also known as stochastic simulation (or scenario generation) methods, have been widely studied and applied to finance, principally to price financial instruments, and to risk evaluation and portfolio allocation (see Jäckel (2002) among others). Furthermore, these methods have been used successfully to deal with uncertainty in valuing real estate assets (see MacFarlane (1995) and Hoesli et al. (2006)).

The structural model proposed by Merton (1974), and enhanced by Black and Cox (1976) is widely used among practitioners and ratings agencies (see Dwyer and Qu (2007), Liu et al. (2007a) and references therein) and has also been applied to real estate finance by Liu et al. (2007b) and Kau et al. (2009) to estimate default probabilities of commercial mortgages. In the empirical study we analyze a contingent-claims model where the trigger event is given by the first time the property value falls below the debt value (see also Capozza et al. (1998)). Given the property value at time t, the trigger event is defined as the time τ such that

$$\tau = \inf\{t > 0 | A_t \leq D_t\}, \tag{4}$$

with the asset value process A_t and the debt process D_t defined as

$$\begin{aligned} A_t &= A_0 e^{mt+X_t} \\ D_t &= D_0 e^{rt} \end{aligned} \tag{5}$$

where r is the cost of the debt, X_t is a given process with zero mean and m describes the trend of the process A_t. We consider two distributional assumptions for the modeling of X_t: (1) a classical model, where asset returns are normally distributed; (2) a non-normal model, where asset returns are distributed according to a normal inverse Gaussian (NIG) distribution (see Appendix A). Since balance-sheet reports are available only twice a year, we consider a discretely monitored framework and the default can occur only at the end of the semester. The default probability (PD) is defined as

$$P_{default}(T) = P(\tau \leq T); \tag{6}$$

where T is a given time, in our case three years. The PD is a function of the property assets and of the net debt: the former behaves randomly, the latter is a deterministic function of the time t. In practice, there are two approaches to computing the default probability, involving the performance of: (1) a Monte Carlo simulation algorithm and checking at the end of each semester if the asset value is above or below the debt value; (2) a backward induction, making it possible to compute the default probability using a recursive form. However, we do not apply this second method in our empirical study, since we deal with only six monitoring dates. If there is the possibility of considering a larger number of monitoring dates, it may be useful to employ more sophisticated methods to evaluate equation (6), as described by Kou (2008).

We point out that if the REIFs are sorted by increasing leverage or by increasing PD, the same ranking is obtained. However, the PD analysis allows us to measure the credit risk with respect to different scenarios.

With regard to the dataset used for the PD computation, we emphasize the following. In theory, three different sources of randomness should be considered: one driving real estate prices, two driving cash flows (respectively, positive and negative). Nevertheless, we do not have a sufficient number of data at our disposal in order to estimate a model that assumes three different random variables. For this reason we implemented the model by assuming only one source of randomness. In practice, we use only one random variable that drives the behaviour of price returns and we make a simple assumption about the cash flows' behaviour. Indeed, cash flows are implicitly assumed to be a deterministic function of the time t and they can only influence the trend of the assets (m in equation (5)). As described in Section 4.3.2, we assume various stress values for the parameter m. In a way, these stress scenarios on m also incorporate a stress on the cash flows. Moreover, we suppose that the fair value of the properties, estimated taking account of independent appraisers' evaluations, reflects the revenues that can be derived from the sale of the properties. We do not consider possible estimation errors in the model. Nor do we consider illiquidity or instability in the real estate or credit markets, which can reduce the proceeds of sales compared with the balance-sheet value. These uncertainty factors are intended to be incorporated into the stress scenarios. Finally, we assume a stress situation where investors are unable to meet the underwriting commitments and debt includes only the liabilities directly attributable to the funds, but not the debt of the subsidiaries.

