

Under Pressure – How the Business Environment Affects Productivity and Efficiency of European Life Insurance Companies

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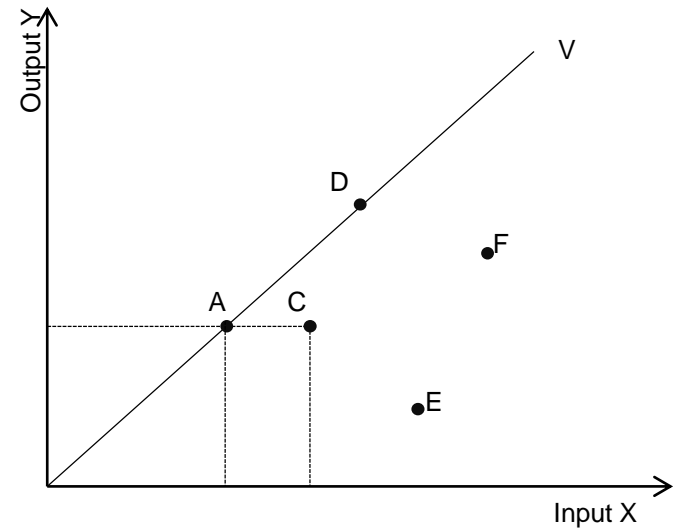


Background

DEA (Charnes et al., 1978)

Inefficiency is caused by bad
Management (Yang and Pollit, 2009)

Fried et al. (1999; 2002): multi-stage DEA



Banking: Dietsch and Lozano-Vivas (2000), Fries and Taci (2005), Liu and Tone (2008)

Insurance: Huang and Eling (2013)

Contribution: Life insurance; European sample; environmental drivers

Central Questions

1. How does the business environment affect life insurers efficiency?
2. What is the interaction between firm-specific characteristics and the business environment?
3. How does productivity and efficiency of the European life insurance sector develop over time?

Hypotheses

How does the operating environment affect life insurers efficiency?

Hypothesis	Specification	Extant Insurance Literature
H1: General economic conditions		
H1a: Economic maturity	Positive relation between GDP per capita and efficiency.	Not yet analyzed in existing literature
H1b: Unemployment	Positive relation between unemployment rate and efficiency.	Not yet analyzed in existing literature
H1c: Inflation	Negative relation between inflation and efficiency.	Huang and Eling (2013)
H2: Capital market conditions		
H2a: Interest rate level	Negative relation between interest rate level and efficiency.	Huang and Eling (2013)
H2b: Stock market performance	Positive relation between stock market performance and efficiency.	Not yet analyzed in existing literature
H3: Insurance market conditions		
H3a: Competition	Positive relation between competition and efficiency.	Fenn et al. (2008); Bikker and van Leuvensteijn (2008); Choi and Weiss (2005); Berry-Stoelzle et al. (2011)
H3b: Regulation	Positive relation between solvency regulation (i.e. capital adequacy) and efficiency.	Rees and Kessner (1999); Eling and Luhnen (2010) ; Huang and Eling (2013)

Methodology

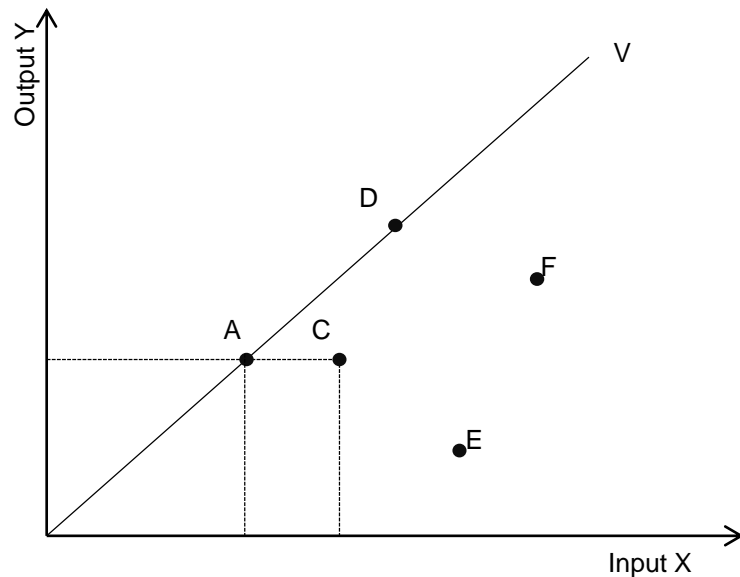
Multistage-DEA (see Fried et al., 2002)

