

Demographic Changes, Financial Markets, and the Economy

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Prepared for IQRF Seminar, October 2011

Pending Publication in Financial Analysts Journal



Motivation

**An aging demography should make a difference.
For the economy, for sure. Perhaps also for the markets.**

<i>Let's Explore Six Linkages!</i>	Economic Growth	Stock Market Returns	Bond Market Returns
Demographic Profile Of a Nation / Economy	<i>Nature of the Link?</i>	<i>Nature of the Link?</i>	<i>Nature of the Link?</i>
Rate of Change of Demographic Profile	<i>Nature of the Link?</i>	<i>Nature of the Link?</i>	<i>Nature of the Link?</i>

**This has been done before, but without much success
garnering statistical significance.**

Literature Review

- **Mixed evidence so far**

- Typically using five year age cohorts.
- Or using ad hoc age groups, which tend to suggest data mining.
- No strong significance found.

- **Criticisms – Poterba (2001)**

- Few degrees of freedom, lack of statistical power.

- **GDP growth**

- Lindh and Malmberg (1999)
 - OECD countries, 1950-1990
 - Positive effect for 50-64 and negative effect for 65+
 - Ambiguous effects under age 50
 - Critique: Why select these age groups?

Literature Review

- **Mixed evidence so far**
- **Criticisms – Poterba (2001)**
 - Few degrees of freedom, lack of statistical power.
- **GDP growth**
 - Lindh and Malmberg (1999)
- **Stock and/or Bond returns**
 - Yoo (1994) – weak statistical significance in U.S. sample
 - Ang and Maddaloni (2003)
 - International sample increases power
 - Negative effect for 65+
 - Weak evidence for working age

First ... Our Findings

■ GDP per capita growth

- Highest GDP Growth associated with young adults 20-39.
- Late teens and early middle-age population helps a bit.
- Transition between age 50-55, from helping to hurting GDP growth.
- Young children hurt GDP growth, a little.
- Senior citizens hurt GDP growth, a lot.
- Little difference between results for demographic composition and rate of change of composition.
- High statistical significance.

First ... Our Findings

(Part II)

■ **GDP per capita growth**

- Highest GDP Growth associated with young adults 20-39.
- Young children hurt GDP growth, a little.
- Senior citizens hurt GDP growth, a lot.

■ **Stocks perform better**

- When there are many in the 35-59 age cadres,
 - And much worse when there are many senior citizens or children.
- When 45-64 age cadres are growing faster,
 - But much worse with young adult or 70+ age cadres growing fast.

■ **Demography affects bonds**

- With roughly a 5-year age difference.
- With greater statistical significance.

Our Strategy to Increase Statistical Power

- **5-year (non-overlapping) returns and growth rates**
- **Control for valuation levels, business cycles**
- **Large cross section of countries**
- **Include all 15 5-year age cadres in the regression**
- **Use polynomials to eliminate noise on adjacent age cadres**
- **Robustness checks**

Data Sources

■ UN Population Division

- Demographics data in 5-year intervals, 1950-2050 (projections)

■ Global Financial Data (with some extensions)

- Stock, Bond and cash returns for 22 developed countries, 1950-2010
- Dividend yield and bond yields, 1950-2010

■ Penn World Table

- Real GDP per capita for almost 200 countries, 1950-2008
- PPP adjustments in 2005 levels for comparisons
- Consumption/GDP ratio, 1950-2008

Variables

- **Stock and (10-year) bond returns**
 - 5-year non-overlapping local return (in excess of cash return)
- **GDP**
 - Per capita real growth
 - PPP-adjusted GDP for weighting
- **Yields**
 - Dividend-yield, 3-month and 10-year yields
- **Demographics**
 - 15 age groups {0-4,5-9,...,75+}
 - Shares of total population and changes thereof

Econometric Methodology

- Ideally we would like to estimate:

$$r_{i,t} = \alpha + \gamma X_{i,t-1} + \sum_{j=1}^{15} b_j \cdot s_{j,i,t} + \varepsilon_{i,t}$$

Valuation or other control variables

Age groups

Age group shares

- **Problems**
 - Too many parameters
 - Multicollinearity
 - Unstable regression coefficients

- **Usual *ad hoc* solutions**

- Select only a small number of age groups
- Aggregate age groups together

Econometric Methodology

■ Our solution (Higgins, 1998)

- Include all age groups
- Fit a smooth function across age groups
- Small number of parameters → Polynomial (parabola, cubic, quartic)

Switch from:

$$r_{i,t} = \alpha + \gamma \cdot X_{i,t-1} + \sum_{j=1}^{15} b_j \cdot s_{j,i,t} + \varepsilon_{i,t}$$

Age groups

Demographic shares

$$r_{i,t} = \alpha + \gamma \cdot X_{i,t-1} + \sum_{j=1}^k \sum_{k \in \{2,3,4\}} D_j \cdot \zeta_{j,i,t} + \varepsilon_{i,t}$$

