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The Role of Demographic Variables in Explaining Financial Returns in Italy

by

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Abstract

This paper contributes to the ongoing debate on the relationship between asset returns and age-structure by investigating the case of Italy, which is experiencing one of the most pronounced ageing in the world. To this end, time-series regressions are run, in which real returns on different financial assets (stocks, long- and short-term government bonds) are used as dependent variables. The dataset contains annual observations spanning over the period 1958-2004. First, as in Poterba (2001, 2004) only demographic variables are used as explanatory ones. Then, following Davis and Li (2003) the regression specifications are completed with a set of financial variables which have finance-theoretical underpinnings. Results point towards a major effect of demographic dynamics on financial asset returns which appear significantly higher in magnitude than what Poterba (2001, 2004) and Davis and Li (2003) report for US, especially in the stock market.

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1. Introduction

The baby boomers effects have been often debated in many fields of economics. As they entered the labour market, the worries were for a wider labour force that, on one hand, could have increased the unemployment rate and, on the other, reduced the wages. Now the debate has shifted to financial economics with the Asset Meltdown Hypothesis (AMH), which was well summarized by Siegel (1998) by: "*Sell? Sell to Whom?*".[1] The rationale behind the AMH is that a larger working-age cohort drives up the demand for financial assets, accumulated to finance retirement, thereby exerting an upward pressure on asset prices. Conversely, the smaller cohort following a baby boom reduces the demand and faces the larger supply stemming from the retiring baby boomers. A downward pressure on asset prices naturally follows.

A number of theoretical models explore the possible link between demographic dynamics and financial asset returns. Poterba (2001) offers a valid starting point and models this relationship in a simplified overlapping generation (OLG) framework. The individuals are supposed to live for two periods: when young they work and save at a fixed rate, when old they retire and consume. The production is normalized to one and the only asset on the market is fixed in supply. In equilibrium supply equals demand, hence an increase in the number of young workers, due for example to a baby-boom, drives up asset prices as both supply and the saving rate are fixed. The model by Poterba (2001) rests on three main simplifying hypotheses: (i) the economy is closed and no international capital flows are allowed, so that the different ageing processes across countries can not compensate through (integrated) financial markets; (ii) the focus is only on the impact that ageing might have on financial markets, disregarding other possible economic implications (e.g. labour force and productivity rate); (iii) the saving rate and the capital supply are fixed. The effect of the fixed-capital hypothesis is stressed by the same Poterba (2001), who in connection with the simulation results obtained by Yoo (1994) writes: "*a rise in the birth rate, followed by a decline, first raises then lowers asset prices*" although "*the effects are quite sensitive to whether or not capital is in variable supply. With a fixed supply of durable assets, asset prices in the baby boom economy rise to a height of roughly 35% above their level in the*

[1] Recently particular attention has also been given to the implications of population ageing on government fiscal policies and pension provisions (see, among others, Visco, 2002). This however goes beyond the scope of this paper.

baseline case. This effect is attenuated, to a 15% increase in asset prices, in a production economy".

Abel (2001) extends the model by Poterba (2001) in two ways: he allows a variable capital supply and includes the bequest motive. The former change however does not affect the AMH conclusion. As for the bequest motive, Abel (2001) proves that under variable capital supply the "*equilibrium dynamics of the price of capital are completely unaffected*". This result however depends on the particular specification of the bequest motive and in a subsequent work Abel (2003) couples the OLG model with a Social Security System (either PAYG, fully funded or a combination of the two). The inclusion of Social Security actually affects the national savings and investments, but over the long run it does not influence the price of capital. The latter in fact increases in response to a baby boom, but follows a mean reverting behaviour.

Geanakoplos et al. (2004) consider the role of expectations: they show that if agents are myopic an increase in the size of middle-aged translates into a proportional increase in the stock prices, while if agents fully anticipate the demographic changes the increase is likely to be more than proportional. Even with further features of realism (e.g. business cycle shocks, uncertainty in wages and dividend), the final impact of demographic dynamics on stock prices varies in terms of magnitude, but goes in the same direction.

In sum, these studies prove that a relationship between demographic dynamics and asset returns is plausible, but the magnitude and hence the importance of the possible implications for financial markets are not clear. This emphasises the role of the empirical studies, which take different approaches. Yoo (1994) and Bellante and Green (2004) use cross-section regressions in which the share held in various kinds of assets (e.g. bonds, stocks) is regressed on a set of explanatory variables measuring both demographic and other household characteristics (e.g. number of children, gender, race, education, income, wealth) which in principle could affect portfolios choices. The overall evidence supports a significant effect of demographic variables on portfolio choices and in particular of an inverse relationship between age and the share held in risky assets (i.e. risk aversion increases with age). Nevertheless, the most widespread approaches are based on time-series and panel regressions. In the former case, real returns on various kinds of financial assets (e.g. T-Bills, bonds and stocks) are generally regressed on a set of explanatory variables. The regression specifications however significantly vary across the contributions, ranging from works including demographic variables only (e.g. Yoo (1994), Erb et al. (1997) and Poterba, 2004) to others considering also financial variables, such as Davis and Li (2003). The specifications may further differ because of the demographic measures selected: in some cases the average age (e.g. Erb et al. (1997), Goyal, 2004), in others the shares of various age-classes (e.g. Poterba (2001, 2004), Davis and Li (2003), Ang and Maddaloni, 2005). As far as panel regressions are concerned, a further distinction is needed, depending on the second dimension considered (beside time). For example, in Erb et al. (1997) or in Davis and Li (2003) the data refer to different countries and the dependent variable is generally represented by real returns. By contrasts, studies such as Guiso and Jappelli (2001) or Bellante and Greeen (2004) employ data referring to households and use as dependent variable the share invested by each household in a particular kind of financial asset.

The great diversification of the empirical works and the overall sensitivity of the findings to model calibration and/or econometric specification further motivate empirical analysis on this issue.

This paper aims to contribute in this direction by assessing the historical link between asset returns and demographic structure in Italy, a country which is experiencing one of the most pronounced ageing in the world (e.g. Brunetti, 2006).[2] To this end, we prefer a time-series approach, which as far as we know has never been used so far to investigate the Italian case. More specifically, we first follow Poterba (2001, 2004) and estimate regressions in which demographic variables, i.e. the shares of different age-classes, explain real returns on different kinds of financial assets: corporate stocks, long-term government bonds and short-term government bonds (*Buoni Ordinari del Tesoro*, hereafter BOT). We then follow Davis and Li (2003) and include in the regression specification some additional financial variables.

The remainder of the paper is organized as follows. Section 2 describes the methodology taken and Section 3 the dataset and the variables selected for the econometric analyses. Preliminary analyses are reported in Section 4, while Section 5

[2] Baldini and Onofri (2001) analyse the Italian case in order to assess the possible effects of the demographic transition on per capita consumption, saving propensity, financial and physical capital accumulation.

provides a comparative evaluation of the results obtained with those reported by Poterba (2004) for US. Section 6 presents the results of the extended specification and the comparison with Davis and Li (2003). Section 7 gives an account of some peculiarities of the Italian case. Section 8 concludes.

