Demography and the Long-run Predictabilty

of the Stock Market

John GEANAKOPLOS

Cowles Foundation for Research in Economics
Yale University

Michael MAGILL

Department of Economics
University of Southern California

Martine QUINZII

Department of Economics
University of California, Davis

April 2001: first draft, very preliminary and incomplete
not for circulation

This paper was begun during a visit at the Cowles Foundation in Fall 2000: Michael Magill and Martine Quinzii are grateful for the stimulating environment and the research support provided by the Cowles Foundation.

Demography and Long-run Predictability of the Stock Market

1. Introduction

The striking outcome that emerges from the explicit introduction of demographic structure into a model of capital market equilibrium is that the future course of stock prices becomes to a significant degree predictable. For the size of the cohort of children today, who will mature into youth and middle age in the next 40 years is known: if, as is commonly observed, agents have typical and distinct financial needs at different periods of their lives—borrowing when young, when their needs exceed their income, investing for retirement in middle age, and disinvesting in retirement—and if fluctuations in the number of births lead to predictable changes in the cohort sizes of the different age groups who will trade on the financial markets in the future, then observed demographic change leads to a substantial degree of predictability of future stock prices.

The idea that demographic forces have a powerful impact on economic activity more generally—on capital accumulation and output–and hence on the stock market, is far from new. It formed the basis for the classic studies of Kuznets (1958, 1961) on the influence of long swings in the growth of population on capital accumulation and the stock market in the late 19$^{\text{th}}$ and early 20$^{\text{th}}$ centuries. More recently the controversial paper of Mankiw and Weil (1989) studied the impact of predictable demographic change on the housing market, a problem which is close in spirit to the problem that we propose to study in this paper for the stock market. Their analysis was based on a partial equilibrium model of the demand for housing by agents at different periods of their life, and their central theoretical conclusion was that the market for housing is not efficient:

> "the fluctuations in prices caused by fluctuations in demand do not appear to be foreseen by the market even though these fluctuations in demand were foreseeable . . . ."

A similar partial equilibrium and econometric analysis was carried out by Bergantino (1997): according to his model, a significant part (about 40%) of the increase in real housing prices between 1965 and 1980 can be accounted for by the baby-boom induced growth in demand and, since peak demand for equity occurs some twenty years after the peak demand for housing, a significant part (about 30%) of the increase in stock prices after 1985 can be attributed to the same demographic phenomenon. He then notes:

> "What makes this conclusion somewhat believable is that the demographic demand variables used to generate it are derived from observed age profiles of investment in

> housing and stocks. What makes this conclusion unbelievable, however, is that it implies predictability of long-run asset price cycles . . . . Many people are sure to be bothered by the thought of predictable booms and busts in stock market prices, since arbitrage by investors with rational expectations would seem to preclude such scenarios. . . . A question that does need to be answered . . . is whether or not the observed timing of movements in asset prices relative to changes in the age distribution of the population is consistent with rational expectations."

Our objective is to provide an analytical framework for studying this relation between changing demographic structure and capital market equilibrium. In the framework of a general equilibrium model which respects the tenets of rational expectations and absence of arbitrage opportunities, we study if predictable change in demographic structure can lead to predictable future change in asset prices—and how significant such prices changes can be.[1] The natural instrument for such an analysis is the overlapping generations model. Up till now the study of this model has mainly focused on the special case where demographic structure is unchanged: the population is assumed to grow at a constant rate, so that the age pyramid consists of a finite number of cohorts of identical size which grow at the same rate. The relative demands for securities are thus unchanged over time. Our objective is to study how the equilibrium of the model is altered when there are systematic changes in the number of births over time which lead to systematic changes in the age pyramid.

For the United States, the 20th century can be divided into approximately five twenty year periods of alternately high and low birth rates, generating the successive baby boom and bust generations of the 1910's, 30's, 50's, and 70's and 90's — the most famous being the remarkable post war baby boom of the 50's. To simplify the analysis and to enable us to mimic in broad outline the demographic changes that have occurred in the US, we focus on the case where the number of births is alternately high and low. The model is a basic OLG exchange economy with a single good in which agents have a random endowment in youth and middle age and the securities consist of a risk free bond and an equity contract. The population structure at any date is summarized by an age pyramid giving the number agents in each age cohort: the number of children, young, middle and old age agents. Changes in the number of births overtime lead to changes in the age pyramid —

[1] Bakshi and Chen (1994) seem to have been the first to observe the striking relation between the age wave—defined as the average age of the US population over 20—and the movements in the SP 500 Index after 1945. They attempt to construct an infinite-horizon representative-agent pricing model to account for the behavior of security prices: the representative agent is a "stand in" for all agents, having an age which is the average age of the population. One of the key assumptions is that the relative risk aversion of the representative agent is an increasing function of the average age. While their analysis is suggestive and provides insights into the behavior of the risk premium, it gives no clear insight into the way demographic forces influence the prices of assets over time.