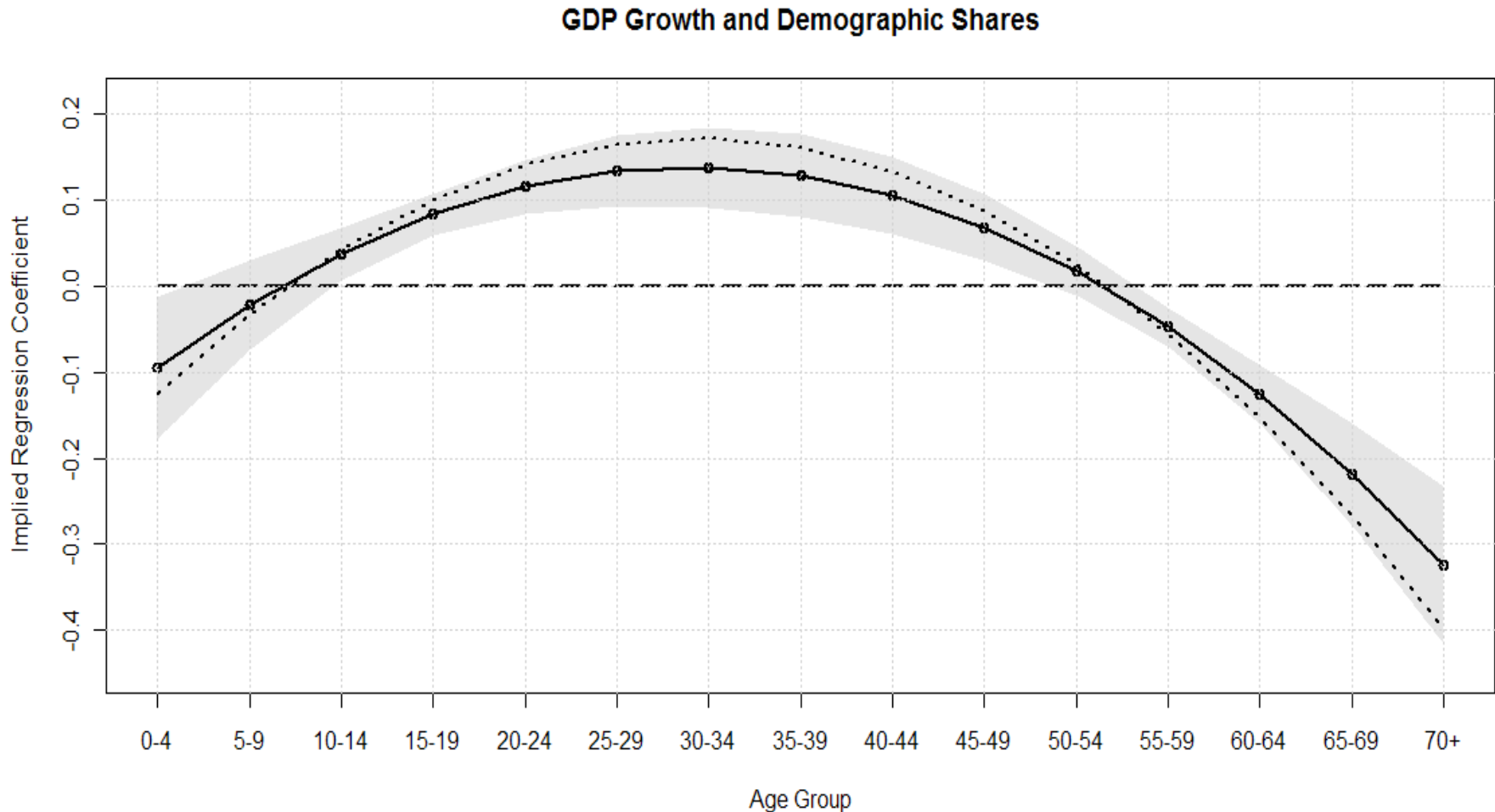
Polynomial order

Modified shares

Regression Results, 1950-2010

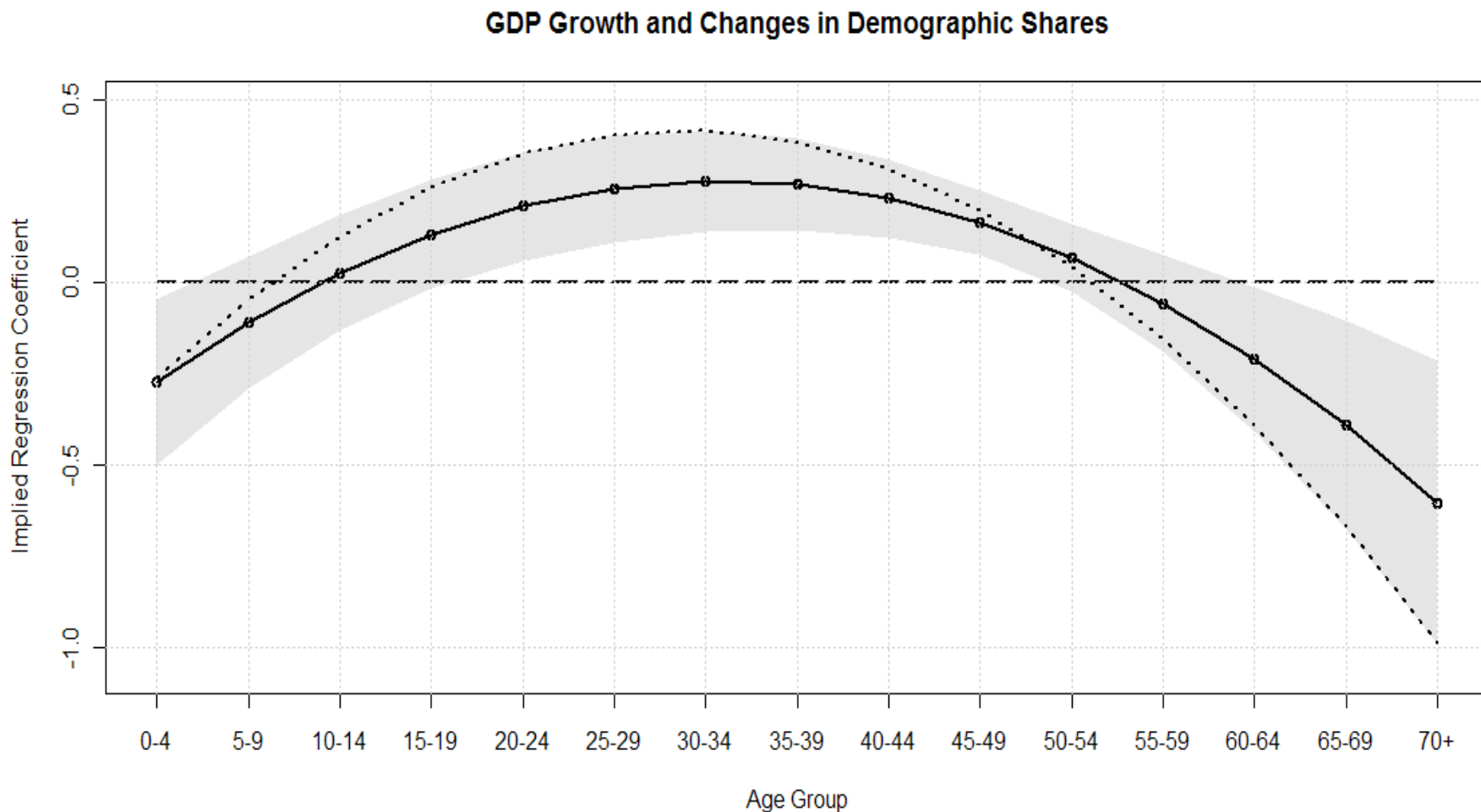
	Demographic Shares			Change in Demographic Shares		
	Stocks	Bonds	GDP	Stocks	Bonds	GDP
Valuation controls	Dividend Yield	3.39 (6.23)		3.38 (6.30)		
	10-year Yield	0.66 (4.98)		0.62 (4.07)		
	3-month Yield		-0.15 (2.97)			-0.19 (4.14)
Polynomial coefficients	D_1 (x1)	-0.81 (1.63)	-1.56 (3.33)	0.09 (3.77)	3.09 (2.90)	-0.02 (0.04)
	D_2 (x10)	1.69 (2.47)	3.47 (3.10)	-0.07 (4.39)	-10.27 (3.57)	-1.83 (1.42)
	D_3 (x100)	-0.83 (3.05)	-2.72 (2.74)		11.81 (4.25)	2.96 (2.58)
	D_4 (x1000)		0.69 (2.37)		-4.22 (4.77)	-1.17 (3.32)
	R^2	28%	34%	30%	31%	30%
	Observations	203	241	255	203	241
	Countries	22	22	22	22	22
Tests for polynomial order	$k=3 \rightarrow k=2$ (%)	0.3	0.0	25.7	7.7	3.4
	$k=4 \rightarrow k=3$ (%)	28.4	1.8	12.4	0.0	0.1

