Fluctuations in Dividend/Price and Demographic Factors: Does MY Ratio predict Risk Premia?

Presentation for Dondena Seminar at Bocconi University

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Outline

- Introduction
- Literature Review
- Demography & Dividend/Price in a Cointegration Framework
- Predictability of Stock Market (Excess) Returns
- Equity Premium Simulation up to 2050
- Conclusion & Future Research

Motivation

“The market is like an excitable dog on a very long leash in New York City, darting randomly in every direction. The dog’s owner is walking from Columbus Circle, through Central Park, to the Metropolitan Museum. At any one moment, there is no predicting which way the pooch will lurch. But in the long run, you know he is heading northeast at an average speed of three miles per hour. What is astonishing is that almost all of the market players, big and small, seem to have their eye on the dog, and not the owner.“

Ralph Wanger ("The four Pillars of Investing", W. Bernstein)

Objectives

- Does a long-run equilibrium relationship exist between fundamentals and dividend/price?
- Can disequilibrium in the short-run be used to forecast price changes?

Our Strategy

- to use economic fundamentals in a cointegration analysis to derive a long-run equilibrium for the dividend/price
- to use disequilibrium of the dividend/price with respect to fundamentals to construct a forecasting model (VECM) for excess returns at different horizons
- to assess the properties of the models against alternative specifications
- to exploit predictability and exogeneity of the demographic factors to produce long term projections for stock market (excess) returns

Return Predictability Literature

$$dp_t \simeq \overline{dp} + \sum_{j=1}^{\infty} \rho^{j-1} E_t[(h^s_{t+j} - \bar{h}) - (\Delta d_{t+j} - \bar{d})]$$

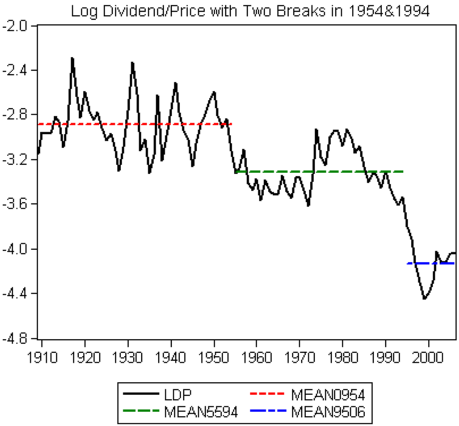
- Return predictability literature (See, for example, Cochrane, 2007)
  - Dynamic dividend growth model proposed by Campbell&Shiller (1988)
  - A loglinear approximation to the definition of returns on the stock market to express the log of the dividend/price, dp_t, as a linear function of the future discounted of future returns, h^s_{t+j} and dividend growth, Δd_{t+j}.
  - Dynamic dividend growth model nests the classical Gordon growth model (1966), the FED model (Lander et al., 1997), Lamont (1998), Asness (2003), Lettau and Ludvigson (2001), Julliard (2004), Ribeiro (2005)...

Potential Problems

- Non-predictability of financial returns (Goyal&Welch, 2008)
  - the degree of predictability varies with the chosen sample and so does the relative performance of different models
- weakness of the fundamental hypothesis of the dynamic dividend growth that log dividend price ratio is a stationary process (Lettau&Van Nieuwerburgh, 2008, LVN henceforth).
- LVN show evidence on the breaks in $\overline{dp}$ and assert that correcting for the breaks improves predictive power of the dividend/price for stock market returns.
  - Breaks are modelled via a purely statistical methods without any explicit relation with economic fundamentals.

$$dp_t \simeq \overline{dp_t} + \sum_{j=1}^{\infty} \rho^{j-1} E_t[(h^s_{t+j} - \bar{h}) - (\Delta d_{t+j} - \bar{d})]$$

Two breaks in the mean (L&VN, 2008)



Demography & Financial Markets Literature

- Role of demographics in financial markets (Bakshi&Chen,1994)
  - Life cycle investment hypothesis
  - Life cycle risk aversion hypothesis
- Empirical Evidence: Yoo (1994), Erb et al. (1996), Poterba (2001), Goyal (2004), Ang & Maddaloni (2005)
- Theoretical Models: Yoo (1997), Brooks (2000,2002), Abel (2003), Geanakoplos et al. (2004, GMQ henceforth)