and these changes in the relative sizes of the cohorts alive at any date, change the relative demands for the different securities on the financial markets. We study the stationary markov equilibrium of the resulting economy.

to be finished

2. Characteristics of the Economy

Consider an overlapping generations exchange economy with a single good (income) in which the economic life of an agent lasts for three periods: young, middle-age and retired. All agents have the same preferences and endowments and only differ by the date at which they enter the economic scene. Their preferences over lifetime consumption streams are represented by a standard discounted sum of expected utilities

$$U(c) = E\Big(u(c^y) + \delta u(c^m) + \delta^2 u(c^r)\Big), \qquad \delta > 0$$

where, for the calibration, u is assumed to be a power utility function

$$u(x) = \frac{1}{a}x^\alpha, \quad \alpha < 1$$

and since a "period" of the model represents 20 years in the lifetime of an agent we take a discount factor $\delta = 0.5$. $c = (c^y, c^m, c^r)$ denotes the random consumption stream of an agent when young, medium and retired. Each agent has a random endowment $w = (w^y, w^m, 0)$ which can be interpreted as the agent's labor income, where the income in retirement is zero. There are two financial instruments — a riskless short-term bond and an equity contract — which agents can trade to redistribute income over time and alter their exposure to risk. The (real) bond promises to pay one unit of income (for sure) in the next period and is in zero net supply; the equity contract is an infinite-lived security in positive supply (normalized to 1) which promises to pay a random dividend each period.

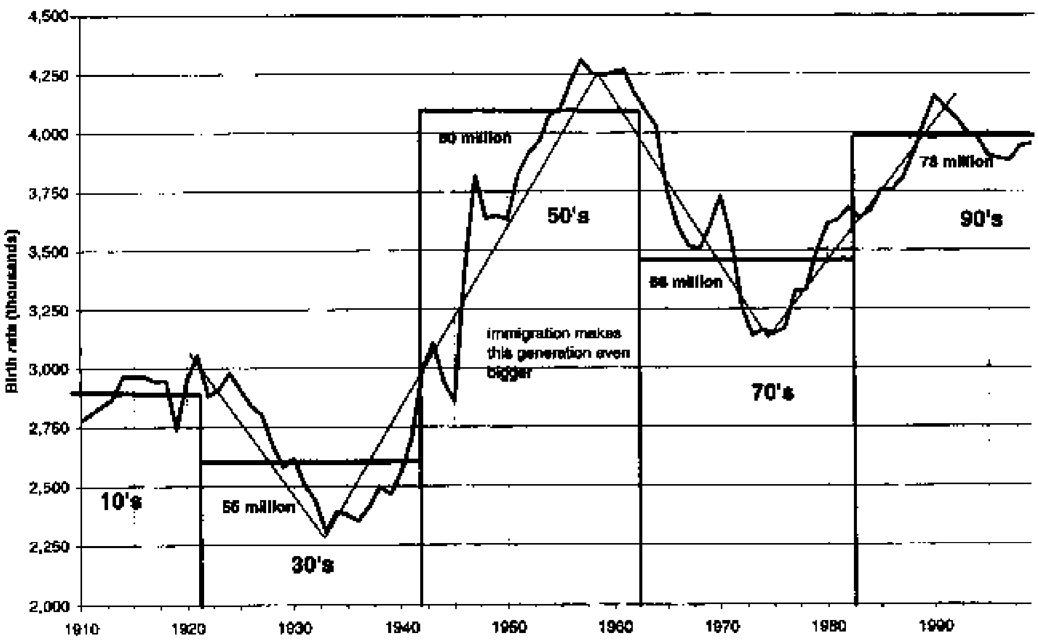
Demographic structure. Live births induce the subsequent age structure of the population: the live births for the US during the 20th century are shown in Figure 1. The number of births can be approximated by five alternating twenty year periods which create the alternatively large and small cohorts known as the 10's, 30's, 50's, 70's and 90's generations. We seek the simplest way of modeling this alternating sequence of generation sizes: time is divided into a sequence of 20 year periods and in each odd period a large cohort (N) comes onto the scene, while in each even period a small cohort (n) enters. As a result, there are two possible age pyramids or "pyramid