Stage 1: Model 1 - DEA

Stage 2: Slack regressions

Stage 3: Input adjustments

Stage 4: Model 2 - Rerun DEA



Inputs	Labor	x1 1,000s	Operating expenses/ILO average annual wage
	Debt	x2 Mio. USD	Total liabilities
	Equity capital	x3 Mio. USD	Capital and capital
Outputs	Benefits + additions to reserves	y1 Mio. USD	Net benefits + additions to reserves
	Investments	y2 Mio. USD	Total invested assets
Input prices	Price of labor	p1 USD	ILO average annual wage
	Price of debt capital	p2 %	OECD long-term interest rates
	Price of equity capital	p3 %	MSCI country-specific equity returns

Methodology

Multistage-DEA (see Fried et al., 2002)

Stage 1: Model 1- DEA

Stage 2: Slack regressions

Stage 3: Input adjustments

Stage 4: Model 2 - Rerun DEA

$$S_{mj} = f^m(Z_j; \beta^m) + v_{mj} + u_{mj} \quad (1)$$

General economic conditions	Economic maturity	GDP	USD	Gross domestic product per capita
	Unemployment	UNE	%	AXCO unemployment rates
	Inflation	INF	%	THE WOLRD BANK Consumer price indices (year 2002 = 100)
Capita l market conditions	Interest rate level	IR	%	OECD long-term interest rates
	Stock market performance	MSCI	%	Rolling returns on MSCI country-specific stock market indices
Insurance market conditions	Competition	COMP	%	Concentration ratio at the four-firm level
	Regulation	SOLV	%	Equity to total assets (country average)

S denotes slack value for input m and DMU j

Institute of Insurance Economics

Methodology

Multistage-DEA (see Fried et al., 2002)

Stage 1: Model 1 - DEA

Stage 2: Slack regressions

Stage 3: Input adjustments

Stage 4: Model 2 - Rerun DEA

$$x_{mj}^A = x_{mj} \left\{ 1 + [\max_j \{f^m(z_j; \hat{\beta}^m)\} - f^m(z_j; \hat{\beta}^m)] + [\max_j \{\hat{v}_{mj}\} - \hat{v}_{mj}] \right\} \quad (2)$$

Adjustment of initial input values w.r.t equation (2)

Companies need additional input quantities for same output level

Scale of adjustments: difference between operating environments

Data

AM Best Insurance Reports database

14 European countries*

960 life insurers

Sample period 2002 to 2013

6'657 firm years

* Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Sweden, Switzerland, UK

Empirical Results

DEA mean efficiency scores

	Model 1		Model 2		Delta (Model 2 - Model 1)	
Country	TE	CE	TE	CE	TE	CE
Austria	0.9401	0.5277	0.8950	0.5139	-0.05	-0.01
Belgium	0.8979	0.5904	0.8609	0.5700	-0.04	-0.02
Denmark	0.9713	0.7244	0.9449	0.7036	-0.03	-0.02
Finland	0.9420	0.6859	0.8719	0.6418	-0.07	-0.04
France	0.9021	0.6560	0.8600	0.6290	-0.04	-0.03
Germany	0.9332	0.5855	0.8965	0.5621	-0.04	-0.02
Ireland	0.8325	0.4911	0.8422	0.5023	+0.01	+0.01
Italy	0.9117	0.5641	0.8900	0.5662	-0.02	0.00
Luxembourg	0.9191	0.6588	0.8656	0.6085	-0.05	-0.05
Netherlands	0.9116	0.5526	0.8719	0.5363	-0.04	-0.02
Norway	0.9598	0.7056	0.9105	0.6658	-0.05	-0.04
Sweden	0.9527	0.4992	0.9182	0.4686	-0.03	-0.03
Switzerland	0.9244	0.5543	0.8471	0.4887	-0.08	-0.07
United Kingdom	0.8333	0.6098	0.8172	0.5987	-0.02	-0.01
Total Sample	0.9142	0.5982	0.8802	0.5770	-0.03	-0.02

Empirical Results

How does the operating environment affect life insurers efficiency?