Relationship between GDP Growth and Demographic Composition ($R^2 = 0.30$), Net of Valuation Effects



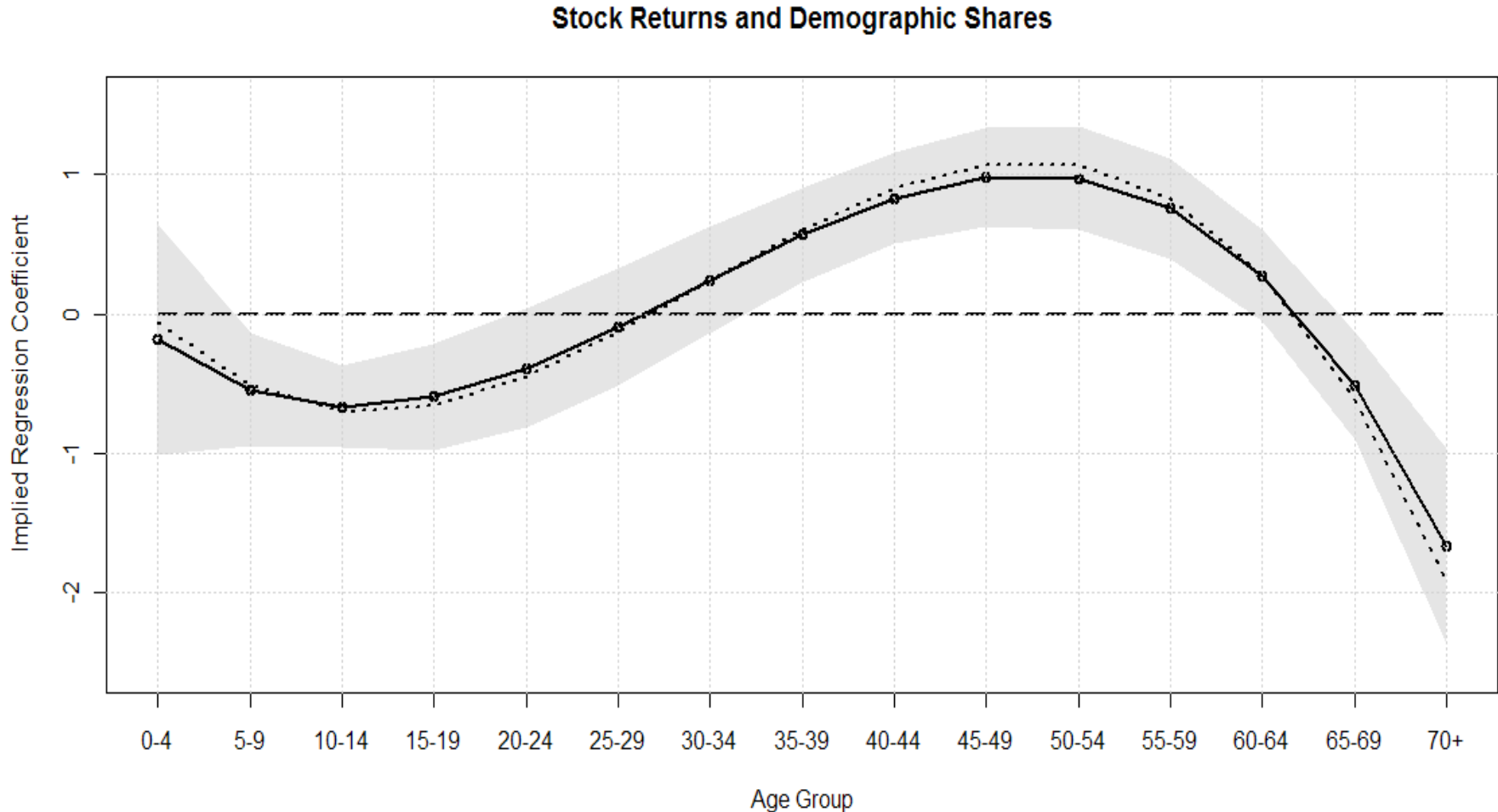
Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Relationship between GDP Growth and Demographic Rate of Change ($R^2 = 0.17$), Net of Valuation Effects