2. The Methodology

The methodology employed to investigate the link between population age-structure and financial asset returns is based on the following sequence of regressions. First, in line with Poterba (2001, 2004) the following regression is estimated:

$$R_t = \alpha + \boldsymbol{\beta}\mathbf{D}_t + \varepsilon_t \tag{1}$$

where R_t is the real return on either stocks, long-term government bonds or BOT, $\mathbf{D_t}$ is the vector of demographic variables and ε_t represents the error term. A purely demographic specification such as (1) is likely to be affected by the problem of omitted variables: stock and bond returns are in fact plausibly driven by other forces than demographic dynamics, as the same Poterba (2004) stresses: "*A key limitation of […] the previous empirical analysis on demography and asset returns is that it does not embed the analysis in a broader model of equilibrium asset return determination. As such, the equations lack control variables that might reduce the omitted variable problem*."

Based on the latter observation, we follow Davis and Li (2003) and estimate an extended version of (1), i.e.:

$$R_t = \alpha + \boldsymbol{\beta}\mathbf{D}_t + \boldsymbol{\gamma}\mathbf{F}_t + \varepsilon_t \tag{2}$$

where $\mathbf{F}_t$ represents the financial variables. To further test the relevance of demographic dynamics on financial market returns, we drop the demographic variables and check whether the following specification:

$$R_t = \alpha + \boldsymbol{\gamma}\mathbf{F}_t + \varepsilon_t \tag{3}$$

produces poorer results in terms of both estimation output and diagnostic tests.

3. Dataset and variable selection for the case of Italy

The main point in this type of empirical work is the selection of both demographic and financial variables, which has to trade off between sensible theoretical underpinnings on one hand and specific features of the Italian case and data availability on the other. This Section describes first the dataset and then the selection of explanatory variables: we first present the demographic ones and then we illustrate how we have made the selection for financial ones for each asset type separately.

The dataset is obtained by merging both demographic and financial data: the former draw from the Eurostat demographic database while the latter are taken either from the IMF International Financial Statistics or Datastream. The dataset contains annual observations spanning over the period 1958-2004 except for dividend-yield, available only starting from 1973, and for BOT, available since 1981. Both the frequency and the time span of the dataset are basically constrained by data availability. In fact, demographic data are not available at a frequency higher than the annual one and financial data, which are instead obtainable also at higher frequencies, are accessible only from the late 1950s.

Moreover, financial variables are typically highly volatile while demographic ones are generally slowly varying: as a result, the actual relationship between these two kinds of variables can be detected only over the long run.[3] Based on this argument some authors have performed estimations using multi-period variables (see e.g. in Bosworth et al., 2004). In the following analyses we prefer annual data for two main reasons: to maintain a sample size which guarantees statistically significant results and to allow consistency with most recent papers, included Davis and Li (2003) and Poterba (2004).

The dependent variables are the real returns on three financial assets differing for riskyness and maturity: (i) stocks, R_t^{STOCK}; (ii) long-term (10 years) government bonds, R_t^{BOND}; and (iii) short-term (12-month)[4] government bonds, R_t^{BOT}. While yields on long-term bonds are directly available, equity returns have to be calculated: in line with the literature, the continuously compounded rate of return of the Italian Share Price Index is used. Similarly, the annual yield on 12-month BOT is computed as the log change in the annual average BOT issue prices. For each asset, real returns are then worked out by using the Consumer Price Index.

[3] For the econometric problems entailed by low frequency financial data see, among others, Campbell et al. (1996).
[4] Alternatively, the 3-month BOT could have been selected to proxy the short-term government bonds yields. Yet, as this kind of interest rate is typically (directly or indirectly) driven by monetary policy interventions (among others see Favero, 2005) we prefer 12-month BOT yields.

The demographic variables included in the models are selected in line with the existing empirical works. In estimating model (1) we follow Poterba (2004) and use either the shares of late working-age and elderly on the entire population (Pop_t^{40-64} and Pop_t^{65+}) or the shares of the same age-classes over the adult population, aged 20 or over ($Pop_t^{40-64/20+}$ and $Pop_t^{65/20+}$). By contrast, when the extended regression specification is tested, we follow Davis and Li (2003) and include first the shares of early and late working-age over the entire population (Pop_t^{20-40} and Pop_t^{40-64}) and then also the shares of retired (Pop_t^{65+}).

Table 1 summarizes the expected sings that the demographic variables should theoretically display in each asset return regression, assuming a fixed supply of each asset and no international capital flows. These sings rest on the argument that age can basically affect financial choices in three different but related ways. First, age is directly linked to risk aversion, so that an older population is likely to prefer safer rather than risky assets, thereby exerting an upward (downward) pressure on the prices of safer (riskier) assets. Second, age also determines the investment horizon, so that an ageing population is likely to reduce the demand for assets such as long-term government bonds. Finally, age affects the financial choices in response to the different working/retirement positions and different life-cycle phases: working-age people have in fact to save and to accumulate assets for retirement (precautionary savings), thereby driving up demand and hence prices of financial assets, while retired people generally disinvest financial investments in order to finance their retirement consumption. Specifically for the Italian case, the latter argument is particularly interesting as the recent social security reforms have introduced the need for a second, e.g. collective pension funds, and third pillar, e.g. life insurances and individual participation to open pension funds (e.g. Baldacci and Tuzi, 2003). It is obvious that the expected signs for the middle-age class may be somewhat undetermined depending on which effect really prevails.

Table 1: Demographic variables: expected signs.*

	Pop_t^{20-40}	Pop_t^{40-64}	Pop_t^{65+}
Stocks	+	+/-	-
Bonds	-	+/-	+
BOT	+	+/-	-

** = assuming no international capital flows and fixed capital supply.*

As for as the financial variables used as explanatory ones for the stock returns, we follow Davis and Li (2003) and rest on Gordon (1962) model, which basically states that under the hypothesis of constant dividend growth rate, real long rate and risk premium, the equity price is given by the discounted value of all future dividends. Hence, the financial variables included in the regression for equities are:

- DY_{-1}, i.e. the lagged divided yield, as a proxy for the initial level of divided;
- r, the real long-term interest rate
- VOL, i.e. the log of the share price volatility, as proxy for the risk-premium[5]
- g, i.e. the trend of the GDP growth rate, included as proxy for the dividend growth rate[6]
- Gap, the difference between GDP growth rate and g. This latter variable is also included based on the observation that, besides the trend growth of GDP, share prices can also be affected, although only temporary, by cyclical fluctuations of GDP.

The expected sign of the coefficients of dividend yield and GDP growth trend, used to proxy dividend yield growth, is not clear: on one hand, they could be positively signed since higher expected dividends entail higher stock values; on the other, it could be negatively signed since when the dividend is paid, the value of the stock is reduced by this value. The possible impact of real interest rate is also unclear: an increase in the interest rates on one hand increases the expected growth rate of share prices; on the other, it reduces the discounted value of the future dividend, thereby shrinking the share prices. By contrast, both volatility and output gap are expected to unambiguously and positively affect the equity returns: the former based on the risk-return theory, the latter

[5] Data for Italian Share Price Index volatility are not directly available and are thus computed as the standard deviation of the last 12 monthly observations.

[6] It is obtained by applying the Hodrick Prescott filter on the log difference of real GDP. Following Davis and Li (2003), the filter is estimated with a smoothing factor of 100.

based on the argument that higher (lower) than expected real GDP growth might boost (reduce) share prices and returns.

As for the model specification for both long and short-term government bonds, following Davis and Li (2003) the financial variables included are derived based on the expectation theory of the term-structure (EH). The following variables are thus included:

- Δsr, the change in the short-rate
- $Spread_{-1}$, the lag of the term spread (only for long-term government bonds)
- π_{-1} and $\Delta\pi$, the lag and the percentage variation of inflation
- g, i.e. the trend of the GDP growth rate
- Gap, the difference between GDP growth rate and g.