	Variable	Definition	TE	CE
General economic conditions				
Economic maturity	GDP	GDP per capita	1.12** (0.29)	60.96** (8.8167)
Unemployment	UNE	Unemployment rate	0.56*** (0.203)	100.18*** (35.68)
Inflation	INF	Consumer price indices (2002=100)	10.55*** (0.66)	-7.29 (12.54)
Capital market conditions				
Interest rate level	IR	Long-term interest rates	3.36*** (0.24)	-45.42*** (17.82)
Stock market performance	MSCI	Rolling returns on MSCI indices	-1.78*** (0.26)	-156.56*** (47.91)
Insurance market conditions				
Competition	COMP	Concentration ratio 4-firm-level	-2.02*** (0.22)	-41.72*** (10.51)
Regulation	SOLV	Equity to total assets (country-average)	0.35* (0.22)	88.69*** (26.22)
Year fixed effects				Yes
Observations				6'657

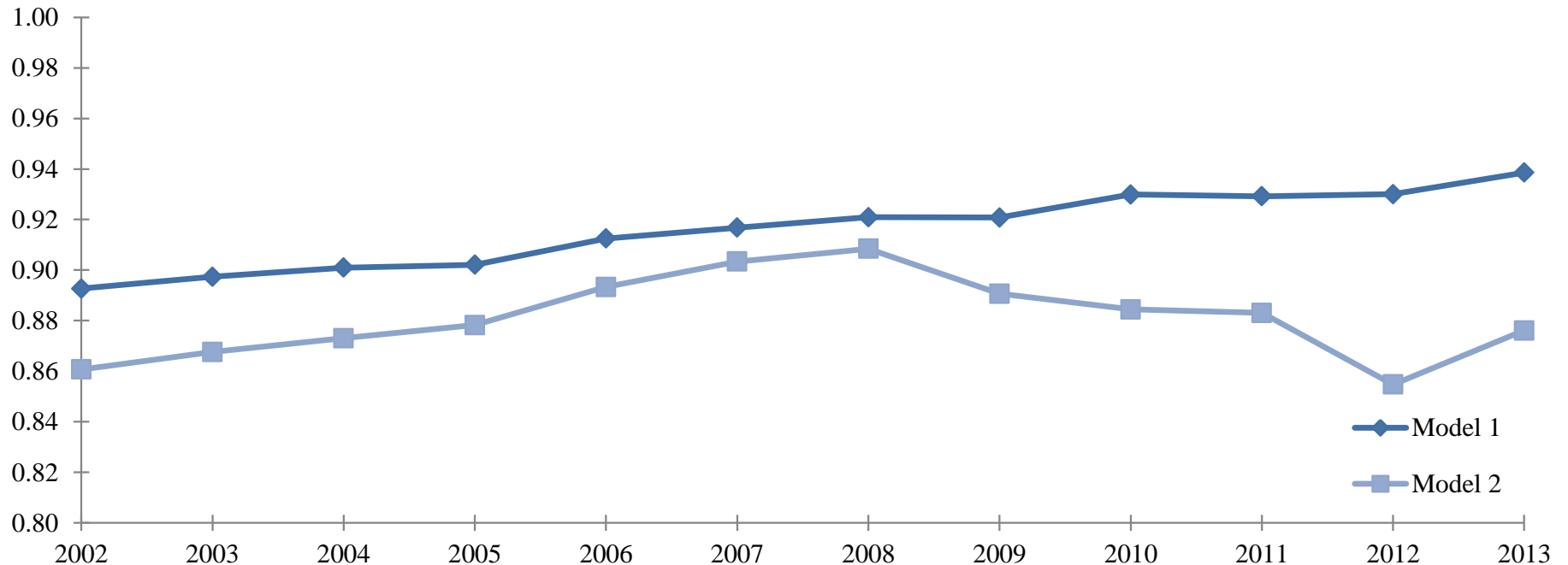
Empirical Results

What is the interaction between firm-specific characteristics and the operating environment?

			Model 1		Model 2	
	Variable		TE	CE	TE	CE
Organizational form	OWN	Dummy (1= stock, 0=mutual)	34.24***	107.01***	0.30	52.48***
			(3.56)	(25.63)	(1.46)	(17.69)
Size	SIZE	ln(Total assets)	-1.66***	-30.52***	-1.97***	-24.94***
			(0.31)	(8.05)	(0.61)	(7.95)
Solvency	SOLV _j	Equity to total assets (firm-specific)	10.26***	44.64***	-56.03***	-297.39***
			(0.27)	(9.68)	(14.32)	(87.38)
Year fixed effects			Yes			
Observations			6'657			

Empirical Results

How does productivity and **efficiency** of the European life insurance sector develop over time? (1/2)



Empirical Results

How does **productivity** and efficiency of the European life insurance sector develop over time? (2/2)