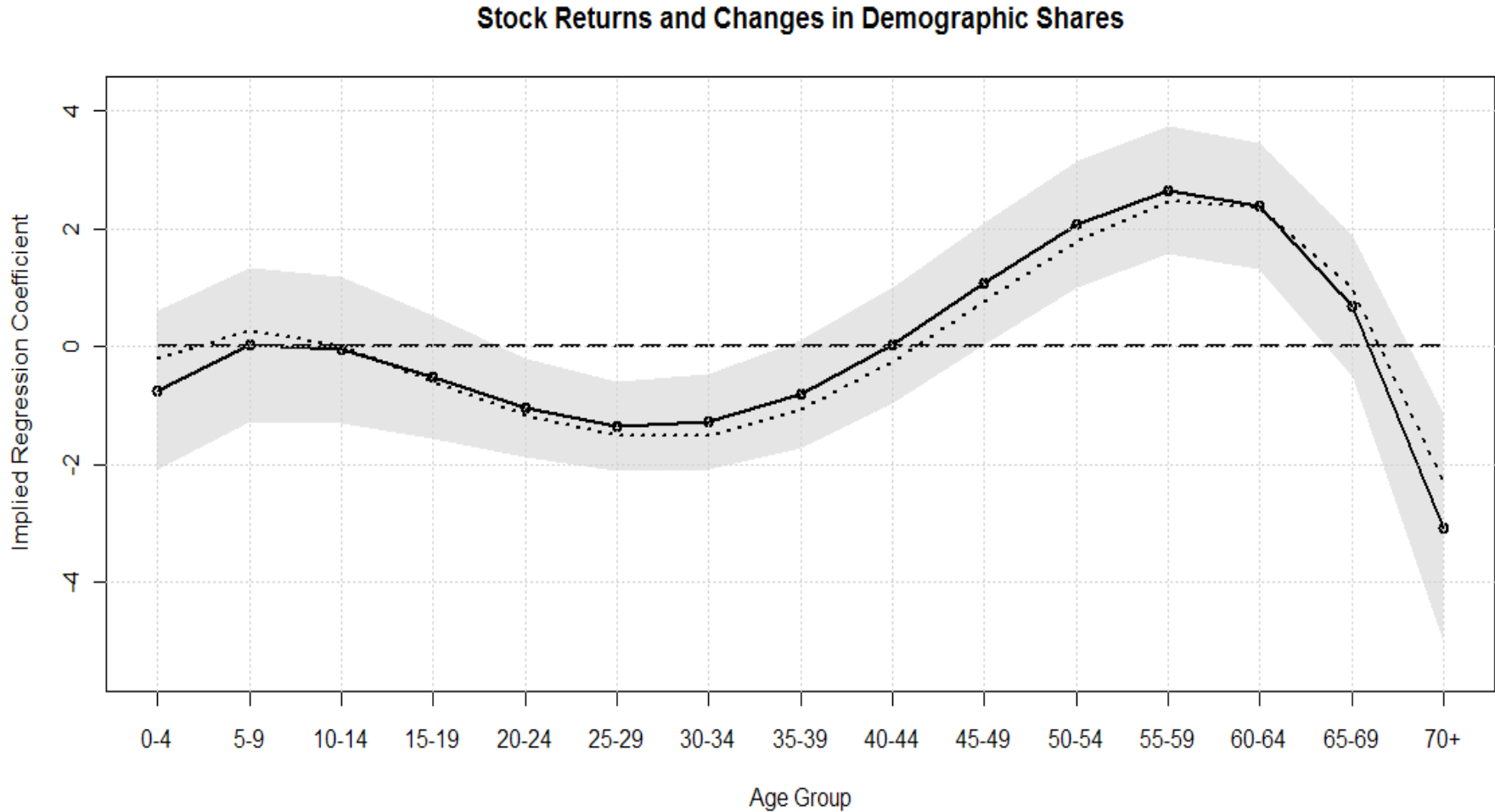
Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Relationship between Stock Returns and Demographic Composition ($R^2 = 0.28$), Net of Valuation Effects