Figure 1:

states" which are indexed by $k \in \{k_1, k_2\}$. In every odd period, $k = k_1$ and the age pyramid is (N, n, N) i.e. N young, n middle age and N retired agents, where the middle age agents entered in the previous period and the retired two period before.[2] In the even periods, $k = k_2$ and the age pyramid is (n, N, n). In the computation of equilibrium we study two cases. The case we call "up" in which $n = 52$ and $N = 79$, where 52 million and 79 million are the approximate respective sizes of the Great Depression generation born 1925 - 1944 and the Baby Boom generation born 1945 - 1964; these two generations traded as medium and young in the period 1965 - 1984. The stationary equilibrium of this case should give an idea of the potential change in equity prices from a pyramid state $k = k_1$ when the large generation is young, to a pyramid state $k = k_2$ in which the large generation is middle aged. Given that the Baby Bust (Xer) generation born 1965 - 84 was larger (69 millions) than the Great Depression generation, this stationary equilibrium will exaggerate the subsequent decline in equity prices implied by the transition from pyramid state 2 to state 1. To correct for this, we compute the equilibrium of the case "down" in which N is kept at $N = 79$ and n is taken to be $n = 69$. Since the Echo Baby Boom generation born between 1985 and the present seems heeded for the same order of magnitude as the Baby Boom generation, the age pyramids

[2] An individual's "biological life" is divided into 4 periods, 0-19 (child), 20-39 (young) 40-59 (medium), 60 -79 (retired); the agent's "economic life" (earning income, trading on financial markets) begins when the agent is young. Thus the Great Depression generation born in the 30's (1925 - 1944) enters the economic scene in the 50's (1945 - 1964) as young and are middle-age in the period (1965 - 84), while the Baby Boom generation born in the 50's (1945 - 1964) enters in the 70's (1965 - 1984) as young and are middle-age agents in the period 1985 - 2004.

US Livebirths & the 5 Alternating Generations of 20th Century



(n, N, n) and (N, n, N) can be taken to approximately represent the age pyramids for the US for the periods 1985 - 2004 and 2005- 2024 respectively.

Wage Income and Dividends. The exchange economy is viewed as an economy with "fixed production plans": the presence of the equity market indicates that in the background there is a collection of firms producing (aggregate) output which is shared between workers and the owners of capital (the equity holders). From the macro literature we take the standard share of output going to labor to be 70% and to capital 30%: the output going to labor is shared between the young and the middle-age agents. Of the 30% going to capital we take the historical average of 50% to be distributed as dividends (see ERP 2000 and Historical Statistics of the US, Table), the other half is kept by the firms as retained earnings, being used to finance investment: a key simplifying assumption of the model is that the capital stock of firms is unchanged, so the retained earnings can be thought of as a heroic overstatement of funds devoted to depreciation allowance. This is an inevitable shortcoming of a model with fixed production plans. Since investment is not explicitly modeled, we choose the dividends paid on equity to be the proportion 15/70 of the total wage income (endowments) of the agents. To calibrate the relative shares of wage income going to young and middle-age agents, we draw on data of the Bureau of the Census shown in Figure 2: the maximum ratio of the average annual real income of agents in the age-groups 45-54 and 25-34 is $65/45 = 1.44$. We round this to 1.5 and calibrate the model on the basis of a wage income of 2 for each young agent and 3 for each middle-age agent. Since the agents have homothetic (CES) preferences the absolute levels of endowments and dividends do not influence the relative prices and relative consumption levels which will be the primary focus of the study.

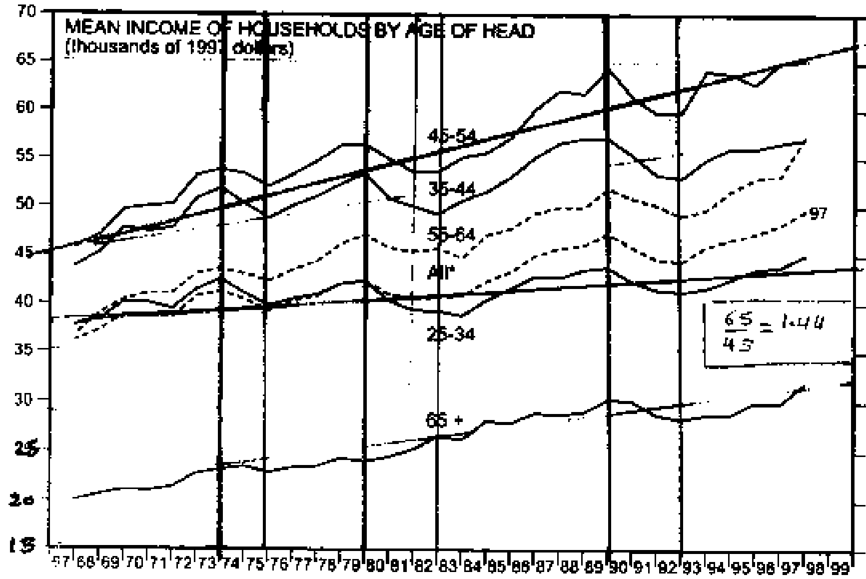
Since the wage income of middle-age agents is greater than that of the young, a change in the age pyramid leads to a change in the total income in the economy: total income is greater when the middle-age generation is large (pyramid $k = k_2$) than when the young generation is large (pyramid $k = k_1$). For the demographic structure of the "up case" $\Big((N, n) = (79, 52)\Big)$ in which there is a large variation in successive cohort sizes, total income is on average 7.2% higher when $k = k_2$ than when $k = k_1$: in the "down case" $\Big((N, n) = (79, 69)\Big)$ with its smaller variation in cohort sizes, the ratio is 2.3%. Since the active population is constant, this increase in output has to be interpreted as coming from an increase in the average productivity of labor: for implicit in the model is that middle-age agents are more experienced and productive than the young since they are paid higher wages, so that an increase in the relative size of the middle-age cohort leads to an increase labor productivity. To simplify the calculation of the stationary Markov equilibrium we assume that