Period	Average No. Of firms	Technical change	TE change	PTE change	SE change	TFP change
Model 1: Unadjusted						
Annual change (arithmetic mean)	479	1.00	1.00	1.00	1.00	1.00
Annual change (geometric mean)	479	1.00	1.00	1.00	1.00	1.01
Sample period: 2002 - 2013	219	1.00	1.02***	1.02*	1.00	1.02**
Pre-crisis period: 2002 - 2007	430	1.01**	1.02***	1.02***	1.00	1.03***
Post-crisis period: 2008 - 2013	191	0.99	1.01	1.00	1.01***	1.00
Model 2: Adjusted for the environment						
Annual change (arithmetic mean)	479	1.00	1.00	1.00	1.00	1.00
Annual change (geometric mean)	479	1.00	1.00	1.00	1.00	1.00
Sample period: 2002 - 2013	219	0.99***	0.98**	1.00	0.99***	0.97***
Pre-crisis period: 2002 - 2007	430	1.02***	1.04***	1.03***	1.01***	1.07***
Post-crisis period: 2008 - 2013	191	0.98***	0.95***	0.96***	0.99***	0.93***

Summary of Main Results

Research Question 1

General economic, capital market and insurance market conditions are important drivers of life insurers' efficiency

Research Question 2

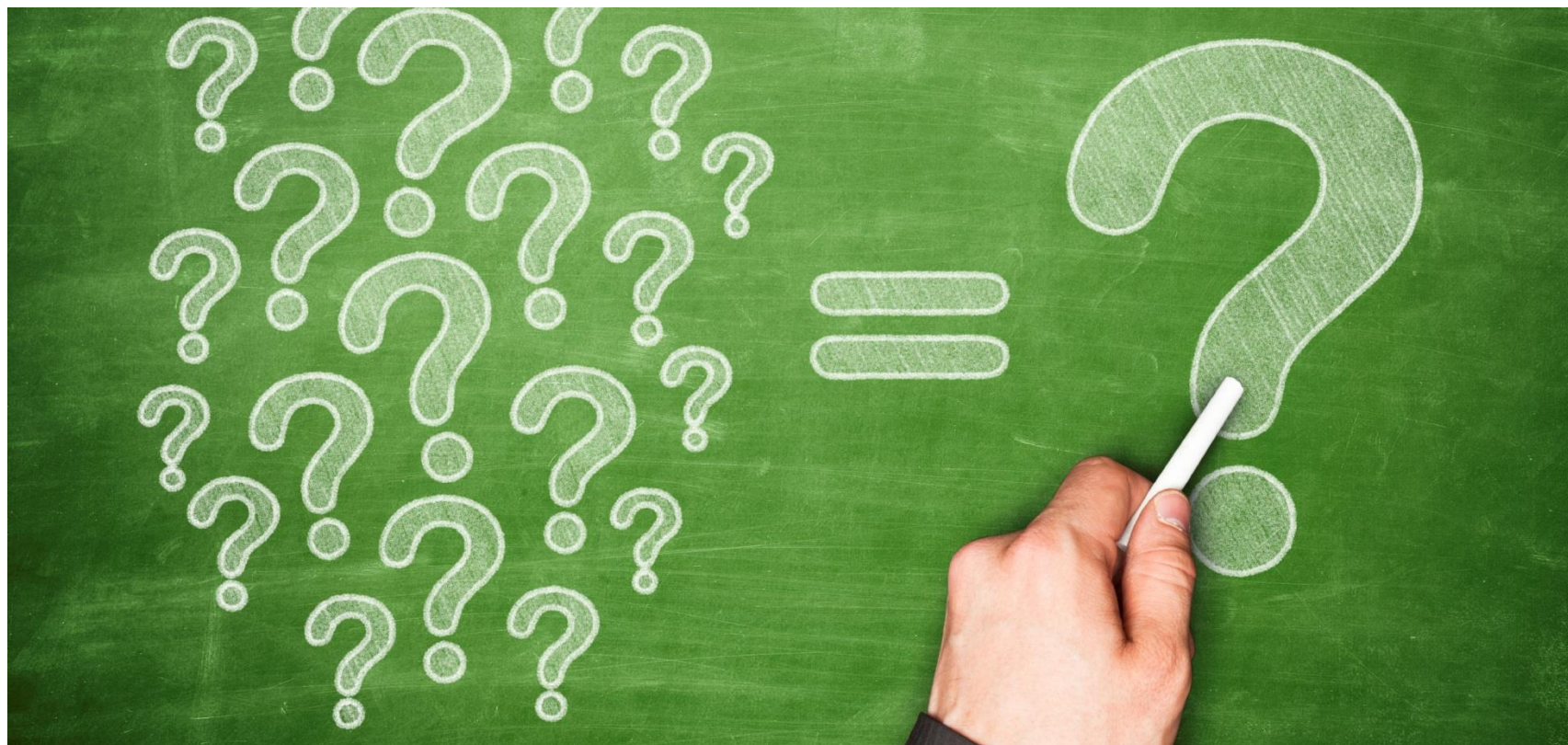
Mutual and larger life insurers tend to be more efficient