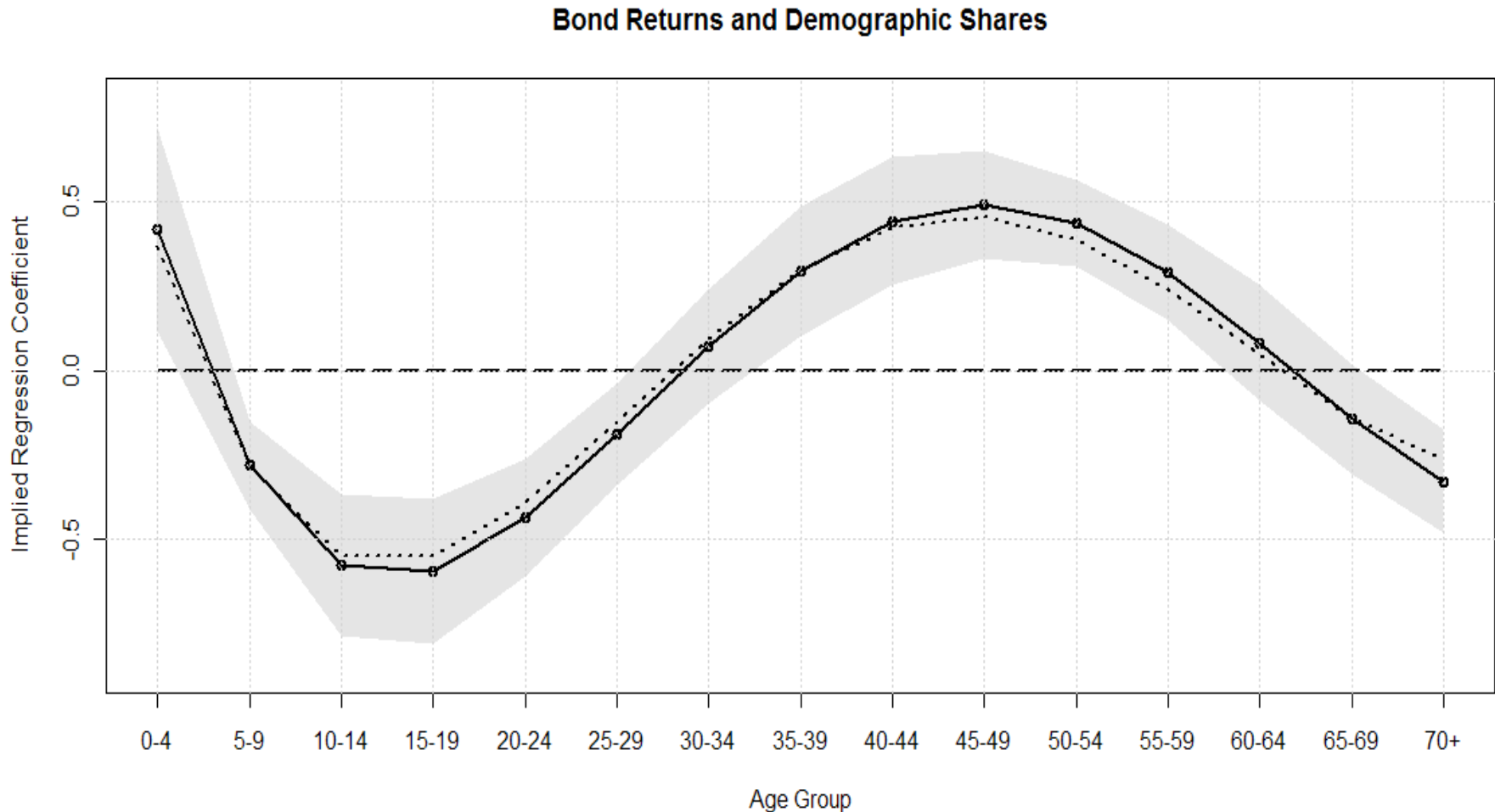
Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Relationship between Stock Returns and Demographic Rate of Change ($R^2 = 0.31$), Net of Valuation Effects



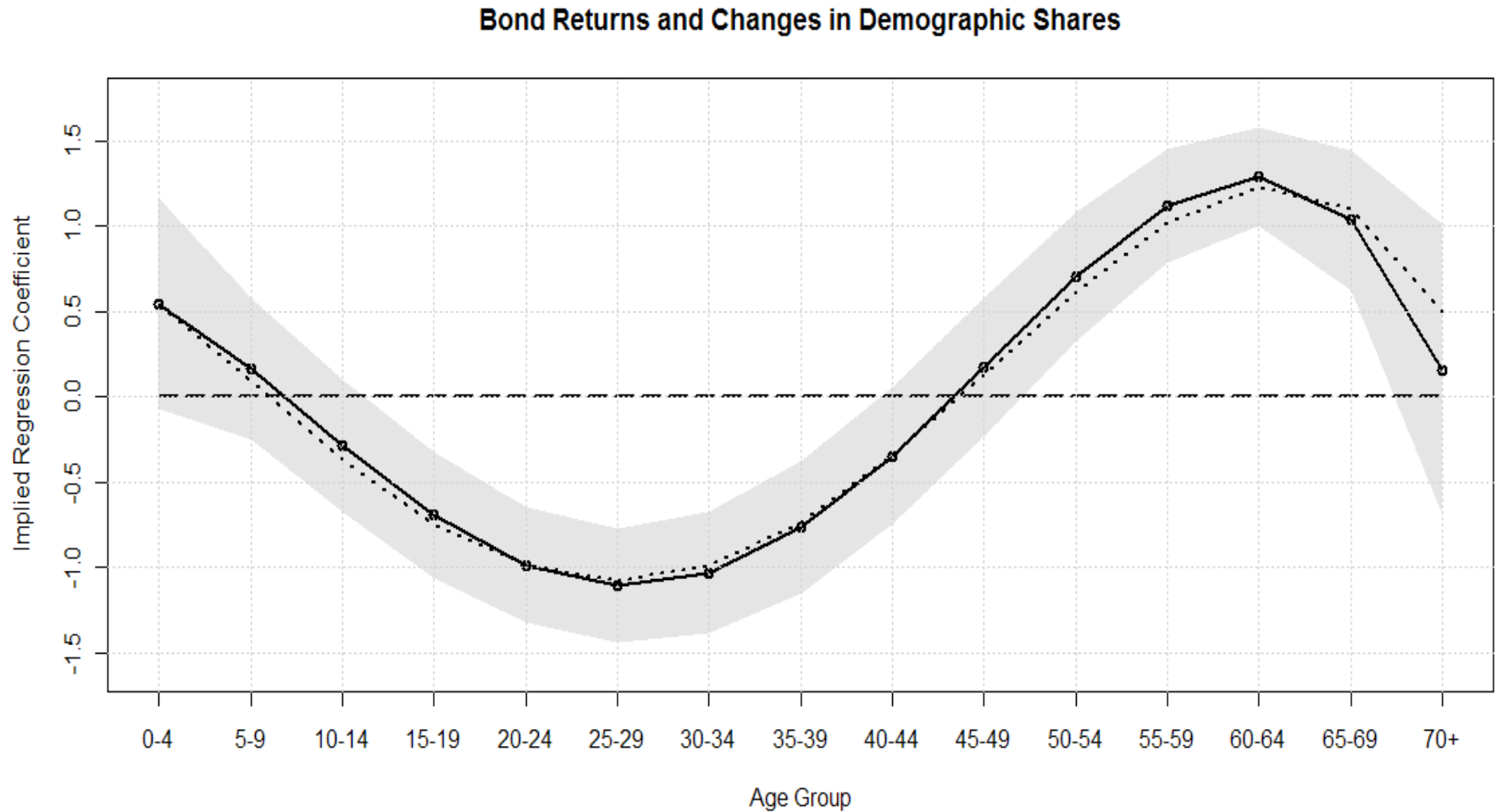
Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Relationship between Bond Returns and Demographic Composition ($R^2 = 0.34$), Net of Valuation Effects