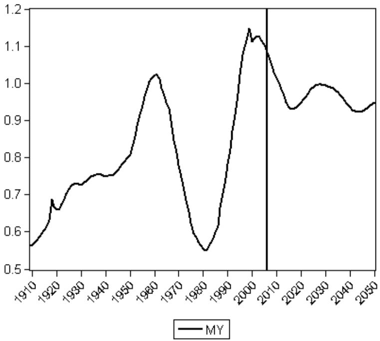
Theoretical Background

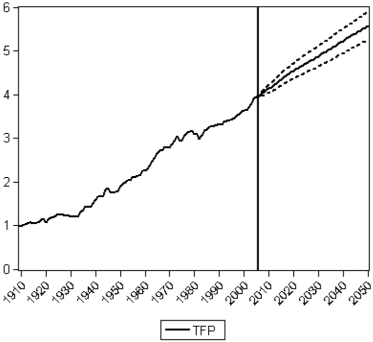
- GMQ study the equilibrium of a cyclical OLG economy to show that the level of asset prices is related to the ratio of middle aged to young adults (MY).
  - Middle / Young (MY) : the ratio of the number of agents aged 40-49 to the number of agents aged 20-29
  - Since fluctuation in prices delivered by the demographic model is not of the same order of magnitude as the observed variability of equity prices GMQ study the combined effect for asset prices of demographic and business cycle fluctuations
- We posit the following potential cointegrating vector as directly determined by the theoretical model:

$$(d_t - p_t) = \beta_0 + \beta_3 MY_t + \beta_4 TFP_t$$

- TFP(MFP) controls for joint effects of many factors including new technologies, economies of scale, managerial skill, changes in the organization of production, etc...

The Series



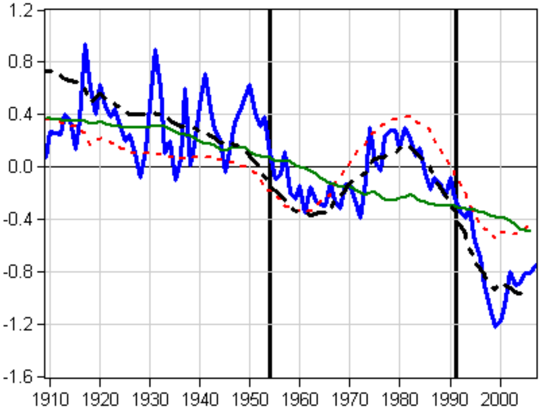


- MY from U.S. Census Bureau, TFP from Bureau of Labor Statistics & Solow (1957)

Empirical Evidence for Cointegration Relation

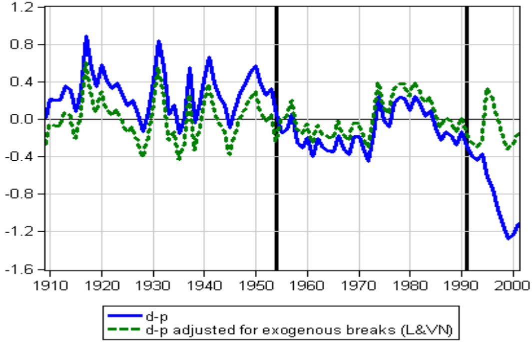
- Our cointegrating vector

$$(d_t - p_t) = \beta_0 + \beta_3 MY_t + \beta_4 TFP_t$$



Explaining the Breaks...

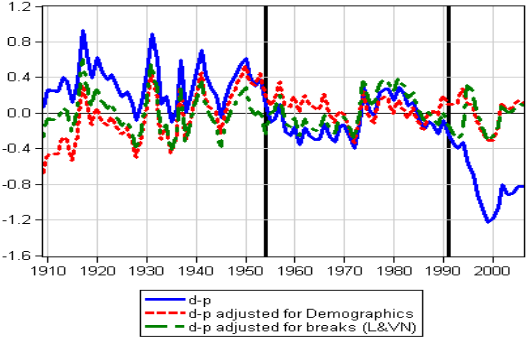
- Exogenous breaks (L&VN, 2008)



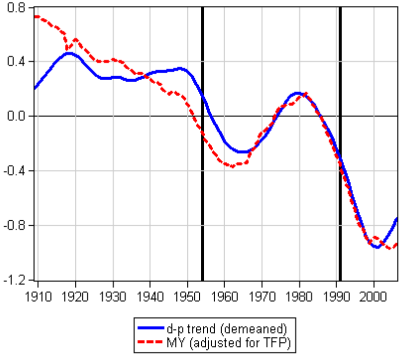
Explaining the Breaks...