Solvency has a negative impact on efficiency; signs of the coefficient change after controlling for the environment

Research Question 3

Efficiency increased over the sample period and lead productivity to increase

Questions and Discussion



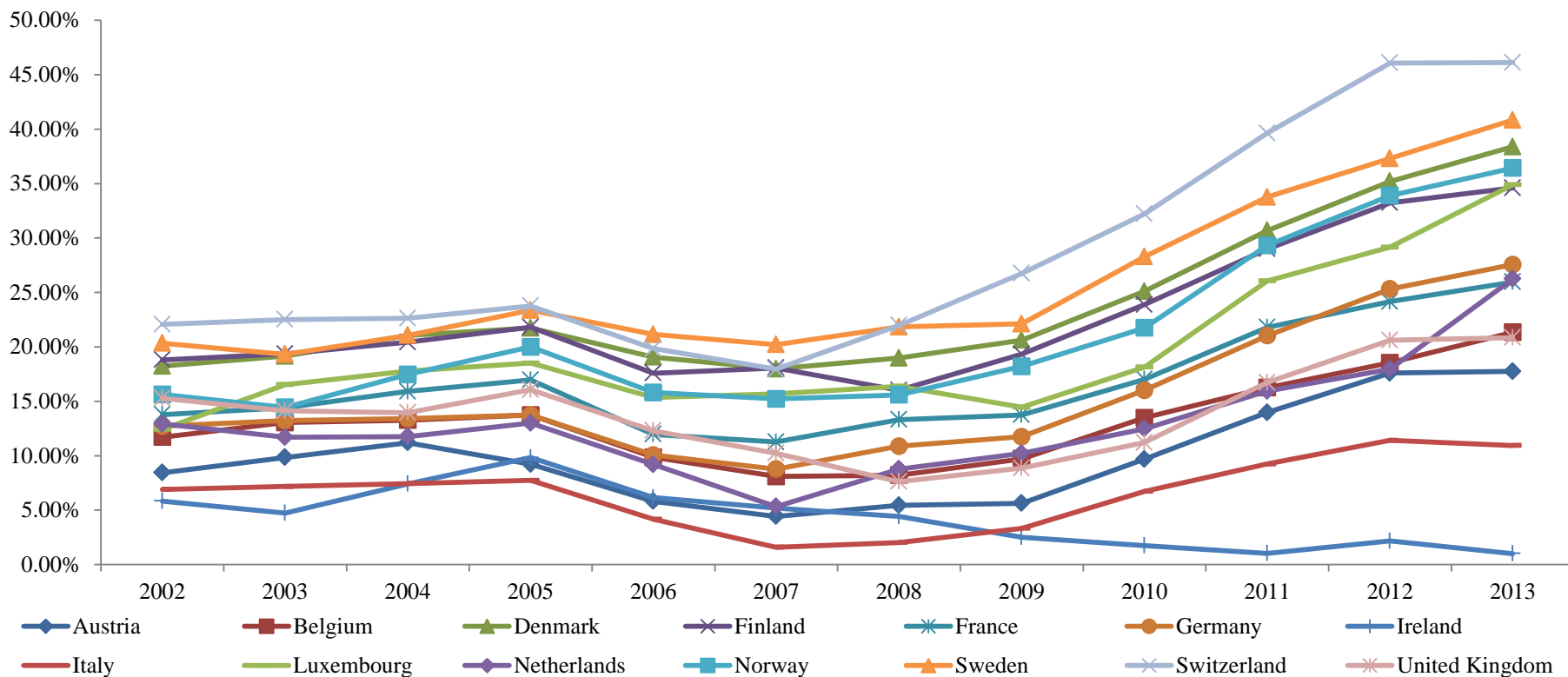
Appendix A1

	Variable	Definition	Slack1 Labor	Slack 2 Debt	Slack 3 Equity
Environmental conditions					
<i>Macro-enomic</i>					
Economic performance	<i>GDP</i>	ln(GDP per capita)	-0.300*** (0.0247)	-0.048*** (0.0092)	-0.049*** (0.0093)
Interest rate level	<i>IR</i>	Long-term interest rates	0.03041046* (0.0164)	0.047798*** (0.0059)	0.04978428*** (0.0059)
Inflation	<i>INF</i>	Consumer price indices (2002=100)	0.709*** (0.1022)	0.013 (0.0366)	0.017 (0.0369)
Equity market performance	<i>MSCI</i>	Rolling returns on MSCI indices	-0.265*** (0.0184)	-0.060*** (0.0066)	-0.063*** (0.0066)
Demand	<i>UNE</i>	Unemployment rate	0.048*** (0.0156)	-0.016*** (0.0056)	-0.020*** (0.0057)
<i>Industry-specific</i>					
Capital requirements	<i>SOLV</i>	Equity to total assets	-0.078*** (0.0116)	0.018*** (0.0042)	0.019*** (0.0042)
Competition	<i>COMP</i>	Concentration ratio 4-firm-level	0.079*** (0.0196)	-0.004 (0.007)	-0.003 (0.0071)
Log likelihood function			-2602.72	4253.74	4217.92
Sigma_v			0.128	0.016	0.016
γ^m			0.00068	0.00001	0.00002
Note: *** (**, *) represents significance at the 1 % (5 %, 10 %) level; the numbers in parentheses are standard errors					

Appendix A2

	Input 1 Labor					Input 2 Debt					Input 3 Equity capital				
	Mean	STD	Min	Max	Adjust- ment	Mean	STD	Min	Max	Adjust- ment	Mean	STD	Min	Max	Adjust- men