Based on EH, the expected sing for both Δsr and $Spread_{-1}$ are positive. The same holds for the GDP variables, as higher GDP growth is generally expected to increase the interest rates of the economy. Conversely, inflation-related variables should turn out negatively signed in the light of the Fisher equation.

4. Descriptive statistics and preliminary analyses

In model (1), the demographic variables can either be considered in levels or in changes. In literature in fact, some authors, such as Goyal (2001) and Ang and Maddaloni (2005), focus on the changes in the shares of population, while some others, such as Yoo(1994), Brooks (2002) and Poterba (2001, 2004) use levels instead. Here the levels rather than changes of demographic variables are included into the models since all dependent and most of the explanatory variables turn out stationary over the period considered.

As for the financial variables, some are included into the final models with slightly different lags with respect to Davis and Li (2003). In particular when model (3) is estimated for stock returns, the volatility and the GDP-related variables (g and Gap) are included with a one-period lag. Similarly, when (3) is estimated for Long-term government bond yields, lagged rather than current GDP-related variables are included. The rationale behind this choice is that the impact of these variables normally realizes with some delay and that similarly data on GDP are released with a certain delay. Likewise, volatility is generally not immediately fully perceived by financial market agents.[7] On the other hand, when estimating (3) for BOT, GDP variables are included at current level, in the light of the higher responsiveness of short interest rates with respect to long-term interest rates.

For each model, first, the stationarity of variables is tested by means of the Augmented Dickey-Fuller (ADF) test.[8] All the regressions are estimated with OLS and the standard diagnostic tests are run to check whether the underlying hypotheses of the basic linear regression model are fulfilled. More specifically, 1st order residual autocorrelation is tested by means of the Durbin-Watson (DW) statistic, and higher order (up to 10th) by means of the Ljung-Box test.[9] The homoskedasticity, normality and stationarity of the residuals are tested by means of the White's Heteroskedasticity Test, Jarque-Bera statistic and ADF test respectively. In case of heteroskedastic and autocorrelated residuals, the model is estimated imposing Newey and West (1987) consistent covariances. In addition, the Chow forecast test is run to check for stability of coefficients before and after 1995, chosen as possible structural break in the light of the Dini 1995 social security reforms which marked the shift from an earning-based (defined benefits) to a contribution-based (defined contribution) pension system in Italy. RESET (with 3 fitted terms) is also run to test for general specification errors (i.e. omitted variables, incorrect functional form or correlation between regressors and disturbances). Finally, Wald test is used to test the joint non significance of demographic variables.

Table 2 reports the main descriptive statistics and the results for the ADF stationarity test for the three dependent variables. All dependent variables appear stationary over the whole sample, as the null of unit root can be rejected at least at the 5% level of significance.

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[7] The models have also been estimated including the current rather than the lagged values of both GDP-related variables and volatility. Nevertheless, the observed results were overall poorer, thereby suggesting a sort of slow response of financial markets to these variables.
[8] The underlying hypotheses for ADF tests are chosen according to Hamilton (1994).
[9] Davis and Li (2003) use instead the Breusch-Godfrey Lagrange Multiplier (LM) test setting the highest order of serial correlation to be tested equal to 2. The LM is however an asymptotic test; hence, in the light of the limited sample size, here the Ljung-Box at 10 lags is preferred.

Table 2: Dependent variables: descriptive statistics and ADF tests.

	STOCK	BOND	BOT
Observations	47	47	24
Mean	-0.0137	0.0298	0.0420
Median	-0.0536	0.0324	0.0473
Max	0.4980	0.0811	0.0896
Min	-0.4521	-0.0726	-0.0037
Std. Dev.	0.2363	0.0324	0.0244
HP	None	None	Constant
t-Statistic	-4.6083***	-1.9660**	-3.5040**
Prob.	0.0000	0.0481	0.0260

*Notes: HP is the hypothesis underlying the ADF tests (none, constant or constant and linear trend) and *, ** and *** denote significance at 10%, 5% and 1% respectively.*

Results of stationarity tests for independent variables are reported in Table 3. As for the financial variables, they all turn out to be stationary except volatility. Note that the unit-root test for inflation is run isolating the period during which the inflation rate jumped as a consequence of the two oil shocks. As far as the demographic variables are concerned, both early and late working-age shares appear stationary while the ADF test strongly accepts the null of unit-root for the shares of the elderly, which is unsurprising given the strength of ageing in Italy (see e.g. Brunetti, 2006).

Table 3: Explicative variables: stationarity tests.

Variable	HP	t-Statistic	Prob.
Gap	None	-5.830***	0.0000
Δsr	None	-7.226***	0.0000
DY	Constant	-3.785**	0.0316
g	Constant, Linear Trend	-3.965***	0.0002
π	Constant, 1959-1973	-3.603**	0.0235
	Constant, 1974-1985	-3.399**	0.0311
	Constant, 1986-2004	-2.893*	0.0638
Vol	Constant, Linear Trend	-1.433	0.8371
Spread	None	-2.149**	0.0327
20 - 39	Constant, Linear Trend	-3.377*	0.0765
40 - 64	Constant, Linear Trend	-3.310*	0.0777
65+	Constant, Linear Trend	-2.846	0.1893

Note: same as in Table 2.

5. A purely demographic specification

In order to allow a direct comparison with the seminal work by Poterba (2004), the relationship between age-structure and real returns on corporate stocks, long-term government bonds and BOT is assessed by estimating (1), which only includes demographic variables. Specifically, we use two explanatory variables: the shares of late middle-aged and retired people computed either over the entire or over the adult (aged more than 20) population. The results obtained are compared with those reported by Poterba (2004) for the post-war period (1947-2003). Note that for comparability reasons the models are evaluated by means of the adjusted R^2 and that, in contrast to Poterba (2004), the standard diagnostic tests are also reported to detect any possible statistical weakness of the estimated models.

Tables 4 and 5 compare the results with Poterba (2004).

Table 4: Stock returns: shares over the entire population.

	Poterba (2004) US: 1947 - 2003		**This Study Italy: 1958 - 2004**	
	Coeff.	***s.e.***	***Coeff.***	***s.e.***
Constant	N/A	N/A	2.042	1.984
Pop_t^{40-64}	3.428	2.146	-9.019	8.379
Pop_t^{65+}	1.716	1.477	4.871	4.175
Adjusted R^2	0.023		-0.013	
DW	N/A		1.307	
White Test	N/A	N/A	2.014	0.110
Jarque-Bera	N/A	N/A	1.121	0.571
ADF	N/A	N/A	-4.666	0.000
Ljung-Box	N/A	N/A	8.499	0.075

Note: according to Hamilton (1994), the ADF test on the residuals is run assuming neither a constant nor a trend. The Ljung-Box provides evidence for residuals serial correlation of 10^{th} order.

Consistently with Poterba (2004), also Italian data suggest that none of the demographic variables is statistically relevant in driving the real returns on equities. Looking at the diagnostic tests however, it emerges a clear serial-correlation in the residuals. Highly correlated residuals are generally symptom of omitted variables, which is in this case particularly plausible.

Interestingly, Table 5 shows that when the same model is estimated using the shares over the adult population (aged 20 or over) results depart from Poterba (2004). In Italy, the share of late middle-aged over the adult population turns statistically significant and the adjusted R^2 is significantly higher. Furthermore, the signs contrast those in Poterba (2004): the negative sign of those aged between 40 and 64 signals that Italy this is a life-cycle phase in which the agents start to abandon very risky investments such as equities, thereby reducing their prices and hence the relative returns. Nevertheless, the severe residual autocorrelation suggests the possibility of omitted variables in the model specification and highlights a strong statistical weakness of this model.