4.3.2 The empirical study

In our empirical study we estimate the model parameters by considering the optimization problem described in the Appendix (see equation A.5). Funds property price returns are computed according to equation (2). Since we consider half-yearly data between December 2003 and June 2010, we have no more than 14 observations for each fund and even if we can draw the trend of the price returns, we cannot perform a model calibration, since a larger number of data is needed to obtain a reasonable parameter estimate. For this reason, by discarding the time component, we merge all the data for each sector (retail, reserved and hedge) in order to obtain three datasets and then calibrate the mode. For completeness, we also consider the set of all funds and the subset of classical funds. We are aware that we make a restrictive and strong assumption that could lead to more variability in the returns of less risky funds and, at the same time, less variability in the returns of more risky funds. However, this is a practical way of dealing with the lack of data and obtaining a statistical consistency: as observed above an estimate with 14 observations is not reliable.

Errors between the empirical and fitted cumulative distribution function are

Figure 7: *Estimated densities.* Estimated density functions for the normal and NIG models from 31 December 2003 to 30 June 2010 related to classical REIFs.

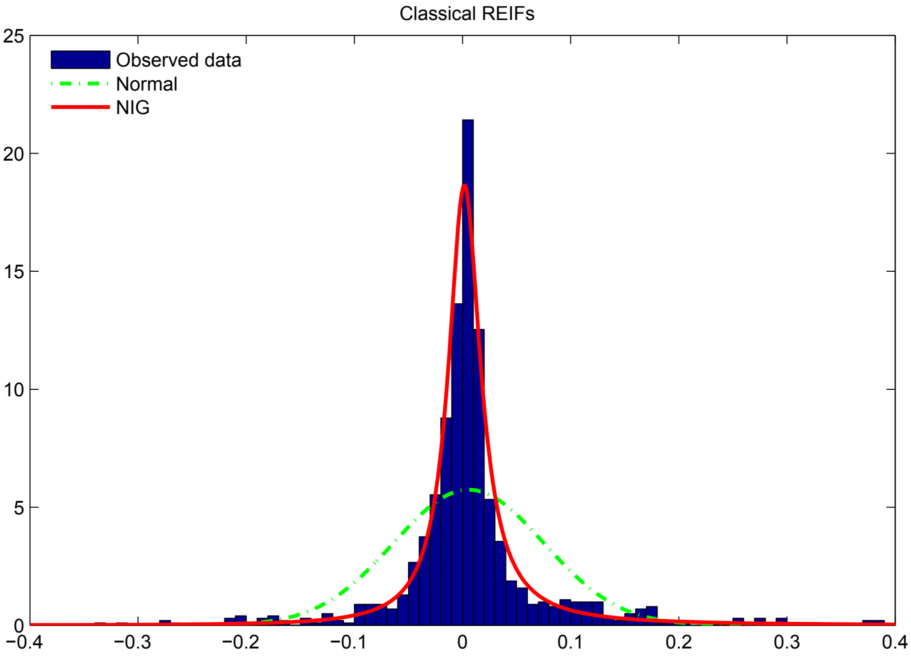
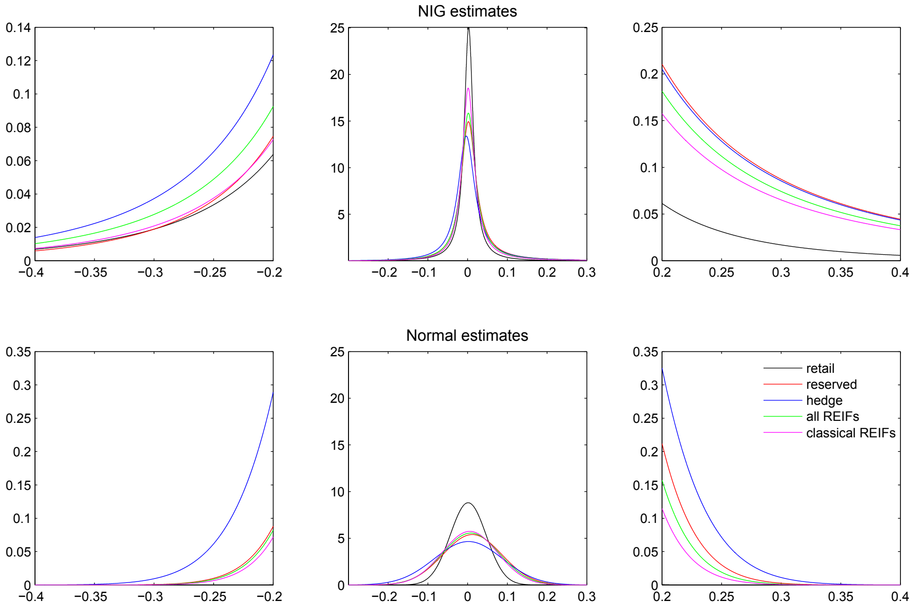