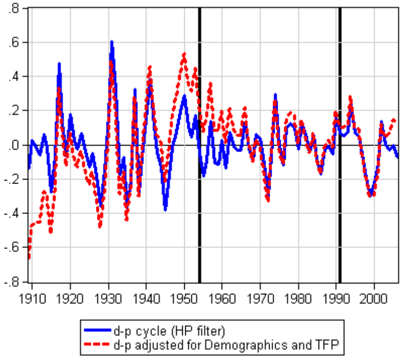
- Endogenizing the breaks using information in demographics

$$dp_t^{TD} = (d_t - p_t) - (\widehat{\beta}_0 + \widehat{\beta}_3 MY_t + \widehat{\beta}_4 TFP_t)$$

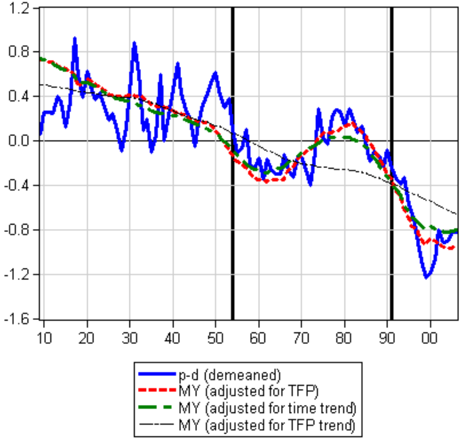


D/P Trend Cycle Decomposition





Alternative Trend Specifications



Johansen Procedure

$$\begin{pmatrix} \Delta p_t \\ \Delta d_t \\ \Delta TFP_t \\ \Delta MY_t \end{pmatrix} = \Pi_0 + \Pi_1 \begin{pmatrix} \Delta p_{t-1} \\ \Delta d_{t-1} \\ \Delta TFP_{t-1} \\ \Delta MY_{t-1} \end{pmatrix} + \begin{pmatrix} \alpha_{11} \\ \alpha_{21} \\ \alpha_{31} \\ \alpha_{41} \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{pmatrix}^T \begin{pmatrix} p_{t-1} \\ d_{t-1} \\ TFP_{t-1} \\ MY_{t-1} \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{2t} \\ v_{3t} \\ v_{4t} \end{pmatrix}$$

- we impose the restrictions: $\beta_1 = -1$, $\beta_2 = 1$

Estimation

Cointegrating Eq:	dp^{TD}_{t-1}	t-stat	χ^2	Prob.
p_{t-1}	-1		6.49	0.01
d_{t-1}	1			
TFP_{t-1}	0.290	(5.39)		
MY_{t-1}	1.554	(5.19)		
constant	1.318			

Error Correction	Δp_t	Δd_t	ΔTFP_t	ΔMY_t
dp^{TD}_{t-1}	0.315	-0.070	0.042	0.002
	(3.78)	(-1.59)	(1.81)	(0.30)
Δp_{t-1}	0.245	0.347	0.083	-0.001
	(2.27)	(6.07)	(2.78)	(-0.15)
Δd_{t-1}	-0.319	0.186	-0.036	0.017
	(-2.09)	(2.30)	(-0.84)	(1.38)
ΔTFP_{t-1}	-0.252	-0.072	-0.005	-0.061
	(-0.66)	(-0.36)	(-0.05)	(-1.97)
ΔMY_{t-1}	1.077	-0.411	-0.306	0.790
	(1.32)	(-0.95)	(-1.36)	(11.87)
constant	0.055	0.021	0.030	0.002
	(2.54)	(1.82)	(5.08)	(1.23)
Adj. R^2	0.17	0.40	0.04	0.63

Robustness

- Different samples
- Constancy of cointegration parameters : Recursively calculated eigenvalues & Nyblom tests (Warne et al., 2003)
- Alternative constructions of TFP (Beaudry & Portier, 2004)
- Additional demographic variables
  - *Support Ratio (SR)*: the ratio between the number of effective number of producers, L_t, over the effective number of consumers, N_t. In practice we adopt the following empirical proxy:

$$SR = a2064/(a019 + a65ov)$$

where $a2064$ $(a019)$: Share of population between age 20-64 (0-19), $a65ov$: Share of population age 65+.

–> The restrictions that the coefficient on SR is zero in the cointegrating vector cannot be rejected.