Table 5: Stock returns: shares over the adult population.

	Poterba (2004) US: 1947 - 2003		**This Study Italy: 1958 - 2004**	
	Coeff.	***s.e.***	***Coeff.***	***s.e.***
Constant	N/A	N/A	3.740**	1.842
$Pop_t^{40-64/20+}$	0.155	0.977	-8.456**	4.051
$Pop_t^{65+/20+}$	0.731	1.577	-1.352	1.404
Adjusted R^2	-0.035		0.051	
DW	N/A		1.391	
White Test	N/A	N/A	0.327	0.858
Jarque-Bera	N/A	N/A	1.685	0.431
ADF	N/A	N/A	-4.904	0.000
Ljung-Box	N/A	N/A	12.151	0.257

Note: same as in Table 4.

As for bonds, Poterba (2004) finds only "*weak evidence that in the fixed income markets, and particularly the Treasury bill market, population age structure is correlated with asset returns*" (Table 6). As for the Italian case, both coefficients turn out to be statistically significant. However, also in this case the estimated model shows a severe problem of serially-correlated residuals, suggesting once again the risk of omitted variables affecting this model specification.

When the analysis is repeated using the shares over the adult population (Table 7), Poterba (2004) reports poorer results as none of the demographic variables turns out statistically relevant. By contrast, referring to the Italian case two main differences arise: first, only the share of late working-age keeps its significance (with the R^2

reducing from 22.40% to 12.97%); second, the sign observed for this variable is negative, consistently with expectations.

Table 6: Bonds yields: shares over the entire population.

	Poterba (2004) US: 1947 - 2003		**This Study Italy: 1958 - 2004**	
	Coeff.	***s.e.***	***Coeff.***	***s.e.***
Constant	N/A	N/A	-0.845***	0.238
Pop_t^{40-64}	-0.585	1.356	3.580***	1.006
Pop_t^{65+}	2.335**	0.933	-1.495***	0.501
Adjusted R^2	0.091		0.224	
DW	N/A		0.554	
White Test	N/A	N/A	1.767	0.154
Jarque-Bera	N/A	N/A	8.637	0.013
ADF	N/A	N/A	-3.498	0.001
Ljung-Box	N/A	N/A	35.385	0.000

Note: same as in Table 4.

Table 7: Bonds yields: shares over the adult population.

	Poterba (2004) US: 1947 - 2003		**This Study Italy: 1958 - 2004**	
	Coeff.	***s.e.***	***Coeff.***	***s.e.***
Constant	N/A	N/A	0.585**	0.248
$Pop_t^{40-64/20+}$	-0.697	0.602	-1.289**	0.544
$Pop_t^{65+/20+}$	1.327	0.971	-0.112	0.189
Adjusted R^2	0.085		0.1297	
DW	N/A		0.471	
White Test	N/A	N/A	1.775	0.152
Jarque-Bera	N/A	N/A	5.315	0.070
ADF	N/A	N/A	-3.199	0.002
Ljung-Box	N/A	N/A	62.778	0.000

Note: same as in Table 4.

Finally, Tables 8 and 9 report the comparison for real returns on T-Bills and BOT (for the Italian case). Consistently with Poterba (2004) this is the case in which the purely demographic specification reveals the most significant evidence of a relationship between demographic and financial dynamics. In fact, regardless of the shares being computed over the entire or adult population, the regressions display R^2 which are much higher than those reported in the previous cases. When the analysis is performed with Italian data both demographic variables turn out strongly significant and the direction of the impact is different.

Table 8: T-Bill and BOT returns: shares over the entire population.

	Poterba (2004) US: 1947 - 2003		**This Study Italy: 1958 - 2004**	
	Coeff.	***s.e.***	***Coeff.***	***s.e.***
Constant	N/A	N/A	-0.521	0.345
Pop_t^{40-64}	-0.311	0.372	2.604*	1.342
Pop_t^{65+}	1.003***	0.256	-1.599***	0.514
Adjusted R^2	0.236		0.406	
DW	N/A		0.372	
White Test	N/A	N/A	1.755	0.180
Jarque-Bera	N/A	N/A	0.600	0.741
ADF	N/A	N/A	-1.442	0.1355
Ljung-Box	N/A	N/A	29.466	0.001

Note: same as in Table 4.

Table 9: T-Bill and BOT returns: shares over the adult population.

	Poterba (2004) US: 1947 - 2003		**This Study Italy: 1958 - 2004**	
	Coeff.	***s.e.***	***Coeff.***	***s.e.***
Constant	N/A	N/A	1.332***	0.245
$Pop_t^{40-64/20+}$	0.077	0.158	-2.252***	0.490
$Pop_t^{65+/20+}$	1.120***	0.255	-1.793***	0.253
Adjusted R^2	0.296		0.698	
DW	N/A		0.817	
White Test	N/A	N/A	0.949	0.458
Jarque-Bera	N/A	N/A	2.335	0.311
ADF	N/A	N/A	-3.424	0.001
Ljung-Box	N/A	N/A	12.798	0.235

Note: same as in Table 4.

It is worth noting however that the results are not robust across the two variants considered. When the population age-structure is assessed by means of shares over the entire population the estimated coefficients display signs which are consistent with the expectation, namely positive for late middle-aged and negative for retired. Conversely, when the shares are computed over the adult population both variables turn out to be negatively signed.

Results for BOT have to be interpreted with caution not only because they are sensitive to the demographic measure used but also because of the possibility of spurious regression (R^2 is quite high and residuals highly correlated, suggesting the possibility of omitted variables).

To sum up, the results reported in this study for the Italian case are overall more supportive of the role of demographics in financial markets than those reported for US by Poterba (2004), but they are not fully consistent across the variants estimated. However, the regression specification studied is likely to be severely affected by a problem of omitted variables, as the models estimated by Poterba (2004) neglect all the additional financial variables that beside demographic changes could actually drive these returns. Therefore, the model specification is extended in the next Section.

6. An extended specification

This Section presents the results obtained by including in the regression specification financial variables, selected as described in Section 3. In each of the following Sections we present the results for stocks, for long-term government bonds and for BOT respectively. Finally, in Section 6.4 the results obtained in this study for Italy are compared, whenever possible, with those reported by Davis and Li (2003) for the US case.

6.1 Results for stocks

Table 10 reports the estimation output for the following regression:

$$R_t^{STOCK} = \alpha + \beta_1 Pop_t^{20-39} + \beta_2 Pop_t^{40-64} + \beta_3 g_{t-1} + \beta_4 Gap_{t-1} + \beta_5 r_t + \beta_6 Vol_{t-1} + \beta_7 DY_{t-1} + \varepsilon_t \qquad (1a)$$

and shows that both demographic variables included in the model turn out to be significant and the R^2 suggests that the whole of financial and demographic variables can explain more than 48% of the variation in the real returns on equities over the sample period.

Table 10: Estimation output of model (1a), 1973-2004.