Figure 8: *Normal vs NIG.* Estimated density functions and tail behaviour for the normal and NIG models from 31 December 2003 to 30 June 2010 related to retail, reserved, hedge, all and classical REIFs.



Property returns estimates							
			Normal based model				
	m	σ			annual volatility	KS	$p-$value
retail	0.0014	0.0453			0.0641	0.1871	0.0000
reserved	0.0120	0.0739			0.1045	0.1700	0.0000
hedge	0.0022	0.0858			0.1213	0.1776	0.0000
all	0.0083	0.0718			0.1015	0.1819	0.0000
classical	0.0056	0.0695			0.0982	0.2033	0.0000
			NIG based model				
	α	β	m	δ	annual volatility	KS	p-value
retail	5.8027	-0.2866	0.0027	0.0136	0.0686	0.0300	0.9378
reserved	4.4971	2.5000	0.0014	0.0229	0.1331	0.0351	0.1537
hedge	3.5057	1.5000	-0.0038	0.0255	0.1402	0.0480	0.5314
all	3.6151	1.5929	0.0015	0.0213	0.1277	0.0316	0.0788
classical	3.7827	1.8634	0.0011	0.0181	0.1204	0.0272	0.4352

Table 2: *Historical parameter estimation.* Estimated parameters of the property value processes for the normal and NIG models from 31 December 2003 to 30 June 2010 (half-yearly data). From m, we can compute the value of μ. The volatility is annualized and the $p-$values of the KS statistic are reported. The $p - value$ indicates the "plausibility" of the null hypothesis *"the values come from a normal (respectively, NIG) distribution"* ; the smaller the p-value, the less plausible the null hypothesis. The low number of observations may affect the goodness of fit.

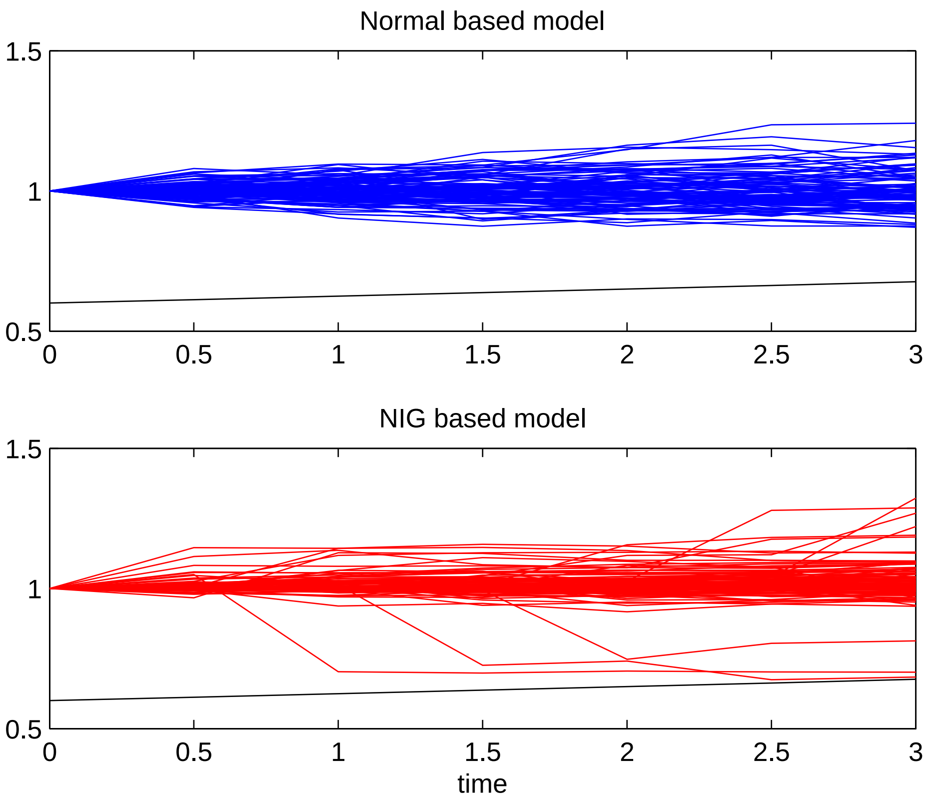
smaller in the NIG model, when the asymmetry and the leptokurtosis are captured. The normal model clearly underperforms its competitor, at least for the data investigated here. According to Table 2, in the NIG model the values of the goodness of fit statistics KS are smaller than those of the normal model. Furthermore, we report the p-values of the related test with the following null hypothesis:

H_0: the values come from a normal (respectively, NIG) distribution.

Figure 7 shows that the empirical density more or less deviates from the normal density and this deviation almost disappears when we use a NIG model. Figure 8 shows the tail behaviour of the estimated densities with respect to different types of funds. The probability of extreme events (both negative and positive) is lower for retail funds, and, as expected, hedge fund losses can occur with a greater probability than for other funds. The normal based model gives very small weights to large deviations from the mean. In the NIG distribution case, even if the estimate may be influenced by the small number of observations, the model calibration offers very promising results. Similar results could be obtained by considering other non-normal distributions, such as the family of tempered stable distributions (see Rachev et al. (2011)). However, without going into technicalities, we consider the NIG distribution, since it is simpler to understand from a practical and computational point of view.

In order to evaluate (6), we assume that D_t is equal to the difference between total liabilities and non-property liquid assets, and we refer to it as *net liabilities*. The initial value of D_t (that is, D_0) is extracted from balance-sheet data. Liquid

Figure 9: *Monte Carlo simulation.* Simulated paths of the normal and NIG based models with $A_0 = 100$, $D_0 = 60$ and $r = 0.04$ ($m = 0.0014$ and $\sigma = 0.0453$, in the normal case; $\alpha = 5.8027$, $\beta = -0.2866$, $m = 0.0027$, and $\delta = 0.0136$, in the NIG case)



assets can be sold in distressed periods in order to repay the debt; conversely, property assets are more difficult to liquidate.

By considering data on the interest expenses paid by funds on their variable rate loans in 2009, we estimated the parameters α and β of the following linear function

$$spread = \alpha + \beta LevRE, \tag{7}$$

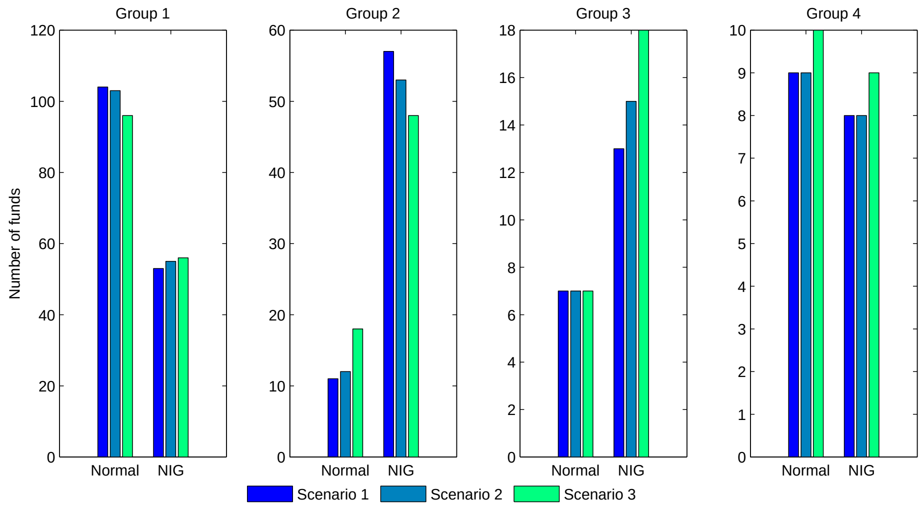
where *spread* is the spread over Libor paid by each fund and $LevRE$ is the real estate leverage, that is the ratio between the property assets and net liabilities. The estimated value of α and β have been used to compute the constant interest rate r used in the Montecarlo simulation