Figure 2: *Wage income of different age groups over time*

the model has been "detrended" so that the systematic sources of growth of output arising from population growth, capital accumulation and technical progress are factored out: the sole source of variation of total output comes from changes in the demographic structure and "business cycle" shocks to which we now turn.

There are inherent limits to how well one can model the stochastic structure of an economy when the heterogeneity of individuals is not explicitly taken into account. For in the representative agent approach that we adopt, a single individual is simultaneously a "stand in" or representative for every individual and for the aggregate of all individuals: since aggregation reduces risk, we end up either overstating aggregate risk or understating the risks faced by individuals. But this presents an awkward problem for a model of the stock market where risk is the essence of the game: how can we retain a simple structure for the OLG general equilibrium model while at the same time delivering reasonable approximations of equity price movements? The strategy we adopt is to somewhat exaggerate the aggregate risks in making the calibration in order to bring out more accurately the exposure of agents to individual risk.

If aggregation across individuals distorts the structure of risk in the economy, then aggregation across time can lead to a further distortion. In our model, a period represents 20 years. The period, or rather the income of consumption for the period can be interpreted in one of two ways. The first is as average income: then the period income, being the average of 20 incomes, will vary much less than the annual income, which is already not very variable since it is an average across



MEAN INCOME OF HOUSEHOLDS BY AGE OF HEAD
(thousands of 1997 dollars)
45-54
35-44
55-64
All
25-34
65 +
97
65/45 = 1.44

individuals. Taken to the extreme this leads to a model in which risk virtually disappears. The second approach — in the spirit of representative agent analysis — lets the period income be a stand in or "representative income" for the 20 annual incomes, taking into account the persistence of shocks by increasing the observed variability of annual income. It is the latter approach which we adopt since it better reflects the risk structure of the economy within a representative agent model.

Risk Structure. To model the risk structure of the economy we assume that the incomes of agents and the dividends on equity are subject to shocks. At each date there are four possible states of nature (shocks), s_1=(high income, high dividend), s_2 = (high income, low dividend), s_3=(low income, high dividend), s_4=(low income, low dividend). Given the nature of the risks and the very extended period of time between shocks (20 years) we have chosen not to a invoke a markov structure, but rather to assume that the shocks are i.i.d. To reflect the fact that aggregate income and dividends are positively correlated we assume that s_1 and s_4 are more likely (probability 0.4 each) than s_2 and s_3 and this gives rise to a correlation between dividends and income of approximately 0.7.

Figure 2 shows that the maximum variability of the annual income of the 45-54 cohort is about 4%: in the recession of 1990-91 the income went from 65 to 60 (thousands of 1997 dollars), a variability of (2.5/62.5)=0.04. To study the impact on the equilibrium of differing levels of income risk for the agents, we consider two cases: a low risk case in which the coefficient of variation (CV) of the wage income of the young is 5% and that of the middle age is 6.7%, and a higher risk case in which the coefficients are 10% and 16.7% respectively. Corresponding to the two demographic cases of "up" and "down" we take the CV of dividends to be 14% and 18% respectively: this leads to a CV for total income of about 7% in the low risk case and 14% in the high risk case.