Variable	**Coefficient**	**S.e.**
α	5.386*	2.679
Pop_t^{20-39}	11.641*	6.631
Pop_t^{40-64}	-24.628**	11.873
g_{t-1}	-39.769***	9.782
Gap_{t-1}	1.405	2.042
r_t	-6.029***	2.135
Vol_{t-1}	-0.019	0.027
DY_{t-1}	0.008	0.014
R^2	0.488	
Adjusted R^2	0.332	
DW	2.156	
Tests	**Stat.**	**Prob.**
F-statistic	3.133	0.018
Ljung-Box	5.457	0.859
Homoskedasticity	0.741	0.711
Normality	0.831	0.660
Unit root	-5.183	0.0000
Wald $H_0 : \beta_1 = \beta_2 = 0$	2.190	0.135
RESET (3)	1.241	0.321
Chow (1995)	1.677	0.189

Among financial variables, the estimated coefficients for long-term interest rates and the GDP trend growth rate are the only statistically significant ones, both displaying negative signs. While for the former this is in line with the theory, the negative sign of GDP trend growth rate might stem from the fact that higher GDP generally inflate interest rates, thereby reducing the real returns on stocks via a downward pressure on firm investments and on the discounted value of future dividend flows.[10] Furthermore, the completely non-significant estimated coefficient for volatility might suggest that volatility may not the best proxy for risk premium.[11]

Turning to demographic variables, while the estimated coefficient for early working-aged is significant only at a 10% significance level, the coefficient for late working-aged appears strongly significant. Both coefficients are correctly signed and,

[10] The GDP growth rate may not be the best proxy for dividend growth rate. Davis and Li (2003) for instance argue that the industrial production index could be suitably used as an alternative. This variant has also been examined, but very similar results (available upon request) are obtained.

[11] There is a debate on most appropriate proxies for risk-premium, which however goes beyond the scope of this work: see e.g. Mehra and Prescott (1985), Welch (2000) and Jones and Wilson (2005).

being also quite high, point towards a strong impact of demographics on real returns on stocks. In particular, the proportion of early working-age tends to increase the returns on equities, while the share of late working-age seems to have the opposite effect. This result is consistent with Brunetti and Torricelli (2006), who examine the average portfolio by age-class and find that on average middle-aged households hold riskier portfolios, while older ones tend to disinvest risky financial instruments and turn to safer assets. The residuals pass all diagnostic tests so that the inference on the estimated results can be considered valid.

The relevance of demographic variables is further confirmed by the poorer results obtained when the latter are omitted (see Table 11):

$$R_t^{STOCK} = \alpha + \beta_1 g_{t-1} + \beta_2 Gap_{t-1} + \beta_3 r_t + \beta_4 Vol_{t-1} + \beta_5 DY_{t-1} + \varepsilon_t \qquad (2a)$$

Table 11: Estimation output of model (2a), 1973-2004.

Variable	**Coefficient**	**S.e.**
α	0.852***	0.247
g_{t-1}	-25.422***	6.879
Gap_{t-1}	0.887	2.114
r_t	-3.733**	1.814
Vol_{t-1}	-0.057***	0.020
DY_{t-1}	0.005	0.015
R^2	0.391	
Adjusted R^2	0.269	
DW	2.004	
Tests	**Stat.**	**Prob.**
F-statistic	3.205	0.023
Homoskedasticity	1.258	0.316
Ljung-Box	5.831	0.829
Normality	0.300	0.861
Unit root	-4.745	0.000
RESET (3)	0.572	0.639
Chow (1995)	2.092	0.095

Since (2a) is nested in (1a), the comparison is done on the basis of adjusted R^2: the purely financial specification reaches a 26.9% which is in fact lower than the 33.2% observed above for model (1a). The diagnostic tests on this model (see bottom panel of Table 11) still confirm its statistical validity. In addition, even though only at a 10%

level of significance, the Chow test rejects the null of coefficient stability before and after 1995.

Following Davis and Li (2003), the robustness of the results is tested by estimating the model including also the shares of the elderly (see Table 12):

$$R_t^{STOCK} = \alpha + \beta_1 Pop_t^{20-39} + \beta_2 Pop_t^{40-64} + \beta_3 Pop_t^{65+} + \beta_4 g_{t-1}, + \beta_5 Gap_{t-1} + \beta_6 r_t + \beta_7 Vol_{t-1} + \beta_8 DY_{t-1} + \varepsilon_t \quad (3a)$$

Table 12: Estimation output of model (3a), 1973 - 2004.

Variable	**Coefficient**	**S.e.**
α	3.609	3.074
Pop_t^{20-39}	15.262**	7.296
Pop_t^{40-64}	-18.422***	2.960
Pop_t^{65+}	-6.469*	3.613
g_{t-1}	-46.186***	11.196
Gap_{t-1}	1.836	2.062
r_t	-8.144***	2.804
Vol_{t-1}	-0.014	0.027
DY_{t-1}	0.007	0.014
R^2	0.517	
Adjusted R^2	0.342	
DW	2.315	
Test	**Stat.**	**Prob.**
F-statistic	2.947	0.021
Ljung-Box	5.814	0.831
Homoskedasticity	1.080	0.446
Normality	1.309	0.520
Unit root	-5.540	0.000
Wald $H_0 : \beta_1 = \beta_2 = \beta_3 = 0$	4.232	0.028
RESET (3)	1.984	0.151
Chow (1995)	1.418	0.280

The increase in adjusted R^2 proves that the inclusion of the share of people aged 65 or over actually adds some information to the estimated model. On the whole, the results obtained are consistent with model (1a): among financial variables, GDP trend growth rate and real long-term interest rata are the only statistically significant and have the same sings as in the previous cases. Furthermore, according with expectations the estimated coefficient for Pop_t^{65+} is negative. Besides, the coefficient for retired is lower than that for middle-aged, suggesting a smaller participation of the former to equity market. Finally, the residuals of this model pass all the diagnostic tests.

In sum, the evidence found across all the variants estimated highlight a relevant role of the age-structure of the population in explaining the real returns on stocks, especially when compared with the US case. More specifically, the proportion of early (late) working-age people over the entire population seems to affect positively (negatively) the real returns on stocks as theory suggests (see Section 3).

6.2 Results for long-term government bonds

The same methodology is taken to assess the impact of a change in the demographic structure of the population on long-term government bond yields, estimated by means of the following regression (see Table 13):

$$R_t^{BOND} = \alpha + \beta_1 Pop_t^{20-39} + \beta_2 Pop_t^{40-64} + \beta_3 \Delta sr_t + \beta_4 Spread_{t-1} + \\ + \beta_5 \pi_{t-1} + \beta_6 \Delta \pi_t + \beta_7 g_{t-1} + \beta_8 Gap_{t-1} + \varepsilon_t \qquad (1b)$$

Diagnostic test reveal the presence of both heteroskedasticity and autocorrelation in the residuals, so that the reported standard errors are Newey-West heteroskedasticity-autocorrelation-consistent. Yet, the residuals are normally distributed and stationary. In addition, the RESET and the Chow test respectively accept the null of no misspecification and of coefficient stability at a 5% level of significance.

All financial variables but those GDP-related are statistically significant and, among the demographic ones, only the share of early working-aged seems to affect the bond yield dynamics. The R^2 indicates that financial and demographic variables together can explain almost 80% of the variation in the long-term government bond Yields. According to the basic expectation theory of the term structure, the spread coefficient should be positively signed. The negative sign obtained may stem from a mean reverting term structure: when the spread is too high, the monetary policy authorities may reduce short rates so that the expected future short rates decrease, thereby reducing the long-term interest rates.[12] As expected, inflation seems to reduce the real bonds yields. In addition, note that the coefficients associated with inflation-

[12] Evidence of a mean reverting term structure of Italian interest rates is also found in Brunetti and Torricelli (2007).

related variables are among the highest and most strongly significant among those estimated: the rationale could rely on the fact that the period under analysis includes episodes of very high inflation movements, such as those following the two oil shocks between the end of 70s and the beginning of 80s.