Austria	1.7370	1.1121	0.0748	3.8617	15 %	2930679	2081342	224046	5753747	08 %	67131	52530	10460	198148	09 %
Belgium	0.2659	0.3598	0.0044	1.5857	23 %	863135	2526946	5053	19200000	07 %	39315	104242	588	696384	07 %
Denmark	0.1573	0.2801	0.0015	2.3385	52 %	4418214	6019551	1623	34400000	10 %	477076	563476	1480	2970132	10 %
Finland	1.3616	2.3496	0.0154	23.7166	42 %	8374750	10300000	21363	41300000	12 %	659220	995710	596	5036277	11 %
France	2.0804	3.8161	0.0031	22.8304	32 %	9289605	14400000	1458	93900000	08 %	401792	575431	1735	3972288	09 %
Germany	2.0886	4.7504	0.0000	77.3875	29 %	6197613	15600000	131	219000000	08 %	113141	211885	296	2361902	09 %
Ireland	2.1786	2.8901	0.0032	20.4180	12 %	4314892	10600000	3477	97100000	01 %	221162	416883	1524	3297199	01 %
Italy	5.9728	9.5795	0.0046	60.3156	08 %	6087366	9431208	6812	67500000	04 %	253362	447582	5118	3485363	05 %
Luxembourg	0.9152	1.5196	0.0879	9.7524	35 %	2964363	3515622	363726	25200000	11 %	56127	39172	7993	190751	11 %
Netherlands	4.8967	12.8578	0.0035	101.6752	20 %	10400000	20400000	2394	92700000	07 %	917442	1906777	336	11600000	08 %
Norway	3.0458	3.3363	0.0004	14.9117	48 %	16100000	17000000	7713	62000000	10 %	1099352	1073010	4719	3626772	09 %
Sweden	3.5968	6.7948	0.0002	48.1742	53 %	11900000	14100000	71	70200000	08 %	5082182	8080594	730	29700000	09 %
Switzerland	2.7588	5.0288	0.0044	41.3438	60 %	17400000	34300000	1242	202000000	14 %	731099	1749427	4135	12700000	16 %
United Kingdom	9.5389	26.3618	0.0003	318.4361	33 %	22700000	47400000	2146	422000000	06 %	1030661	1882445	893	14500000	06 %
Total sample	3.2384	10.7156	0.0000	318.4361	28 %	8996787	22200000	71	422000000	8 %	562540	1986452	296	29700000	08 %