Stationary Equilibrium. Since the economy $\mathcal{E}(u, w, d, N, n)$ has a stationary structure, it is natural to look for a stationary equilibrium. Since agents' (economic) lives span 3 periods, it can be shown that a markov equilibrium cannot be constructed which depends on the exogenous states — the pyramid and shock states. What is needed is an endogenous variable which summarizes the dependence of the equilibrium on the past — the income which the middle-age agents inherit from their portfolio decision in their youth. Thus we will study equilibria with a state space $\Xi = \Gamma \times K \times S$ where Γ is a compact subset of $\mathbb{R}_+$,$K = \{k_1, k_2\}$ is the set of pyramid states and $S = \{s_1, s_2, s_3, s_4\}$ is the set of shock states: we let $\xi = (\gamma, k, s)$ denote a typical element of the state space Ξ, γ denoting the portfolio income inherited by the middle age agents from their youth.

The pyramid state $k \in K$ determines the age pyramid $N(k) = \Big(N^y(k), N^m(k), N^r(k)\Big)$ i.e. the number of young, middle-age and retired agents. If k is the population state at date t, we let k^+ (resp. k^-) denote the pyramid state at date $t+1$ (resp. $t-1$). Since the pyramid states alternate, if $k = k_1$ then $k^+ = k^- = k_2$. The output shock $s \in S$ determines the incomes $w^h = (w^y_s, s \in S)$ and $w^m = (w^m_s, s \in S)$ of the young and medium agents, as well as the dividend $d = (d_s, s \in S)$ on the equity contract.

To find a markov equilibrium, we note that the security prices only need to make the portfolio trades of the young and middle-age agents compatible: the retired agents have no portfolio decision to make — they collect the dividends and sell their equity holdings. Thus we are led to study the portfolio problems of the young and the middle age agents, the latter inheriting the income γ, and to look for security prices which clear the markets. This problem can be reduced to the study of a family of two-period portfolio problems in which middle-age agents anticipate the consequences of their decisions for their retirement — they need to anticipate the next period equity price Q^e — and young agents anticipate the portfolio income they will transfer into middle age (which also depends on Q^e) and the saving decision F that they will make next period to provide income for their retirement. A correct expectations equilibrium then has the property that the agents' expectations are fulfilled in the next period. Given that an equilibrium will involve both current and anticipated variables we introduce the convention that current variables are denoted by lower case letters, while anticipated variables are denoted by capitals. A stationary markov equilibrium will be a function $\Phi : \, \Xi \longrightarrow \mathbb{R}^4 \times \mathbb{R}^2_+ \times \mathbb{R}^8_+$ with $\Phi = (z, q, Q^e, F)$, where $z = (z^y, z^m) = (z^y_b, z^y_e, z^m_b, z^m_e)$ is the vector of bond and equality holdings of the young (medium) agents respectively, $q = (q_b, q_e)$ is the vector of current bond and equity prices, $Q^e = (q^e_s, s \in S)$ is the vector of *anticipated* next period equity prices and $F = (F_s, s \in S)$ is the vector of *anticipated* next period savings of the young. To express the condition on correct expectations we need the following notation: if in state ξ young agents choose a portfolio $z^y(\xi)$ and anticipate equity prices $Q^e(\xi)$, then the income $\Gamma(\xi) = \Big(\Gamma_s(\xi), s \in S\Big)$ which they *anticipate* transferring into middle age is given by

$$\Gamma(\xi) = V(\xi) z^y(\xi), \quad \xi \in \Xi$$

where $V(\xi) = (\mathbf{1}, d + Q^e(\xi))$ with $\mathbf{1} = (1, \ldots, 1) \in \mathbb{R}^4$ denoting the sure payoff on the bond and $d = (d_s, s \in S)$ the random dividend on equity. We let $f(\xi)$ denote the actual savings chosen by middle-age agents when the state is ξ, thus

$$f(\xi) = q(\xi) z^m(\xi), \quad \xi \in \Xi$$

Definition. A function $\Phi = (z, q, Q^e, F) : \Xi \longrightarrow \mathbb{R}^4 \times \mathbb{R}^2_+ \times \mathbb{R}^8_+$ is a *stationary (markov) equilibrium* of the economy $\mathcal{E}(u, w, d, N(k), k \in K)$ if $\forall\ \xi = (\gamma, k, s) \in \Xi$

$$\text{(i)}\ \ z^y(\xi) = \arg\max_{z^y \in \mathbb{R}^2} \left\{ u(c^y) + \delta \sum_{s' \in S} \rho_{s'} u(C^m_{s'}) \ \middle|\ \begin{array}{l} c^y = w^y_s - q(\xi) z^y \\ \\ C^m = w^m + V(\xi) z^y - F(\xi) \end{array} \right\}$$

$$\text{(ii)}\ \ z^m(\xi) = \arg\max_{z^m \in \mathbb{R}} \left\{ u(c^m) + \delta \sum_{s' \in S} \rho_{s'} u(C^r_{s'}) \ \middle|\ \begin{array}{l} c^m = w^m_s + \gamma - q(\xi) z^m \\ \\ C^r = V(\xi) z^m \end{array} \right\}$$