Table 13: Estimation output of model (1b), 1958 - 2004.*

Variable	**Coefficient**	**S.e.**
α	0.347	0.404
Pop_t^{20-39}	-1.063**	0.480
Pop_t^{40-64}	0.230	0.864
Δsr_t	0.375**	0.185
$Spread_{t-1}$	-0.399**	0.166
π_{t-1}	-0.598***	0.176
$\Delta\pi_t$	-1.126***	0.162
g_{t-1}	-0.754	0.554
Gap_{t-1}	0.003	0.034
R^2	0.808	
Adjusted R^2	0.751	
DW	0.901	
Diagnostic Test	**Stat.**	**Prob.**
F-statistic	14.216	0.000
Ljung-Box	35.453	0.000
Homoskedasticity	2.498	0.030
Normality	1.322	0.516
Unit root	-2.631	0.010
Wald $H_0 : \beta_1 = \beta_2 = 0$	4.914	0.035
RESET (3)	1.769	0.173
Chow (1995)	2.107	0.085

** = Newey-West standard errors.*

As far as the demographic variables are concerned, the share of early working-aged is signed as expected. The coefficient for late working-aged instead is not statistically significant, suggesting that this share of population does not actually affect the dynamics of long-term government bonds yields.

The relevance of demographic dynamics is further tested by dropping out the demographic variables:

$$R_t^{BOND} = \alpha + \beta_1 \Delta sr_t + \beta_2 Spread_{t-1} + \beta_3 \pi_{t-1} + \beta_4 \Delta \pi_t + \beta_5 g_{t-1} + \beta_6 Gap_{t-1} + \varepsilon_t \quad (2b)$$

As reported in Table 14, model (2b) leads to poorer results in terms of both estimation output and of diagnostic tests, which thus supports the relevance of the demographic variables.

Table 14: Estimation output of model (2b), 1958-2004.*

Variable	**Coefficient**	**S.e.**
α	0.058***	0.015
Δsr_t	0.345*	0.175
$Spread_{t-1}$	-0.643***	0.217
π_{t-1}	-0.301***	0.092
$\Delta\pi_t$	-1.007***	0.169
g_{t-1}	-0.045	0.301
Gap_{t-1}	0.008	0.038
R^2	0.684	
Adjusted R^2	0.630	
DW	0.729	
Diagnostic Test	**Statistics**	**Prob.**
F-statistic	12.640	0.000
Ljung-Box	36.128	0.000
Homoskedasticity	1.423	0.211
Normality	1.733	0.420
Unit root	-3.025	0.003
RESET (3)	3.096	0.059
Chow (1995)	3.311	0.007

** = Newey-West standard errors.*

The variant including the shares of the elderly leads to the estimation of the following model:

$$R_t^{BOND} = \alpha + \beta_1 Pop_t^{20-39} + \beta_2 Pop_t^{40-64} + \beta_3 Pop_t^{65+} + \beta_4 \Delta sr_t + \beta_5 Spread_{t-1} + \\ + \beta_6 \pi_{t-1} + \beta_7 \Delta\pi_t + \beta_8 g_{t-1} + \beta_9 Gap_{t-1} + \varepsilon_t \qquad (3b)$$

Table 15 reports the estimation output and diagnostic tests. Except for homokedasticity and serial correlation, the residuals of this model fulfil the required hypotheses and the stability tests provide evidence of no misspecification and of coefficient stability at a 5% level of significance. Although not individually significant, the share of people aged

65 and over adds some information to the model, as the adjusted R^2 slightly rises (from 75.1% to 83.6%).

Table 15: Estimation output of model (3b), 1959 - 2004.*

Variable	Coefficient	S.e.
α	0.395	0.320
Pop_t^{20-39}	-1.021***	0.385
Pop_t^{40-64}	-0.065	0.849
Pop_t^{65+}	0.298	0.415
Δsr_t	0.318*	0.179
$Spread_{t-1}$	-0.414***	0.123
π_{t-1}	-0.661***	0.151
$\Delta\pi_t$	-1.140***	0.186
g_{t-1}	-0.791	0.516
Gap_{t-1}	0.000	0.037
R^2	0.882	
Adjusted R^2	0.836	
DW	1.227	
Diagnostic Test	**Statistics**	**Prob.**
F-statistic	19.154	0.000
Ljung-Box	38.250	0.000
Homoskedasticity	2.281	0.061
Normality	1.136	0.567
Unit root	-3.700	0.001
Wald $H_0 : \beta_1 = \beta_2 = \beta_3 = 0$	5.295	0.006
RESET (3)	1.859	0.167
Chow (1995)	2.386	0.073

** = Newey-West standard errors.*

As for stocks, also the results for long-term government bonds are overall consistent across the different variants estimated. In particular as concerns the demographic variables, only the shares of early working-aged is steadily significant. Consistently with the theoretical underpinnings, the negative sign of this variable suggests that a larger share of young people increases the demand for long-term government bonds, thereby increasing their prices and decreasing their returns. On the other hand, the non significant coefficient for late working-aged and retired suggest that they are not particularly active in this market, which can be justified by the long investment horizon of these assets.

6.3 Results for BOT

The model, which due to data availability is estimated over a different sample period (1981-2004), is:

$$R_t^{BOT} = \alpha + \beta_1 Pop_t^{20-39} + \beta_2 Pop_t^{40-64} + \beta_3 \Delta sr_t + \beta_4 \pi_{t-1} + \beta_5 \Delta \pi_t + \beta_6 g_t + \beta_7 Gap_1 + \varepsilon_t \qquad (1c)$$

Note that the spread, previously included based on the expectation theory of the term structure, is here dropped.[13] Furthermore, the GDP variables are included in current levels rather than lagged based on the fact that short-term rates are generally shaped by monetary policy interventions based on the current situation of the whole economy.

Table 16: Estimation output of model (1c), 1981 - 2004.

Variable	**Coefficient**	**S.e.**
α	-2.738***	0.537
Pop_t^{20-39}	2.323***	0.367
Pop_t^{40-64}	5.822***	1.358
Δsr_t	0.002	0.002
π_{t-1}	0.501**	0.189
$\Delta\pi_t$	-0.201	0.263
g_t	12.493***	1.625
Gap_t	-0.542***	0.172
R^2	0.916	
Adjusted R^2	0.879	
DW	1.898	
Diagnostic Test	**Statistics**	**Prob.**
F-statistic	24.976	0.000
Ljung-Box	6.378	0.783
Homoskedasticity	0.509	0.876
Normality	0.674	0.714
Unit root	-4.819	0.000
Wald $H_0 : \beta_1 = \beta_2 = 0$	20.141	0.000
RESET (3)	2.150	0.143
Chow (1995)	0.841	0.615

[13] When included the estimated coefficient of the spread is always found not significantly different from zero.

Estimation output and diagnostic tests of model (1c) are reported in Table 16. All the diagnostic tests are passed. On the whole, the estimated model fits quite well real data and the obtained R^2 is quite high if compared with the values observed for stocks (48.8%) and long-term government bonds (80.8%). Nevertheless, in contrast with what observed for long-term government bonds, both the demographic variables display positive signs.

The relevance of the demographic variables is further tested by re-estimating the following model:

$$R_t^{BOT} = \alpha + \beta_1 \Delta sr_t + \beta_2 \pi_{t-1} + \beta_3 \Delta \pi_t + \beta_4 g_t + \beta_5 Gap_{t} + \varepsilon_t \quad (2c)$$

The exclusion of the demographic variables not only leads to overall poorer results in terms of diagnostic tests but also significantly reduces the degree of fit of the model to real data as the adjusted R^2 reduces from 87.9% to 62.3% (see Table 17).