Within Sample Evidence

- Our within sample evidence is constructed by comparing raw and adjusted dividend-price ratios for the sample 1909-2006, 1909-1954 and 1955-2006. We consider a sample split in 1954 in the light of the evidence in provided by LVN (2008).
- In practice, we consider the following set of regressions where excess returns at different horizons (one to ten years), $r_{m,t+H} - r_{f,t+H}$, are projected on a constant and the relevant measure of the dividend-price ratio

$$
\begin{aligned}
r_{m,t+H} - r_{f,t+H} &= \gamma_0 + \gamma_1 z_t + \varepsilon_{t+H} \\
z_t &= dp_t, \widetilde{dp}_t, dp_t^{TD}
\end{aligned}
$$

Results 1909-2006

$z_t =$	Horizon h (in years) 1	2	3	4	5
dp_t	0.073	0.158	0.201	0.276	0.355
	(1.60)	(2.28)	(2.36)	(2.87)	(3.31)
	[2.18]	[6.08]	[7.27]	[10.5]	[14.4]
$\tilde{dp}_t$	0.171	0.454	0.526	0.673	0.767
	(2.20)	(4.08)	(2.94)	(3.03)	(3.21)
	[2.97]	[12.6]	[12.7]	[16.0]	[17.8]
dp_t^{TD}	0.259	0.568	0.688	0.885	1.025
	(3.80)	(5.78)	(4.77)	(5.32)	(6.36)
	[11.1]	[25.9]	[28.6]	[35.5]	[40.3]
dp^{CFN}	0.671	1.286	1.526	1.593	1.579
	(5.93)	(5.88)	(6.31)	(7.08)	(6.05)
	[22.7]	[38.7]	[39.5]	[33.2]	[28.9]

$z_t =$	Horizon h (in years) 6	7	8	9	10
dp_t	0.403	0.460	0.538	0.592	0.642
	(3.26)	(3.36)	(3.35)	(3.11)	(2.71)
	[16.8]	[19.4]	[22.0]	[22.2]	[20.8]
$\tilde{dp}_t$	0.736	0.748	0.882	0.842	0.879
	(2.93)	(3.13)	(4.10)	(3.12)	(3.71)
	[15.4]	[14.5]	[18.1]	[12.9]	[16.1]
dp_t^{TD}	1.028	1.017	1.051	0.986	0.951
	(6.56)	(7.00)	(7.53)	(6.12)	(5.36)
	[37.7]	[34.2]	[33.0]	[26.9]	[22.3]
dp^{CFN}	1.517	1.698	1.917	2.127	2.402
	(3.59)	(3.46)	(3.92)	(3.63)	(3.56)
	[24.8]	[30.9]	[35.4]	[38.9]	[42.2]

- We report Newey-West (1987) corrected t-statistics in parenthesis and adjusted R^2 in square brackets.

Univariate Regressions

- Other financial ratios used in the framework of the dynamic dividend growth model over the sample 1955-2001.
- We do so by first considering alternative univariate models based on the different ratios:

$$
\begin{aligned}
r_{m,t+H} - r_{f,t+H} &= \gamma_0 + \gamma_1 z_t + \varepsilon_{t+H} \\
z_t &= dp_t^{TD}, RREL_t, de_t, term_t, \\
&\quad default_t, cay_t, cdy_t, pe_t
\end{aligned}
$$

where dp_t^{TD} : (dp_t) adjusted for demographics, $RREL_t$: detrended short term interest rate, de_t: log dividend earningratio, pe_t ,log price earning ratio, $term_t$: long term bond yield (10Y) over 3M treasury bill, $default_t$: the difference between the BAA and the AAA corporate bond rates, cay_t and cdy_t cointegration variables introduced by LL (2001, 2005).

- We also consider a forecasting model exploiting simultaneously all the available information.

$$
\begin{aligned}
r_{m,t+H} - r_{f,t+H} &= \gamma_0 + \gamma_1 \mathbf{x}_t + \varepsilon_{t+H} \\
\mathbf{x}_t &= \begin{bmatrix} RREL_t \\ term_t \\ default_t \\ dp_t^{TD} \\ de_t \\ pe_t \\ cay_t \\ cdy_t \end{bmatrix}
\end{aligned}
$$

- We adopt Bayesian Model Averaging (BMA) to deal with the following problems such as potential multicollinearity between regressors in the multivariate model and model uncertainty.