$$r = r_{IRS-3Y} + \alpha + \beta LevRE, \tag{8}$$

where r_{IRS-3Y} is the one-year moving average value of 3Y Euro Swap (at 30 June 2010 it was equal to $199.73bp$), $\alpha = 85bp$ and $\beta = 22bp$. The equation allows us to determine, for each fund, a specific value of r. The values of α and β estimated for 2009 were used also in an update of this analysis carried out on data on 2010.

In the simulation study we compute the default probabilities defined in equation (6) by generating 500,000 paths for each single fund (the computational time is only a few seconds on a Pentium D processor-based PC). We consider three sets

Figure 10: *Simulation analysis.* Three-year default probabilities (PDs) under the normal and the NIG assumption. For each scenario, PDs are divided into 4 groups: (1) PD equal to 0 – very low risk; (2) PD between 0 and 0.001 – low risk; (3) PD between 0.001 and 0.1– medium risk; (4) PD greater than 0.1 – high risk. The number of funds in each group and for each scenario is reported. Only classical REIFs are considered for a total of 131 funds.



of parameters, one for each type of fund (retail, reserved, and hedge). Figure 9 shows possible paths of the net liabilities and of the property asset value by considering the estimate based on retail funds data. To estimate the impact of a hypothetical fall in property prices on the capital adequacy of the funds, a stress test is conducted to determine the probability that the value of real estate assets will fall below net liabilities within three years. In practice, estimates reported in Table 2 for retail, reserved and hedge funds and three possible *stress* parameters for the mean are considered to define three possible scenarios:

(Scenario 1) parameters in Table 2 are used without any correction to simulate the process in equation (5);

(Scenario 2) parameters in Table 2 and $m' = m - 0.0125$ are considered to simulate the process in equation (5);

(Scenario 3) parameters in Table 2 and $m' = m - 0.025$ are considered to simulate the process in equation (5).

Scenarios (2) and (3) correspond to an additional yearly drop (in mean) of the process of 2.5 per cent and 5 per cent, respectively: in this sense, m' is defined a *stress* parameter.

As a first step, we limit our analysis to funds operating for at least two years and which are not involved in real estate development (classical REIFs), for a total of 131 funds. In Figure 10 funds are grouped by default probabilities and by scenarios. We define 4 different groups: (1) PD equal to 0 - very low risk; (2) PD between 0 and 0.001– low risk; (3) PD between 0.001 and 0.1 – medium risk; (4) PD greater than 0.1– high risk. The two proposed models present slight differences for more risky funds with PD greater than 0.1. However, the left tail of the NIG distribution predict a greater number of possible defaults for low and medium risky funds, that is for funds with a PD between 0 and 0.1. As expected, under Scenario 3, the number of funds with PD greater than 0.1 increases.

Then, we extend the analysis to all REIFs. We find that, assuming particularly adverse property market conditions, with an annual decrease of 5 per cent for all funds with respect to the average real estate price growth value between December 2003 and June 2010, the PD of 12 funds on a total of 281 exceeds 20 per cent (very high risk).[7] There is an improvement with respect to the corresponding year-earlier period: a similar analysis with older data (June 2009) showed that the PD of 22 funds exceeded 20 per cent. The improvement in the 12-month interval between the two stress tests seems mainly linked to a leverage reduction of developing funds as a result of supervisory action.

To conclude, the analysis found that for a number of funds the capital position was vulnerable to very adverse real estate market conditions. These risk indicators have of course to be integrated with other types of information, like for example other balance sheet data or the planned structure of investments over a long horizon (available in the business plan). More importantly, it has to be integrated with day by day supervisory activity. For a review of the results of supervisory activity of REIFs in Italy in recent years, see Bank of Italy (2010a,b, 2011a,b), Baldinelli (2011), Rinaldi (2011) and FSB (2011).