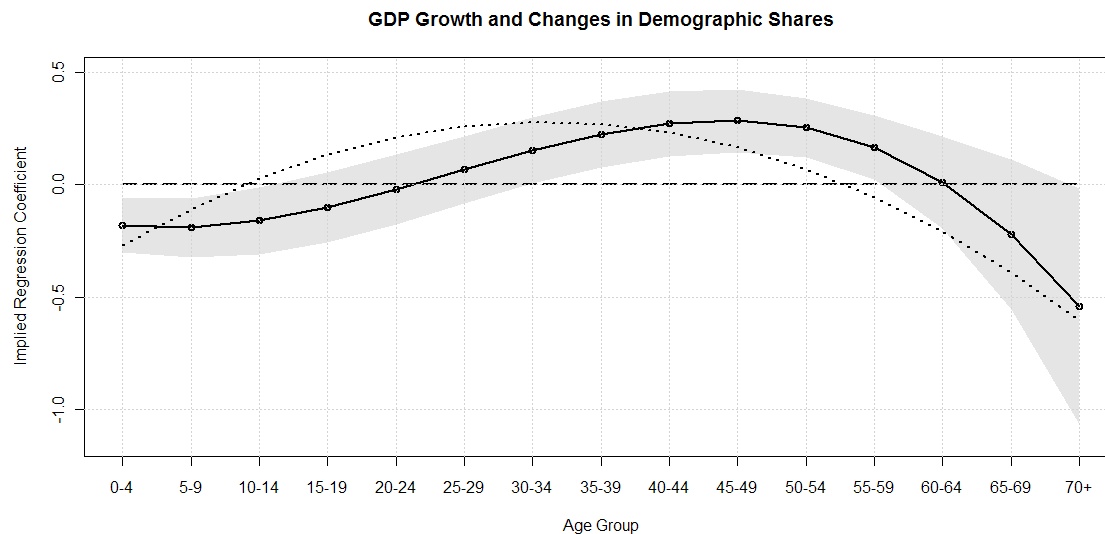
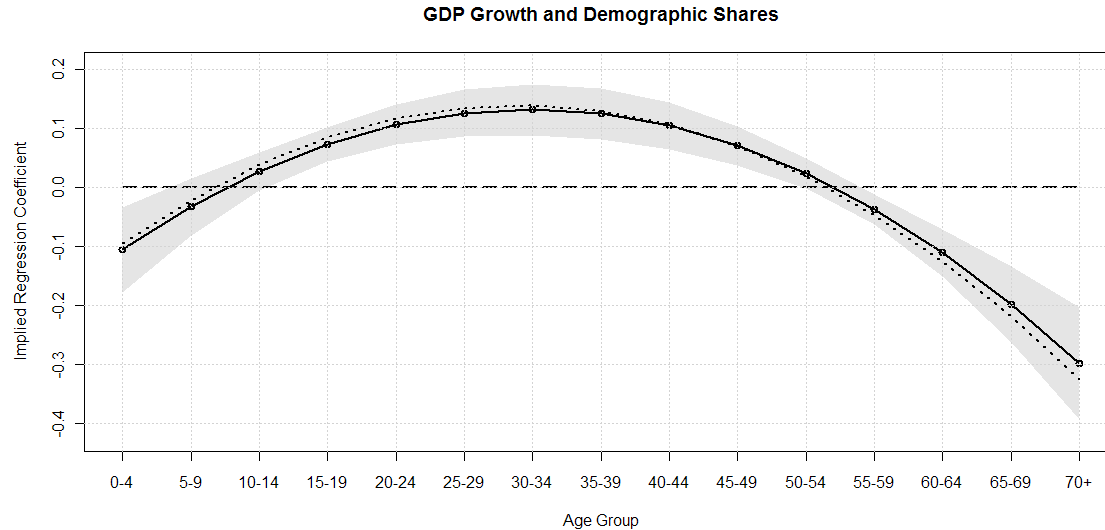
Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Relationship between Bond Returns and Demographic Rate of Change ($R^2 = 0.30$), Net of Valuation Effects



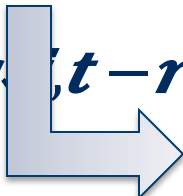
Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Robustness Check – Do the Same Relationships Apply in Emerging Markets? Yes, they do.