Table 17: Estimation output of model (2c), 1981 - 2004.

Variable	**Coefficient**	**S.e.**
α	-0.067***	0.017
Δsr_t	0.004	0.003
π_{t-1}	-0.497***	0.135
$\Delta\pi_t$	-0.527	0.456
g_t	7.415***	1.152
Gap_t	-0.742**	0.298
R^2	0.705	
Adjusted R^2	0.623	
DW	0.940	
Diagnostic Test	**Statistics**	**Prob.**
F-statistic	8.607	0.000
Ljung-Box	9.2763	0.506
Homoskedasticity	1.894	0.140
Normality	1.560	0.458
Unit root	-2.767	0.008
RESET (3)	0.930	0.450
Chow (1995)	2.730	0.084

When the share of the elderly is included in the specification, the model is:

$$R_t = \alpha + \beta_1 Pop_t^{20-39} + \beta_2 Pop_t^{40-64} + \beta_3 Pop_t^{65+} + \beta_4 \Delta sr_t + \beta_5 \pi_{t-1} + \beta_6 \Delta \pi_t + \beta_7 g_t + \beta_8 Gap_t + \varepsilon_t \quad (3c)$$

As reported in Table 18, this specification not only passes all the diagnostic tests but also displays a higher fit to the real data, as the adjusted R^2 raises up to 92.5%. In fact, all financial variables, but the inflation change rate, are statistically significant and display signs which are consistent with those reported above for model (1c). Similarly, all the demographic variables turn out to be strongly significant and signed as expected. Nevertheless, the inclusion in the model of a non-stationary variable (the share of elderly) and the consequent possibility of "overfitting" problems entail a cautious interpretation.

Table 18: Estimation output of model (3c), 1981 - 2004.

Variable	**Coefficient**	**S.e.**
α	-2.099***	0.467
Pop_t^{20-39}	2.377***	0.290
Pop_t^{40-64}	4.886***	1.109
Pop_t^{65+}	-1.351***	0.414
Δsr_t	0.004**	0.001
π_{t-1}	0.340**	0.157
$\Delta\pi_t$	-0.082	0.211
g_t	5.334*	2.540
Gap_t	-0.365**	0.147
R^2	0.951	
Adjusted R^2	0.925	
DW	2.026	
Diagnostic Test	**Stat.**	**Prob.**
F-statistic	36.392	0.000
Ljung-Box	14.384	0.156
Homoskedasticity	1.811	0.217
Normality	0.688	0.709
Unit root	-5.694	0.000
Wald $H_0 : \beta_1 = \beta_2 = \beta_3 = 0$	25.095	0.000
RESET (3)	1.826	0.196
Chow (1995)	0.253	0.969

To sum up, also results for BOT are consistent across all estimated variants and point towards a significant effect of population age structure on asset returns.

Two observations naturally arise when the estimated coefficients for demographic variables are compared across all the three asset return regressions. First, coefficients estimated for the fixed income market are generally lower than those reported for the stock market. This might stem from the fact that Italian households are more active as investors on the stock rather than on fixed-income market.[14] Italian stock market thus appears more sensible to population age-structure changes than government bond ones. Based on this evidence, the most striking consequences of Italian population ageing are expected to be experienced by the stock market. Second, within each asset return regression, the highest coefficients among demographic variables are generally associated with the share of working-aged, which are typically the most financially active share of the population. By contrast, the lowest (or even not statistically different from zero) coefficients are observed for elderly, which thus appears to be the less active over the entire Italian financial market, which is reasonable in the light of the pension system previously in force in Italy.

6.4 A comparative assessment with Davis and Li (2003)

Differently from Poterba (2004), Davis and Li (2003) study the relationship between age-structure and financial asset returns including in their model specifications some additional financial variables besides demographic ones. In this section we compare the results obtained for the Italian case with those reported by the authors for the US case. Note that the comparative evaluation is only possible for stocks and long-term government bonds as Davis and Li (2003) do not extend their analyses also to short-term public bonds. Furthermore, due to lack of sufficiently long time-series observations for dividend-yield, the estimation period for stock returns is different: 1950 – 1999 for Davis and Li (2003), 1973 – 2004 for this study.

As for the model specification of real returns on stocks, the financial variables included are the trend growth rate of GDP, a proxy for the output gap, the real long term interest rate, the volatility of share price index as a proxy for the risk premium and the lagged dividend-yield. The results for stock returns are reported in Table 19.[15]

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[14] This conclusion is suggested by the Bank of Italy Financial Accounts (over the period 1995 – 2005) which provide data on the aggregate financial wealth of Italian households and explicitly take into account financial assets indirectly held via banks and other financial intermediaries. This evidence is somewhat in contrast to the Bank of Italy Survey on Household Income and Wealth, whereby the latter may also be affected by non- or under-reporting (see Brunetti and Torricelli, 2006).

[15] In this study the regressions are estimated without any dummy, while Davis and Li (2003) include dummies for years 1953 and 1957 in the model specification for equities, and dummies for 1982, 1983, 1984 and 1985 in that for long-term government bonds in order to "*capture the high level of real rates in that period*".

Table 19: Comparison with Davis and Li (2003), returns on stocks.

Davis and Li (2003) US: 1950 - 1999			This Study Italy: 1973 - 2004		
Model	***Coefficient***	***s.e.***	***Model***	***Coefficient***	***s.e.***
Constant	-2.97**	0.64	Constant	5.386*	2.679
Pop_t^{20-39}	-0.0024	0.0098	Pop_t^{20-39}	11.641*	6.631
Pop_t^{40-64}	0.108**	0.02	Pop_t^{40-64}	-24.628**	11.873
g_t	-3.4	6.5	g_{t-1}	-39.77***	9.782
Gap_t	-1.28	0.97	Gap_{t-1}	1.405	2.042
r_t	0.03**	0.009	r_t	-6.029***	2.135
Vol_t	-1.19*	0.62	Vol_t	-0.019	0.027
DY_{t-1}	0.092**	0.026	DY_{t-1}	0.008	0.014
R^2	0.54		R^2	0.488	
Adjusted R^2	0.45		Adjusted R^2	0.332	
RSS	0.58		RSS	0.951	
SE of regression	0.12		SE of regression	0.203	
Test	**Statistic**	**Prob**	**Test**	**Statistic**	**Prob**
F-statistic	6.0	0.0	F-statistic	3.133	0.018
LM (2)	1.1	0.36	LM (2)	1.081	0.357
White	0.53	0.47	White	0.741	0.711
Jarque-Bera	1.53	0.28	Jarque-Bera	0.831	0.660
ADF	-5.9	N/A	ADF	-5.183	0.000
Wald on Pop_t^{40-64}	15.2	0.0	Wald on Pop_t^{40-64}	4.303	0.049
RESET	2.4	0.09	RESET	1.241	0.321
Stability	0.81	0.62	Stability	1.677	0.189

*Note: *, ** and *** denote 10%, 5% and 1% level of significance. LM (2) is the Lagrange multiplier test for serial correlation up to second order. The Chow test is performed over the period 1990-99 for Davis and Li (2003) while over the period 1995-2004 in this study.*

The better fit of Italian returns on equities to lagged rather than current values of these variables may be interpreted as a sort of stickiness of stock markets to real dynamics, which is reasonable in the light of the timing of data delivery. Since these variables are used as proxy for the expectations on future dividends growth and since data on the real economy are generally available with some delay, and generally not before the following year, it is not surprising that the returns on stocks do not react to current values and react instead, quite soundly, to lagged values. Both models pass all the diagnostic tests and seem to fit quite well the data. In fact, when the model is estimated for the Italian case both demographic and most financial variables are found strongly significant and the R^2 is in line with Davis and Li (2003). Both demographic variables display signs that contrast those in Davis and Li (2003) but are consistent with theoretical expectations: a larger share of early middle-aged, typically more risk-loving, pushes upwards the demand for equities, thereby increasing their prices and hence their returns, while the opposite holds for older working-age people. Finally, note that the estimated coefficients for the Italian case are on the whole higher than those reported for the US market and that this is particularly true for demographic variables. The population age-structure might thus play a more relevant role in determining stock returns in the Italian market than in the US one, possibly because of the more marked demographic transition occurring in Italy with respect to the US.