BMA Results 1955-2006

Bayesian Model Averaging (BMA) Model Selection (Sample:1955-2006)								
Model: $r_{m,H}-r_{f,H-1}$	dp^{TD}_{t-1}	de_{t-1}	pe_{t-1}	cay_{t-1}	$RREL_{t-1}$	$Term_{t-1}$	$Default_{t-1}$	Prob.
H:1 Year								
Model 1	1	0	0	0	0	0	0	44.17
Model 2	1	0	0	0	1	0	0	14.06
Cum. Probability	0.99	0.07	0.08	0.17	0.23	0.11	0.08	
H:3 Years								
Model 1	1	0	0	1	0	1	0	46.14
Model 2	1	0	0	1	0	0	0	25.49
Cum. Probability	1.00	0.06	0.10	0.94	0.06	0.66	0.05	
H:5 Years								
Model 1	1	0	0	1	0	0	0	25.08
Model 2	1	0	1	0	0	1	1	24.44
Cum. Probability	0.96	0.07	0.39	0.65	0.09	0.62	0.45	
H:7 Years								
Model 1	0	0	0	1	0	0	0	32.85
Model 2	0	0	0	1	0	0	1	8.85
Cum. Probability	0.39	0.11	0.16	0.85	0.07	0.32	0.39	
H:10 Years								
Model 1	0	0	1	1	0	0	0	29.55
Model 2	0	0	0	1	0	0	1	17.98
Cum. Probability	0.10	0.12	0.67	0.99	0.07	0.20	0.50	

Out-of-Sample

- We follow Goyal and Welch (2008) and assume that the real-world investor, who does not have access to ex-post information, and uses only data available before the prediction point, and then make an out-of-sample prediction.
- In fact, this is a pseudo out-of-sample forecast exercise.
- We select predictors on the basis of our within sample evidence, therefore we focus only on cay_t and dp_t^{TD}.

	In-Sample				Out-Of-Sample			
$z_t =$	R^2	t-stat	MAE	RMSE	R^2_{OS}	MAE	RMSE	DM
dp_t	2.33	1.41	11.08	12.71	-15.83	12.56	14.90	-21.68
$\tilde{dp}_t$	6.30	2.04	9.87	11.79	12.82	10.85	12.92	14.86
dpp_t^{TD}	21.50	4.17	9.71	11.29	26.84	9.98	11.84	12.79
cay	21.00	4.02	10.30	12.76	3.35	10.95	13.61	1.15
cay,dpp_t^{TD}	32.08	3.33,3.34	9.87	11.69	11.54	10.43	13.02	3.31
Historical Mean	-	-	11.07	13.10	-	11.70	13.84	-

	In-Sample				Out-Of-Sample			
$z_t =$	R^2	t-stat	MAE	RMSE	R^2_{OS}	MAE	RMSE	DM
dp_t	6.65	1.66	16.79	23.09	-58.04	28.37	36.99	-2.28
$\tilde{dp}_t$	5.44	1.68	15.77	22.77	2.65	23.43	29.03	1.75
dpp_t^{TD}	28.89	4.28	15.42	19.73	29.70	20.76	24.67	3.81
cay	35.58	4.13	13.23	16.47	57.55	16.58	19.17	4.00
cay,dpp_t^{TD}	49.49	4.38,3.99	10.92	14.22	61.95	15.53	18.15	4.00
Historical Mean	-	-	17.97	24.65	-	23.80	29.42	-

	In-Sample				Out-Of-Sample			
$z_t =$	R^2	t-stat	MAE	RMSE	R^2_{OS}	MAE	RMSE	DM
dp_t	14.29	3.85	19.29	27.89	-38.34	40.85	48.68	-1.80
$\tilde{dp}_t$	2.08	1.12	21.83	30.97	-20.06	37.01	45.35	-1.12
dpp_t^{TD}	33.77	5.47	19.88	26.60	30.02	29.77	34.63	3.40
cay	36.38	5.10	15.40	20.84	57.64	22.68	26.94	4.52
cay,dpp_t^{TD}	52.70	4.57,4.55	14.66	20.64	59.16	20.67	26.45	3.26
Historical Mean	-	-	23.18	30.77	-	37.19	41.39	-

Why does Equity Premium matter? (Damodaran, 2008)

- Central component of every risk and return model in finance
- It reflects fundamental judgements
  - how we make about how much risk we see in an economy
  - what price we attach to that risk
- It affects how we allocate wealth across different asset classes and which spesific asset within the asset class.
- It is the premium investors demand for the average risky investment.
- It has wide implications for corporate valuations as well as government policies for pension fund and health care obligations.