5 Conclusions

In this paper we studied the Italian REIF industry from various perspective. First, we described the structure of the sector in the period between 2003 and 2010, by looking at property price behaviour, by computing REIF property price returns, and by constructing property return and total return indexes. The proposed indexes are computed by considering only REIF data without any other data source. Then, we analyzed some indicators that can enhance our understanding of risks and returns that characterize this sector. The performance of these investment products was satisfactory before the financial crisis, albeit with some exceptions. The recent global financial meltdown has led to shrinking net operating income, registering losses in both property values and cash flows; returns have been affected by the recession, since funds invest mainly in non-residential properties, whose value is particularly sensitive to economic performance. Furthermore, in the evaluation of the funds' future performances one has to take into account the possible differences between balance-sheet values and selling prices as a result of disinvestment.

The Italian REIF sector is studied from: (1) a financial; (2) a profitability, and; (3) a property value perspective. Balance-sheet and report data have been used to find the funds with a weak financial structure, to measure fund returns over an observed period and to estimate the probability that the property portfolio of the

[7] The stress test reported in Baldinelli (2011) and Rinaldi (2011) hypothesized slightly different stress parameters. Under those hypotheses the number of funds with PD greater than 20 per cent was equal to 9 on a total of 281.

funds will fall below net liabilities (defined as the difference between debt and liquid assets) within three years. These three aspects can been integrated to define a risk indicator that can be useful for investment analysis and, more importantly, for surveillance purposes. As outlined in the paper, these quantitative aspects are of interest in the risk assessment process, but they must be considered as the starting point for an in-depth analysis. The selection of risky funds allows us to examine not only the REIFs but may also help evaluate the management capability of the SGRs.

In 2009 the Bank of Italy conducted a risk assessment of all Italian REIFs based on both supervisory and statistical reports and an ad-hoc data request. The purpose of the assessment was to select the riskiest funds, in order to submit them to a particularly in-depth supervision analysis. By applying two different criteria (funds with very high PD or funds showing weakness in two of the three analyses), we employed a selection process that took into account the interrelations between structural and market risks. At that time, the property position analysis allowed us to find 22 funds with a PD higher then 20 per cent.

In the work carried out with more recent data (June 2010) the empirical study showed that there were 12 funds with a PD higher then 20 per cent. The improvement in the 12-month interval between the two stress tests seems mainly linked to a leverage reduction of developing funds.

Finally, focusing on the property value analysis, the empirical analysis showed that the use of the normal based model to estimate the REIF return distribution is rejected by some classical statistical tests. A NIG based model is calibrated on historical data and used to compute a Merton type default probability. The proposed model is able to generate large shocks (positive or negative) and consequently also less leveraged funds can default, albeit with a low probability. Furthermore, Monte Carlo NIG simulation of paths has a computational cost comparable to the normal based model.

A Appendix – The *normal inverse Gaussian* distribution

In this section we describe the main properties of the normal inverse Gaussian (NIG) distribution. The NIG distribution introduced by Barndorff-Nielsen (1997), belongs to the class of infinitely divisible distributions (Sato (1999)), and has been widely used in applications to finance (Schoutens (2003)). This random variable presents some characteristics useful in the modelling of asset returns: (1) it can capture heavy-tail and asymmetry in the distributions of returns; (2) the density function can be written in a closed-form expression; (3) it can be easily simulated; (4) it can be applied to construct option pricing models; (5) the density function has tails larger than the normal distribution but thinner than both Student-t and α-stable distributions.