Figure A1



	2003/2004			2004/2005			2005/2006			2006/2007			2007/2008			2008/2009			2009/2010			2010/2011			2011/2012			2012/2013			2002/2013			
FP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	
97	1.02	1.00	1.02	0.99	1.00	0.99	0.99	1.00	0.99	0.99	1.00	0.99	1.00	1.00	1.00	0.99	1.00	0.99	1.00	1.00	1.00	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	0.93	1.00	0.93	
97	1.00	1.00	1.00	0.98	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	0.97	1.03	1.01	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.99	0.95	1.00	0.95	
00	0.99	1.00	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.99	1.01	1.01	1.02	1.00	0.99	0.99	0.99	1.00	1.03	1.03	1.00	0.99	0.98	0.99	1.03	1.02	0.98	1.00	0.98
99	0.99	1.00	0.99	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.00	1.02	0.98	1.00	0.98	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.99	0.98	1.03	1.01	
99	0.99	1.00	0.99	0.98	1.00	0.98	0.98	1.00	0.98	1.00	1.00	1.00	0.99	1.02	1.00	0.99	0.99	0.98	0.99	1.00	0.99	1.00	1.00	1.00	1.03	0.98	0.99	0.99	1.00	1.00	0.98	1.00	0.98	
99	0.99	1.00	1.00	0.98	1.01	0.99	0.99	1.00	0.99	0.99	1.00	0.99	1.00	1.03	1.03	1.00	0.99	0.99	1.00	1.04	1.03	1.00	1.00	0.99	1.00	1.00	1.00	0.99	1.01	1.00	0.96	1.00	0.96	
96	1.01	0.99	1.01	1.01	1.00	1.01	1.07	1.00	1.07	1.02	1.00	1.02	1.08	1.08	1.14	1.07	0.97	1.02	0.98	1.03	1.01	1.01	0.98	0.99	0.99	1.02	1.01	0.99	1.00	1.00	1.09	1.00	1.09	
98	0.99	1.00	0.99	0.99	1.00	0.99	1.01	1.00	1.01	1.01	1.00	1.01	1.00	1.00	1.00	0.98	1.00	0.98	1.00	1.01	1.01	1.01	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	0.97	1.06	1.03	
98	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.99	1.00	1.00	1.00	1.02	1.00	1.02	1.29	0.97	1.26	1.06	1.05	1.11	0.94	1.05	0.99	0.95	0.97	0.93	1.00	1.06	1.06	0.97	0.97	0.94	
99	0.99	1.00	0.99	0.97	1.00	0.97	0.98	1.00	0.98	1.00	1.00	1.00	1.02	1.00	1.02	0.99	1.00	0.99	0.99	1.00	0.99	1.00	1.00	1.00	0.99	1.00	0.99	1.00	1.00	1.00	0.96	1.00	0.96	
99	0.98	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.00	1.01	0.91	1.01	0.92	0.97	1.00	0.97	1.00	1.00	1.00	1.01	1.03	1.04	1.00	1.00	1.00	1.00	1.01	1.01	0.98	1.00	0.98	
99	1.01	1.00	1.01	0.98	0.99	0.97	0.99	1.00	0.99	1.00	0.99	0.99	0.98	1.13	1.10	1.00	1.01	1.01	1.03	1.01	1.03	1.02	1.00	1.02	1.01	1.00	1.00	0.99	1.00	1.00	0.99	1.00	0.99	
99	1.01	0.99	1.00	1.23	0.97	1.12	0.95	0.99	0.94	1.11	1.00	1.12	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.02	1.01	1.00	0.98	0.99	0.99	1.00	0.99	1.00	1.00	1.00	0.97	1.00	0.97	
95	0.99	1.01	1.00	0.99	1.00	1.00	1.01	1.00	1.00	0.99	1.01	1.00	0.91	1.04	0.95	0.99	1.00	0.99	1.00	1.00	1.00	1.02	1.00	1.02	1.01	0.96	0.97	1.00	1.03	1.03	1.03	0.97	1.01	
98	1.00	1.00	1.00	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.03	1.03	1.00	0.99	0.99	0.99	1.02	1.01	1.00	1.00	1.00	1.00	0.99	0.99	1.00	1.01	1.01	0.98	1.00	0.98	