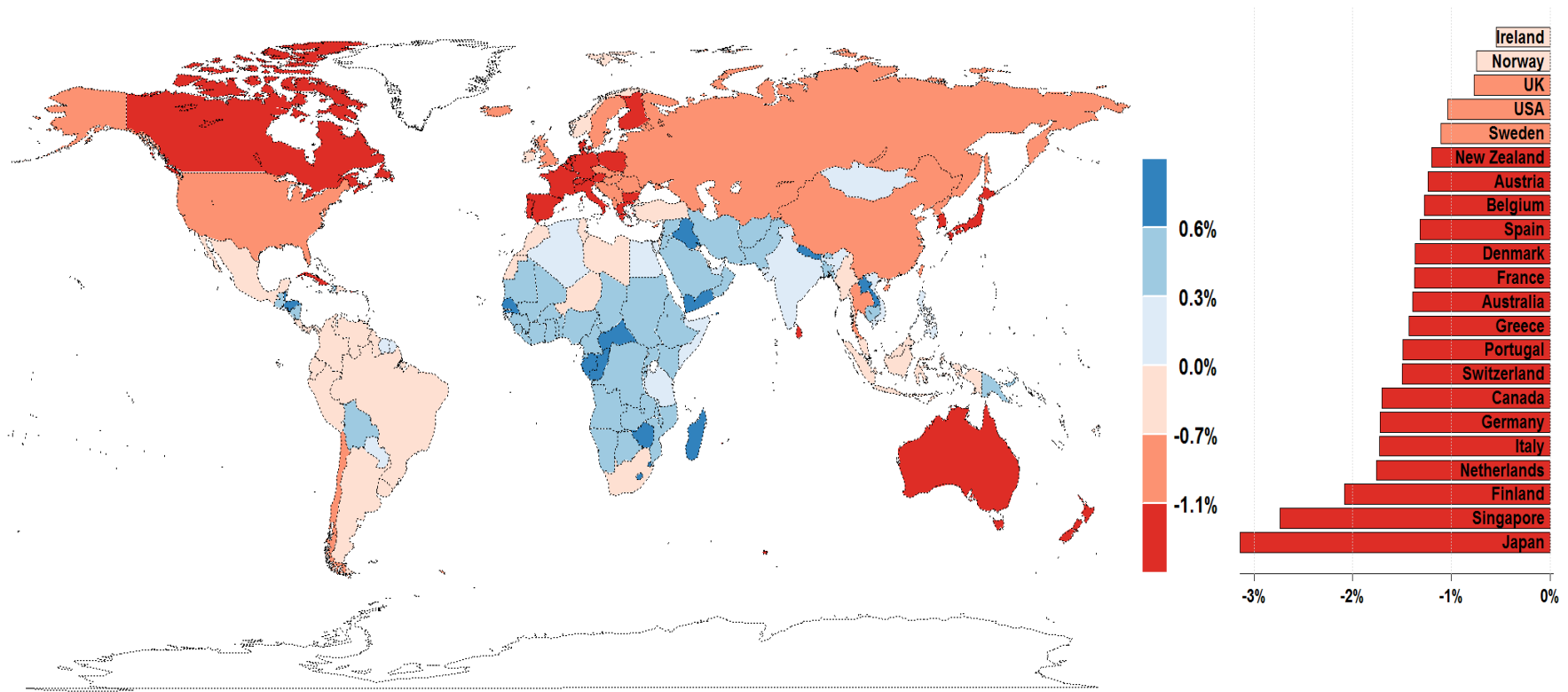
So ... What Does This Work Say About the Future?

$$r_{i,t} - r_i = \gamma \cdot (X_{i,t-1} - X_i) + \sum_{j=1}^4 \sum_{k \in \{2,3,4\}} D_j \cdot (\zeta_{j,i,t} - \zeta_{j,i}) + \varepsilon_{i,t}$$

$$E[r_{i,t} - r_i] = \sum_{j=1}^4 \sum_{k \in \{2,3,4\}} D_j \cdot E[\zeta_{j,i,t} - \zeta_{j,i}]$$


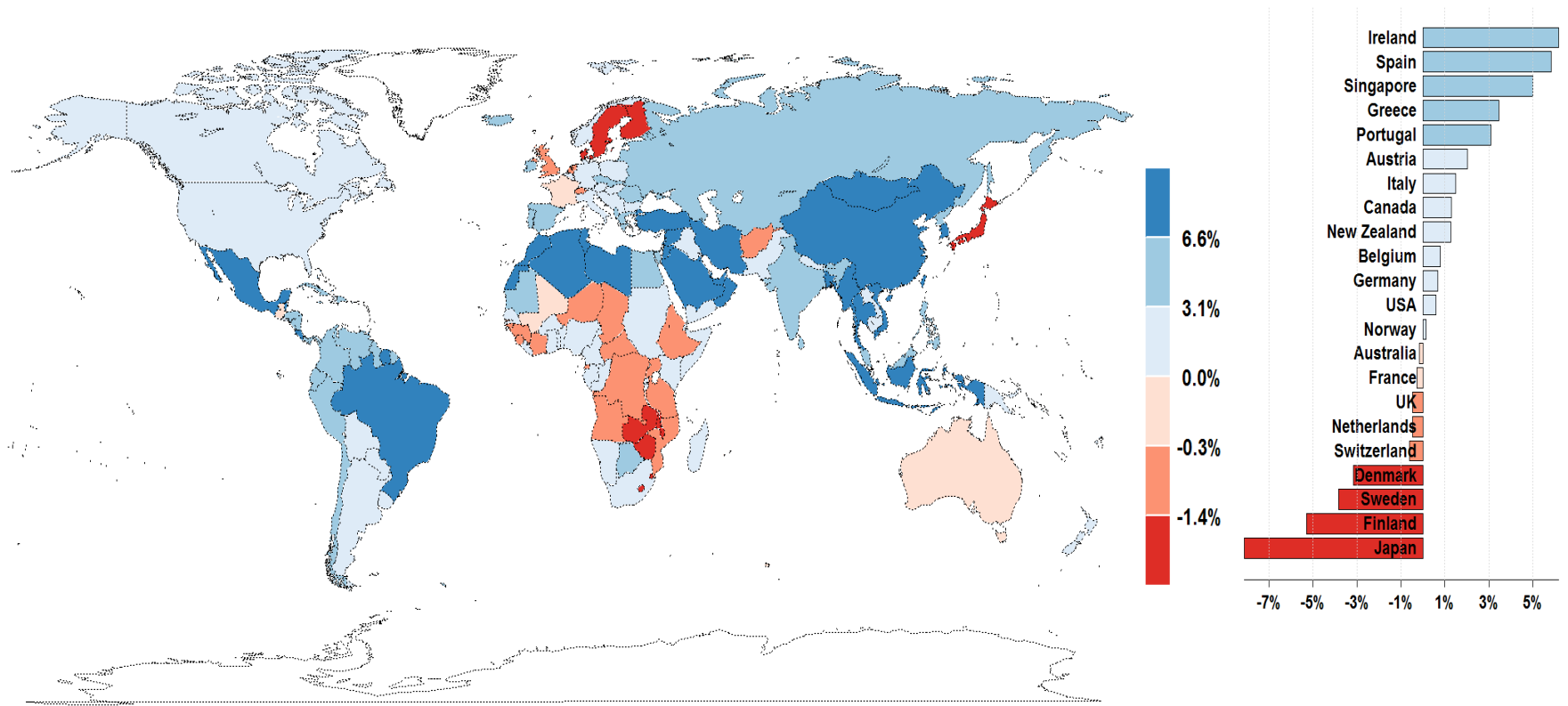
- Include only demographic variables
- UN forecasts allow us to obtain $\zeta_{j,i,t}$ many years ahead
- We compound forecasts for 2011-2015, 2016-2020
- Average between shares and changes in shares
- Deviations from long term country means