A NIG random variable can be defined through its characteristic function,

$$\phi_{NIG}(u;\alpha,\beta,\delta,m) = \exp\left(\delta\left(\sqrt{\alpha^2-\beta^2}-\sqrt{\alpha^2-(\beta+iu)^2}\right)+imu\right), \qquad \text{(A.1)}$$

with $u \in \mathbb{R}$, $m \in \mathbb{R}$, $\delta > 0$ and $0 \le |\beta| \le \alpha$ and where α governs the tail behaviour, β controls the asymmetry, δ, m are the location and the scale parameter, respectively, and, as usual, i is the imaginary unit. By considering the characteristic function (A.1) we can compute the moments shown in Table 3 as well as the density function

$$f_{NIG}(x;\alpha,\beta,\delta,m) = \frac{\alpha\delta K_1\left(\alpha\sqrt{\delta^2+(x-m)^2}\right)}{\pi\sqrt{\delta^2+(x-m)^2}}\exp\left(\delta\sqrt{\alpha^2-\beta^2}+\beta(x-m)\right) \qquad \text{(A.2)}$$

with $x \in \mathbb{R}$ and K_1 is the modified Bessel function of third order (Gil et al. (2007)).

	NIG(α, β, δ, m)
mean	$m + \frac{\delta\beta}{\sqrt{\alpha^2-\beta^2}}$
variance	$\alpha^2\delta(\alpha^2-\beta^2)^{-\frac{3}{2}}$
skewness	$3\beta\alpha^{-1}\delta^{-\frac{1}{2}}(\alpha^2-\beta^2)^{-\frac{1}{4}}$
kurtosis	$3\left(1+\frac{\alpha^2+4\beta^2}{\delta\alpha^2\sqrt{\alpha^2-\beta^2}}\right)$

Table 3: *Normal inverse Gaussian random variable.* First four moments.

Furthermore, it can be proved that if

$$m = -\frac{\delta\beta}{\sqrt{\alpha^2-\beta^2}}$$

the random variable has zero mean. Since the density function has a closed-form expression, a maximum likelihood or a minimum Kolomogorov-Smirnov distance (see equation A.5) estimate can be computed without computational burdens, for example by using the Matlab's *Optimization Toolbox*. To be more precise, the maximum likelihood estimation (MLE) minimizes the function

$$log\ L(\theta, \{r_1, ..., r_T\}) = -\sum_{i=1}^{T} \log f(\theta, r_i) \tag{A.3}$$

where θ is the vector of model parameters, f is the selected density function and $\{r_1, ..., r_T\}$ is the set of T observations. If f has a simple analytical form, it is possible to find a maximum likelihood estimate by solving the optimization problem

$$\min_{\theta} log\ L(\theta, \{r_1, ..., r_T\}). \tag{A.4}$$

Alternatively, the model can be estimated by searching the parameter vector θ that minimizes the following distance, commonly known as the Kolomogorov-Smirnov statistic,

$$KS(\theta, \{r_1, ..., r_T\}) = \max |F(r_i) - \hat{F}(r_i)| \tag{A.5}$$

where F and $\hat{F}$ are the theoretical cumulative distribution function (CDF) and the empirical distribution function, respectively. This second approach is particularly useful for small samples.

In our empirical study we assume that the stochastic process governing the dynamic of real estate assets has the following form

$$\begin{aligned} A_t &= A_0 e^{mt+X_t} \\ m &= \mu - \frac{\delta\beta}{\sqrt{\alpha^2 - \beta^2}} + \delta\left(\sqrt{\alpha^2 - (\beta+1)^2} - \sqrt{\alpha^2 - \beta^2}\right). \end{aligned} \tag{A.6}$$

where X_1 (that is, X_t when $t = 1$) is a NIG random variable with parameters (α, β, δ, 0). For the process defined in equation (A.6) the following equality holds

$$E[A_t] = A_0 e^{\mu t}. \tag{A.7}$$

Note that the last addend $\delta\left(\sqrt{\alpha^2 - (\beta+1)^2} - \sqrt{\alpha^2 - \beta^2}\right)$ is the so-called *convexity correction* term and if X_t were a Brownian motion with parameter (0, σ), then m would satisfy the equation $m = \mu - \frac{\sigma^2}{2}$, where the term $\frac{\sigma^2}{2}$ ensures that the equation (A.7) is fulfilled.

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