$$\text{(iii)}\ \ N^y(k)\, z^y_b(\xi) + N^m(k)\, z^m_b(\xi) = 0, \quad N^y(k)\, z^y_e(\xi) + N^m(k)\, z^m_e(\xi) = 1$$

$$\text{(iv)}\ \ Q^e_{s'}(\xi) = q^e\Big(\Gamma_{s'}(\xi), k^+, s'\Big), \quad \forall\ s' \in S, \qquad F_{s'}(\xi) = f\Big(\Gamma_{s'}(\xi), k^+, s'\Big), \quad \forall\ s' \in S$$

Remark. (i) and (ii) are the conditions requiring maximizing behavior on the part of young and middle-age agents who anticipate the equity prices $Q^e(\xi)$ and, in the case of the young agents, anticipate the savings $F(\xi)$. Note that the vector of consumption $C^m \in \mathbb{R}^4_+$ which a young agent anticipates for middle age (hence the capital letter) must be distinguished from $c^m(\xi) \in \mathbb{R}$ which is the current consumption of a middle-age agent. (iii) requires that the aggregate demands of the two cohorts for the bond and equity clear the markets. (iv) is the condition requiring the agents' expectations be correct. In choosing their portfolio $z^y(\xi)$ in state ξ, young agents anticipate transferring the income $\Gamma(\xi) = V(\xi) z^y(\xi)$ to the next period — where $V(\xi)$ is the anticipated payoff of the securities depending on $Q^e(\xi)$. In order that $Q^e_{s'}(\xi)$ be a correct expectation, it must coincide with the price $q_e\Big(\Gamma_{s'}(\xi), k^+, s'\Big)$ which is realized in output state s' when middle-age agents receive the portfolio income $\gamma' = \Gamma_{s'}(\xi)$ and the pyramid state is k^+; in the same way the saving $F_{s'}(\xi)$ that the young anticipate doing in their middle age must coincide with the actual savings of a middle-age agent with asset income $\gamma' = \Gamma_{s'}(\xi)$.

Before examining how the equilibrium of the calibrated model behaves, we will indicate briefly a few broad outlines of the way the stock market has behaved, particularly since 1945, which is the first period where two of the generations born entirely within this century trade together.

brief description of these facts, see Figure 3

To derive the equilibrium of the calibrated model we take a grid over the asset income carried over by the middle-aged representative agent and by a sequential procedure compute an approximation to the equilibrium. The results can be summarized as follows:

Real Standard & Poors Index of Common Stock Prices 1871-2024: Possible Scenarios

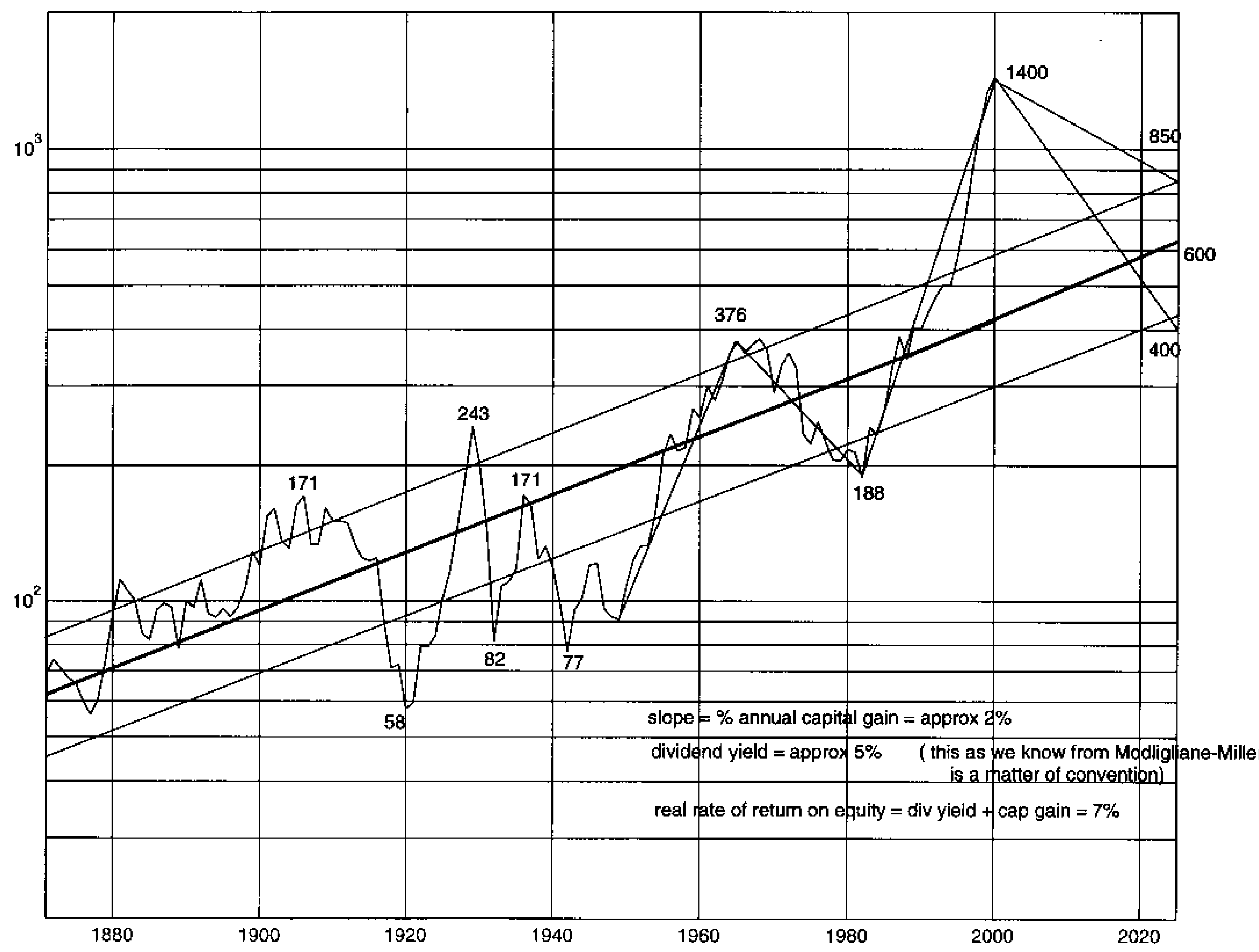


Table 1. Case "up", High risk

$N = 79,\ n = 52,\ w^y = (2.2, 2.2, 1.8, 1.8),\ w^m = (3.5, 3.5, 2.5, 2.5),\ D = (70, 50, 70, 50)$

		pyramid 1			pyramid 2		
		p_e	r^{an}	rp^{an}	p_e	r^{an}	rp^{an}
rra2	s_1	70 (.5)	3.7% (0)		122 (3)	-.5% (.02)	
	s_2	70 (.4)	3.7% (0)		116 (3)	-.2% (.02)	
	s_3	44 (.3)	6.2% (0)		72 (2)	2.2% (.02)	
	s_4	44 (.4)	6.2% (0)		69 (2)	2.4% (.02)	
	Average	57 (12.8)	4.9% (1.3)	0.32 (0)	94 (26)	1.1% (1.4)	0.26 (0)
		ratio of av. prices: 1.6			*peak / trough*: 2.8		
rra4	s_1	87 (1.4)	3.1% (.01)		243 (21)	-4% (.2)	
	s_2	83 (1)	3.4% (.01)		215 (17)	-3.4% (.2)	
	s_3	41 (0.6)	7.5% (.02)		87 (7)	0.9% (.2)	
	s_4	39 (.6)	8% (.02)		71 (6)	2% (.2)	
	Average	61 (23)	5.7% (2.3)	1.2 (0)	155 (84)	-1% (2.9)	0.8 (.02)
		ratio of av. prices: 2.5			*peak / trough*: 6.2		
rra6	s_1	109 (6)	2.3% (.1)		465 (78)	-7.2% (.6)	
	s_2	100 (4)	2.9% (.1)		361 (58)	-6% (.5)	
	s_3	42 (2)	8.3% (.1)		94 (16)	.4% (.6)	
	s_4	39 (1)	9.1% (.1)		67 (11)	2.1% (.7)	
	Average	75 (34)	5.5% (3.3)	2 (0)	252 (195)	-2.5% (4.4)	1.3 (.03)
		ratio of av. prices: 3.4			*peak / trough*: 11.9		