Long Run Simulations

- One of the interesting aspects of the demographics variable is that long-forecasts for these variables are readily available.
- In order to produce forecasts, we take directly the projections from Bureau of Census for our exogenous variables (MY_t) and we project our endogenous variables by solving a model through stochastic simulations.
- We introduce two VEC models, where p_t, d_t, TFP_t, c_t, a_t, y_t enter as endogenous variables, MY_t as exogenous variable in the model.

Our VEC Model

$$\begin{pmatrix} \Delta p_t \\ \Delta d_t \\ \Delta TFP_t \end{pmatrix} = \Pi_0 + \Pi_1 \begin{pmatrix} \Delta p_{t-1} \\ \Delta d_{t-1} \\ \Delta TFP_{t-1} \\ \Delta MY_{t-1} \end{pmatrix} + \begin{pmatrix} \alpha_{11} \\ \alpha_{21} \\ \alpha_{31} \end{pmatrix} \begin{pmatrix} -1 \\ 1 \\ \beta_3 \\ \beta_4 \end{pmatrix}^T \begin{pmatrix} p_{t-1} \\ d_{t-1} \\ TFP_{t-1} \\ MY_{t-1} \end{pmatrix} + \begin{pmatrix} v_{1t} \\ v_{2t} \\ v_{3t} \end{pmatrix}$$

- Using the simulation output from our model, we construct the equity premium for 2007-2050, i.e.

$$equity\ \ premium_t = \log\left(\frac{\tilde{P}_t + \tilde{D}_t}{\tilde{P}_{t-1}}\right) - \tilde{r}_{f,t} \tag{1}$$

  where $\tilde{P}_t, \tilde{D}_t, \tilde{r}_{f,t}$ are simulated series from the model.
- Following Campbell&Viceira (2005) $\tilde{r}_{f,t}$ is simulated using $\tilde{r}_{f,t-1}$ and excess stock returns.

LL Model

- In the second VEC model, we use the cointegrated system suggested in Lettau&Ludvigson (2001)

$$\begin{pmatrix} \Delta c_t \\ \Delta a_t \\ \Delta y_t \end{pmatrix} = \bar{\Pi}_0 + \bar{\Pi}_1 \begin{pmatrix} \Delta c_{t-1} \\ \Delta a_{t-1} \\ \Delta y_{t-1} \end{pmatrix} + \begin{pmatrix} \bar{\alpha}_{11} \\ \bar{\alpha}_{21} \\ \bar{\alpha}_{31} \end{pmatrix} \begin{pmatrix} 1 & \bar{\beta}_2 & \bar{\beta}_3 \end{pmatrix} \begin{pmatrix} c_{t-1} \\ a_{t-1} \\ y_{t-1} \end{pmatrix} + \begin{pmatrix} \bar{v}_{1t} \\ \bar{v}_{2t} \\ \bar{v}_{3t} \end{pmatrix}$$

- We augment the model with an autoregressive process for the nominal risk-free rate and a predictive regression for equity premium, i.e. $equity\ premium_t = f(cay_{t-1})$. In particular, we assume that the functional relation is linear, i.e.

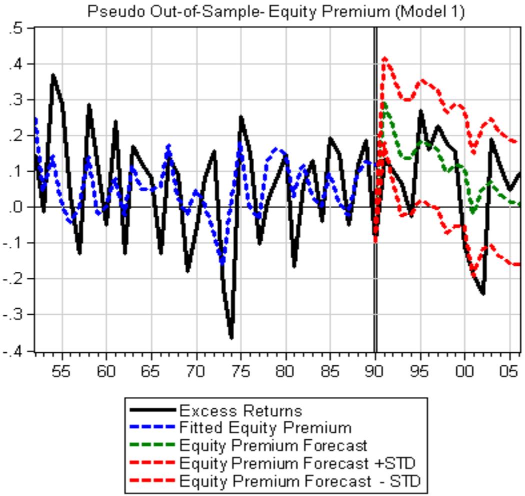
$$equity\ premium_t = \gamma_0 + \gamma_1 * \widetilde{cay}_{t-1} + \varepsilon_t$$

- $\gamma = \begin{bmatrix} \gamma_0 & \gamma_1 \end{bmatrix}$ is estimated in the sample 1952-2006.