Table 20: Comparison with Davis and Li (2003), bonds yields.

Davis and Li (2003) US: 1950 - 1999			**This Study Italy: 1958 - 2004**		
Model	***Coefficient***	***s.e.***	***Model***	***Coefficient***	***s.e.***
Constant	12.3**	4.0	Constant	0.347	0.404
Pop_t^{20-39}	0.266**	0.052	Pop_t^{20-39}	-1.063**	0.480
Pop_t^{40-64}	-0.239**	0.084	Pop_t^{40-64}	0.230	0.864
Δsr_t	0.628**	0.1	Δsr_t	0.375**	0.185
$Spread_{t-1}$	-0.73**	0.125	$Spread_{t-1}$	-0.399**	0.166
π_{t-1}	-109.1**	9.7	π_{t-1}	-0.598***	0.176
$\Delta\pi_t$	-142.6**	10.0	$\Delta\pi_t$	-1.126***	0.162
g_t	-197.3**	58.9	g_{t-1}	-0.754	0.554
Gap_t	-5.8	6.4	Gap_{t-1}	0.003	0.034
R^2	0.98		R^2	0.808	
Adjusted R^2	0.97		Adjusted R^2	0.751	
RSS	4.9		RSS	0.009	
SE of regression	0.4		SE of regression	0.018	
Test	**Statistic**	**Prob**	**Test**	**Statistic**	**Prob**
F-statistic	102.9	0.0	F-statistic	14.216	0.000
LM (2)	16.2	0.0	LM (2)	11.017	0.000
White	1.8	0.19	White	2.498	0.030
Jarque-Bera	0.045	0.97	Jarque-Bera	1.322	0.516
ADF	0.06	N/A	ADF	-2.631	0.010
Wald on Pop_t^{40-64}	1.98	0.81	Wald on Pop_t^{40-64}	1.231	0.275
RESET	0.74	0.14	RESET	1.769	0.173
Stability	-3.7	0.67	Stability	2.107	0.085

Note: see note under Table 19. Newey-West standard errors.

Table 20 compares the results obtained for long-term government bonds yields. On the whole, the results reported in this study are basically comparable with those reported by Davis and Li (2003), both in terms of diagnostic tests and of fit of the model to the observed data. By contrast, as far as the estimated coefficients are concerned, some differences concern demographic variables. While Davis and Li (2003) find that both early and late working-aged are statistically significant, we find that in Italy only the younger share of the population actually affects the dynamics of the long-term government bond yields. Furthermore, as it was the case for stocks, we report the opposite signs with respect to what Davis and Li (2003) observe. The minus observed for the early working-aged is in fact the one suggested by the theory, as a higher share of young increases the demand for long-term bonds, thereby exerting an upward pressure on their prices and a negative one on their returns.

7 Specific features of the Italian labour market

The age-class partition used so far in this study is the standard one generally employed in the comparable empirical works. Nevertheless, as reported also by Davis and Li (2003) "*[…] the end-points of each cohort are open to debate – in some countries activity may begin later than 20 and retirement is earlier than 65*". Based on this argument and on the specific features of Italian labour market we perform a study that attempts to fix the most representative ending-points of the working-age in Italy.

Data for the average age of exit from the job market in Italy are available over the period 1994-2005 and are taken from Belloni et al. (2002) up to 2001 and from Eurostat thereafter. By contrast, data for the average age of entering on the Italian labour market are not directly available. Thus, a specific study has been performed using employment rates by age-classes provided by Eurostat and available since 1998. Data highlight that the bulk of the working activity occurs between 25 and 55 years of age, suggesting that most of the working people generally enter the labour market somewhere between 15 and 25 and leave between 55 and 65. Focussing on employment rates by 5-year age-classes, it emerged that the strongest raise in the average employment rate occurs between 15-19 and 20-24 and that the employment rate more than halves passing form 55-59 to 60-64 age-class. Based on this evidence, the effective ending points of the working-age in Italy are respectively set at 20, i.e. the most likely age of entry the job market, and 60, i.e. the most likely age of leaving the job market.

Consequently, the age-class partition has been adapted (20-40 for early working-aged, 40-59 for late working-aged and 60 or over for retired) and the regressions have been re-estimated. While the resulting coefficients for both early working-aged and retired shares are consistent with those reported above (i.e. significant and correctly signed), the share of late working-aged generally displayed poorer results, in terms of both significance and sings. A possible explanation stems from the fact that the data for the determination of the average ages of entry and leaving the job market in Italy are available only starting from 1998. The picture obtained is thus suitable only over the last decade. In addition, the age class of late working-aged has certainly the most mixed composition: wealth conditions, investment horizons and precautionary motives might significantly vary between the two end points of the age-class.

8 Conclusions

This paper assesses the role of the population age-structure in explaining financial returns on stocks, long- and short-term government bonds in Italy. In line with the literature, time-series regressions are run, first using only demographic variables as explanatory ones, as in Poterba (2001, 2004), and then including also financial variables, as in Davis and Li (2003).

In the purely demographic specification the most significant results for the Italian case are observed for the fixed-income market, although the estimated coefficients not always display expected sings and the evidence found is overall not robust across all the variants examined. These results, which are overall similar to those reported by Poterba (2001, 2004) for US, thus entail that demographic variables alone can not satisfactorily explain the dynamics of financial asset returns over the sample period considered.

By contrast, when the regression specification is extended to include also a set of financial variables as explanatory ones a different picture emerges. The evidence found is largely consistent across variants and suggests quite a relevant role of demographic variables in affecting financial returns. More specifically, the results indicate that financial and demographic variables together can explain up to 48.8% of the total variation in real returns on stocks. In addition, the estimated coefficients of demographic variables display signs in line with the theory, suggesting a positive (negative) effect of the share of early (late) working-aged on the real returns on stocks. Also the results for long-term government bonds point to a strong significance of both financial and demographic variables: together they explain up to 80.8% of the dependent variable variation, which is again in line with the US. However, in contrast to the US case, we find that only the share of early working-aged is statistically significant and has a negative sign. This evidence is sensible from a theoretical point of view, as a higher share of young investors pushes up the demand for long-term bonds reducing their returns. By contrast, late working-aged and retired seem not to play a significant role in affecting the course of long-term government bonds yields, as they probably are not particularly active in this market due to the investment horizon of these assets, which is uninteresting to them. Finally, also for BOT the estimated model fits quite well Italian data: both financial and demographic variables are strongly significant with extremely high R^2.

Comparing the demographic variable coefficients across all the three asset return regressions it emerges that the estimates for the fixed income market are generally lower than those reported for the stock market. Based on the latter observations, the impact of the projected population ageing in Italy might be more relevant for the stock market rather than for the fixed income one.

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