Forecasts for GDP Growth, 2011–2020, Based on Demographic Composition



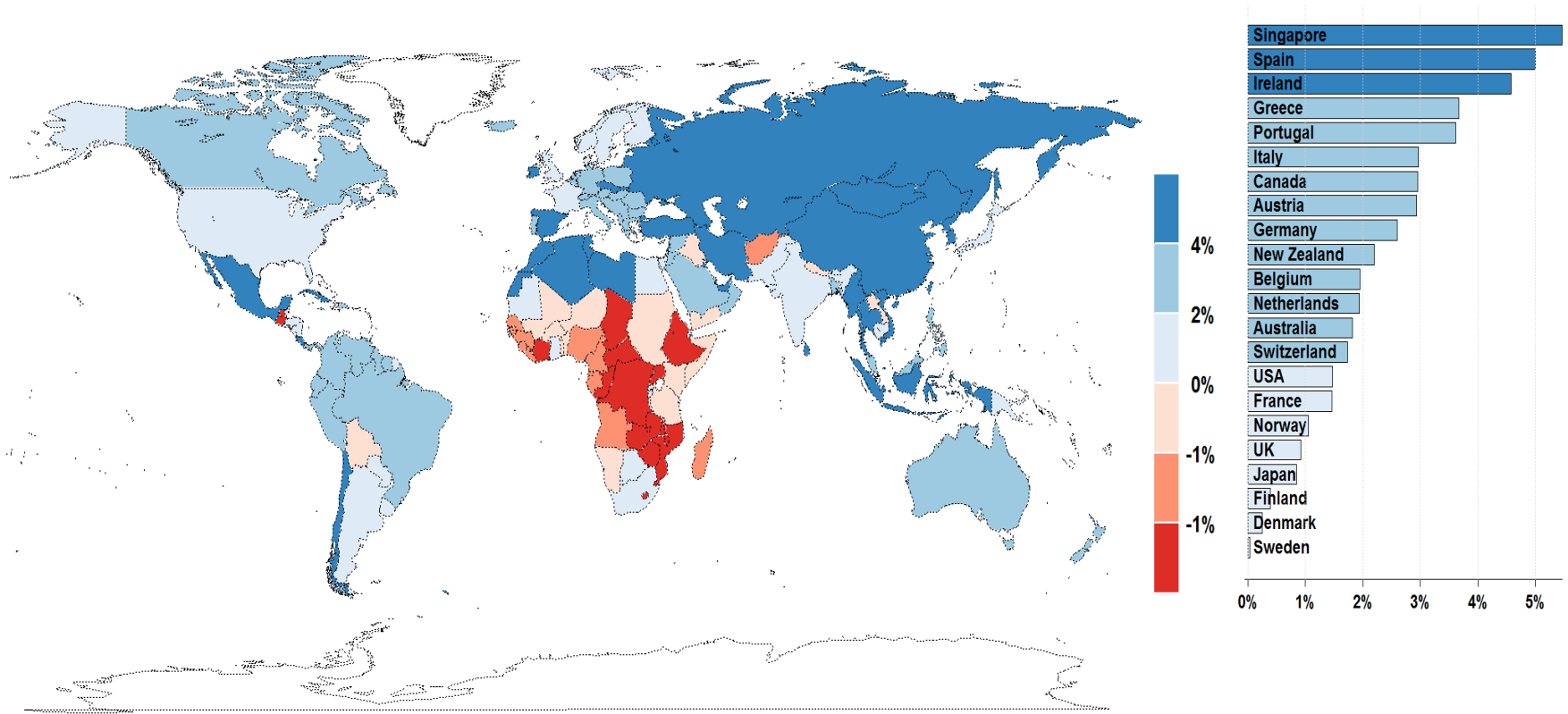
Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Forecasts for Stock Returns, 2011–2020, Based on Demographic Composition



Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Forecasts for Bond Returns, 2011–2020, Based on Demographic Composition



Source: Research Affiliates, based on data from United Nations, Penn World Table and Global Financial Data.

Conclusion

We find a strong link between demographic shares (or changes thereof) and:

- **Per capita real GDP growth**
- **Stock excess returns**
- **Bond excess returns**

Polynomials give us a powerful and intuitive way to understand these relationships.

Forecasts for the next 10 years are sobering, to say the least.

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