FP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	TEC	TC	ΔTFP	
97	1.02	0.99	1.01	0.98	1.00	0.98	0.99	1.00	0.99	0.98	1.00	0.98	0.99	1.02	1.01	1.02	0.98	0.99	1.02	1.01	1.04	1.01	1.02	1.03	1.01	0.99	1.00	1.00	1.00	1.01	1.00	0.96	1.00	0.96
95	1.01	0.99	1.01	0.98	1.00	0.98	0.99	1.00	0.99	0.99	1.00	0.99	1.00	1.01	1.01	1.02	0.99	1.01	0.99	1.04	1.03	0.99	1.04	1.03	1.04	0.96	1.00	0.97	1.01	0.98	0.96	1.01	0.96	
99	0.99	0.98	0.97	0.99	1.01	1.00	0.99	0.99	0.99	0.99	0.99	0.98	1.01	1.03	1.04	1.01	0.99	1.00	1.00	1.02	1.02	1.00	1.07	1.07	1.04	0.97	1.00	0.99	1.01	1.00	1.02	1.00	1.02	
97	0.99	0.99	0.98	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.02	1.02	1.03	1.00	0.98	0.98	1.01	1.00	1.02	0.98	1.05	1.03	1.06	0.95	1.01	0.97	1.02	0.98	1.03	1.02	1.05	
98	0.99	0.99	0.98	0.98	1.00	0.98	0.98	0.99	0.97	0.99	1.00	0.99	0.98	1.03	1.01	1.03	1.03	0.97	1.00	1.01	1.01	1.02	0.99	1.04	1.03	1.06	0.95	0.99	0.98	1.02	0.99	1.03	0.99	1.02
99	0.99	1.00	0.99	0.98	1.01	0.99	0.98	1.00	0.98	0.99	0.99	0.98	1.00	1.04	1.05	1.02	0.98	1.00	1.01	1.05	1.06	1.00	1.03	1.03	1.04	0.98	1.01	0.97	1.02	0.98	1.01	1.01	1.02	
96	1.02	0.98	1.00	1.01	1.01	1.02	1.07	1.00	1.07	1.02	1.00	1.02	1.07	1.09	1.14	1.07	0.97	1.02	0.98	1.05	1.02	1.01	0.98	0.99	0.99	1.02	1.02	0.99	1.02	1.01	1.07	1.01	1.08	
96	0.99	0.99	0.98	0.99	1.00	0.99	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.00	0.99	0.99	1.02	1.01	1.03	1.03	1.01	1.03	0.99	1.00	0.98	0.99	1.01	1.00	0.97	1.07	1.04
98	1.01	0.99	1.00	1.00	1.00	1.00	0.99	1.00	0.98	0.99	1.00	0.99	1.01	1.02	1.03	1.30	0.95	1.25	1.08	1.08	1.15	0.97	1.08	1.05	1.00	0.95	0.94	0.96	1.13	1.09	0.98	0.99	0.97	
98	0.99	0.99	0.98	0.97	1.00	0.97	0.97	1.00	0.97	0.99	1.00	0.99	1.02	1.01	1.03	1.01	0.99	0.99	1.00	1.01	1.01	1.01	1.02	1.03	1.01	0.99	1.00	0.99	1.01	1.01	0.98	1.00	0.98	
99	0.99	0.99	0.98	0.99	1.00	0.99	0.99	1.00	0.98	1.00	1.00	1.00	0.93	1.01	0.94	1.00	0.98	0.98	1.02	1.01	1.04	1.02	1.07	1.08	1.04	0.97	1.01	0.98	1.01	0.99	1.04	0.99	1.03	
99	1.00	0.99	1.00	0.98	0.99	0.97	0.98	0.99	0.98	0.99	0.99	0.98	0.98	1.12	1.10	1.01	1.00	1.01	1.04	1.03	1.07	1.04	1.02	1.06	1.04	0.98	1.02	0.95	1.02	0.97	0.99	1.02	1.01	
99	1.00	0.99	0.99	1.22	0.97	1.12	0.94	0.98	0.93	1.10	1.00	1.11	0.99	1.01	1.00	1.04	0.98	1.02	1.02	1.03	1.05	1.01	1.02	1.02	1.05	0.97	1.02	0.96	1.02	0.97	1.03	1.00	1.03	
94	0.99	1.00	0.99	0.98	1.00	0.99	1.00	0.99	0.99	0.99	1.01	1.00	0.91	1.05	0.96	1.01	0.99	1.00	1.02	1.01	1.03	1.02	1.03	1.05	1.03	0.95	0.99	0.96	1.04	1.00	1.03	0.99	1.02	
97	0.99	0.99	0.99	0.99	1.00	0.99	0.99	1.00	0.99	1.00	1.00	0.99	1.00	1.04	1.04	1.02	0.98	1.01	1.01	1.03	1.04	1.00	1.03	1.03	1.03	0.97	1.01	0.97	1.02	0.99	1.02	1.01	1.02	

Technical Change, TC stands for Technical Change, TFP stands for Total Factor productivity