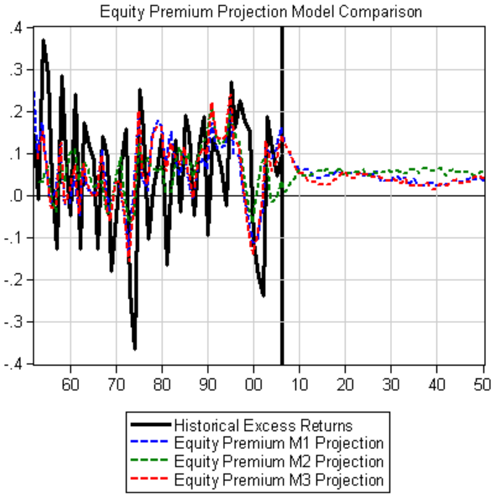
Combined Model

- We combine the two VEC models, where $p_t, d_t, TFP_t, c_t, a_t, y_t$ enter as endogenous variables, MY_t as exogenous variable in the model.
- We augment the model with an autoregressive process for the nominal risk-free rate
- Given the high number of parameters to be estimated in the model, we set the identification restrictions using previous results and literature

Our VEC Model Pseudo Out-of-Sample Performance



Model Comparison Out-of-Sample



Conclusion

- Demography, accounting for technological change, is one of those anchors that bring prices to their long run trend.
- Correcting for non-stationarity of dividend price ratio improves forecasting ability and delivers robust results.
- A forecasting model based on demographics and demand factor as captured by excess consumption outperforms alternative models proposed in the empirical literature.
- Predictability of demographic factors implies some cyclical declines in the equity risk premium for the next few decades.

Future Research

- Implications for second moment of stock market returns
- Bond risk premia predictability, in particular for the long end of the yield curve
- Portfolio choice for long term investors, such as pension funds and SWF's

The End...

Thank you...

Feel free to contact us for any comments:

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Summary Statistics

Correlation Matrix (Sample 1909-2006)					
	$r_{m,t} - r_{f,t}$	dp_t	TFP	SR	MY
$r_{m,t}-r_{f,t}$	1.00	-0.24	0.01	0.08	0.10
dp_t	-0.24	1.00	-0.75	-0.21	-0.73
TFP	0.01	-0.75	1.00	0.34	0.47
SR	0.08	-0.21	0.34	1.00	0.17
MY	0.10	-0.73	0.47	0.17	1.00
Univariate Summary Statistics					
Mean	0.057	-3.217	2.278	1.290	0.793
Median	0.093	-3.133	2.143	1.294	0.752
Std	0.179	0.453	0.937	0.133	0.172
Min	-0.530	-4.450	0.983	1.048	0.550
Max	0.423	-2.287	3.976	1.509	1.149
Autocorrelation	0.081	0.880	0.972	0.974	0.967

Correlation Matrix (CRSP: Sample 1926-2006)					
	$r_{m,t}-r_{f,t}$	dp_t	TFP	SR	MY
$r_{m,t}-r_{f,t}$	1.00	-0.07	0.08	0.06	0.03
dp_t	-0.07	1.00	-0.72	-0.09	-0.69
TFP	0.08	-0.72	1.00	0.17	0.29
SR	0.06	-0.09	0.17	1.00	0.01
MY	0.03	-0.69	0.29	0.01	1.00
Univariate Summary Statistics					
Mean	0.096	-3.299	2.525	1.312	0.827
Median	0.134	-3.210	2.724	1.357	0.780
Std	0.194	0.424	0.841	0.137	0.169
Min	-0.586	-4.499	1.197	1.048	0.550
Max	0.454	-2.627	3.976	1.509	1.149
Autocorrelation	0.095	0.915	0.964	0.977	0.973

Exact Present Value Relation (Ang&Bekaert, 2006)

$$\frac{P_t}{D_t} = E_t[\sum_{i=1}^{\infty} \exp\left(-\sum_{j=0}^{i-1} \delta_{t+j} + \sum_{j=1}^{i} g^d_{t+j}\right)]$$

- where $\delta_{t+1} = E_t[\frac{P_{t+1}+D_{t+1}}{P_t}] = E_t[h_{t+1}]$, $g^d_{t+1} = \log(\frac{D_{t+1}}{D_t})$