Table 2. Case "down", High risk							
$N=79,\ n=69,\ w^y=(2.2,2.2,1.8,1.8),\ w^m=(3.5,3.5,2.5,2.5),\ D=(80,60,80,60)$							
		pyramid 1			**pyramid 2**		
		p_e	r^{an}	rp^{an}	p_e	r^{an}	rp^{an}
rra2	s_1	89 (1)	2.5% (.01)		107 (2)	1.1% (.01)	
	s_2	88 (1)	2.6% (0)		104 (2)	1.3% (.01)	
	s_3	55 (1)	5.1% (.01)		65 (1)	3.8% (.02)	
	s_4	55 (1)	5.1% (.01)		63 (1)	3.9% (.01)	
	Average	72 (17)	3.8% (1.3)	0.27 (0)	84 (22)	2.6% (1.4)	0.25 (0)
		ratio of av. prices: 0.86			*trough / peak* : 0.51		
rra4	s_1	118 (2)	1.1% (.01)		168 (9)	-1.3% (.1)	
	s_2	111 (2)	1.4% (.01)		153 (7)	-.8% (.1)	
	s_3	50 (1)	5.7% (.01)		64 (3)	3.5% (.1)	
	s_4	46 (1)	6.3% (.01)		57 (2.4)	4.3% (.1)	
	Average	81 (35)	3.7% (2.5)	1 (0)	116 (54)	1.2% (2.7)	0.8 (.03)
		ratio of av. prices: 0.71			*trough / peak* : 0.27		
rra6	s_1	166 (4)	-.7% (.02)		274 (26)	-3.8% (.2)	
	s_2	147 (3)	0% (.01)		229 (20)	-2.9% (.2)	
	s_3	50 (1)	5.7% (.01)		65 (6)	3.2% (.2)	
	s_4	42 (1)	7% (.02)		51 (4)	4.6% (.2)	
	Average	104 (60)	3% (3.7)	2 (0)	154 (108)	0.6% (4)	1.6 (.07)
		ratio of av. prices: 0.68			*trough / peak* : 0.15		

Table 3: Case up, High risk: Lifetime Consumption Streams

		rra 2				rra 4				rra 6			
		boomer		*Xer*		*boomer*		*Xer*		*boomer*		*Xer*	
Average consumption	*young*	18,200 (1,900)		22,800 (3,000)		17,300 (1,500)		23,900 (3,700)		16,800 (1,200)		24,400 (4,300)	
	middle	21,300 (3,200)		18,500 (2,900)		20,000 (2,700)		19,800 (3,200)		18,700 (2,400)		21,600 (3,500)	
	retired	17,000 (2,500)		21,400 (3,200)		16,500 (2,600)		22,700 (3,300)		16,600 (2,700)		23,800 (3,300)	
Market prices	*young*	57 (13)	5 (1.3)	93 (26)	1 (1.4)	61 (23)	5.7 (2.3)	155 (84)	-1 (2.9)	75 (34)	5.5 (3.3)	251 (195)	-2.5 (4.4)
	middle	93 (26)	1 (1.4)	57 (13)	5 (1.3)	155 (84)	-1 (2.9)	61 (23)	5.7 (2.3)	251 (195)	-2.5 (4.4)	75 (34)	5.5 (3.3)
	retired	57 (13)		93 (26)		61 (23)		155 (84)		75 (34)		251 (195)	

References

Bakshi, G.S. and Z. Chen (1994), "Baby Boom, Population Aging and Capital Markets", *Journal of Business*, 67, 165-202.

Bergantino, S.M. (1997), "Booms, Busts and babies: The Effect of Demographics on Housing and Stock Prices", MIT Discussion Paper.

Campbell, J and R.J. Shiller (1988), "Stock Prices, Earnings, and Expected Dividends," *Journal of Finance*, 43, 661-676.

Constantinides,G.M., Donaldson,J.B. and R. Mehra (2000), "Junior Can't Borrow: A New Perspective on the Equity Premium Puzzle", forthcoming, *Quarterly Journal of Economics.*

Easterlin, R.A. (1987), *Birth and Fortune*, University of Chicago Press.

Fama, E.F and K.R. French (1988), "Permanent and Temporary Components of Stock Prices," *Journal of Political Economy*, 96, 246-273.

Jagannathan, R. and N.R. Kocherlakota (1996), "Why Should Older People Invest Less in Stocks Than Younger People," *Federal Reserve Bank of Minneapolis Quarterly Review*, Summer 1996, 11-23.

Kuznets, S. (1958), "Long Swings in the Growth of Population and in Related Economic

Variables," *Proceedings of the American Philosophical Society*, 102, 25-52

Kuznets, S. (1961), *Capital and the American Economy: its Formation and Financing*, Princeton University Press.

Mankiw, N. and D. Weil (1989), "The Baby Boom, the Baby Bust and the Housing Market," *Regional Science and Urban Economics,* 19, 235-258.

Mehra, R. and E.C. Prescott (1985), "The Equity Premium: A Puzzle," *Journal of Monetary Economics*, 15, 145-161.

Poterba, J. and L. Summers (1988), "Mean Reversion in Stock Prices: Evidence and Implications," *Journal of Financial Economics*, 22, 27-59.

Shiller R.J. (2000), *Irrational Exuberance*, Princeton University Press.