More on Population Aging and International Capital Flows

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1 Introduction

This document provides additional information and results to our paper Domeij and Flodén (2005).[1] We present results of alternative model specifications in Section 2. First, we report additional results using pooled regressions. Second, we calibrate country-specific depreciation rates to match evidence on country-specific capital-output ratios. Third, we calibrate social security tax rates to match the size of pension systems in the different countries. Finally, we consider alternative specifications of the initial steady states. In Section 3, we present further information about the population data and population forecasts used in the paper.

2 More Results

2.1 Pooled regressions

Table 2 in Domeij and Flodén (2005) report regression results for fixed effects panel specifications

$$CA_{i,t} = \alpha_i + \beta X_{i,t} + \varepsilon_{i,t}$$

and pooled OLS regressions

$$CA_{i,t} = \alpha + \beta X_{i,t} + \varepsilon_{i,t}$$

where $X_{i,t}$ denotes current account data implied by the model and $CA_{i,t}$ denotes real-world current account data for country i in period t.

The robustness checks and the regression results for savings and investment (Tables 3 and 4 in Domeij and Flodén 2005) only report results for the panel specification. Here we report

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[1]Domeij, David, and Martin Flodén (2005), "Population Aging and International Capital Flows", manuscript, Stockholm School of Economics.

the corresponding results for the pooled OLS specification. The estimated coefficient β and the explanatory power reported in Table 1 are similar to those in the baseline specification used in Domeij and Flodén (2005). These results thus confirm that the results are robust to a variety of model specifications also when running pooled OLS regressions.

Table 2 reports pooled OLS results with savings and investment as the dependent variables. Just as in the fixed effect panel specification, the savings regression results in high and significant β estimates. The explanatory power is also similar. The regressions with investment as the dependent variable are, however, less sucessful. Both the estimated β and the explanatory power are close to zero. A possible explanation for the failure of the pooled OLS regression for investment is that real-world investment rates, and in particular country-specific average levels, are mostly determined by non-demographic factors. The theoretical link from life-cycle savings and a country's demographic development to savings rates is more direct.

2.2 Country-Specific Capital-Output Ratios

In the baseline specification of the model, all preference and technology parameters are identical in all countries. In particular, we choose the discount factor β so that the world capital-output ratio in 1990 is 2.74 as in the data.[2] Here, we instead calibrate the capital-output ratios for each country separately. To do this, we keep the β from the baseline calibration and choose separate depreciation rates δ for each country so that the capital-output ratios implied by the model are identical to the World Bank estimates for 1990.[3] Table 3 shows capital-output ratios estimated by the World Bank (the Nehru-Dhareshwa dataset), Penn World Tables, and Maddison (1991)[4]. The Penn World Tables systematically report lower values than the other sources since they assume that capital depreciates over time whereas the other studies assume that capital maintains its full value until it is scrapped.

The final column in Table 3 reports the country-specific depreciation rates that imply that the capital-output ratios generated for 1990 in the model match the World Bank estimates. Figure 1 shows the equilibrium interest rate path and capital-output ratios implied by this model specification. The interest rate path is similar to the baseline scenario, but the heterogeneity in depreciation rates implies that capital-output ratios are at different levels. Regression results based on model data from this specification are reported in Table 4. As in Domeij and Flodén (2005), we run fixed effects panel regressions

$$CA_{i,t} = \alpha_i + \beta X_{i,t} + \varepsilon_{i,t}$$

and pooled OLS regressions

$$CA_{i,t} = \alpha + \beta X_{i,t} + \varepsilon_{i,t}$$

where $X_{i,t}$ denotes current account data implied by the model and $CA_{i,t}$ denotes real-world current account data for country i in period t . The results in Table 4 are almost

[2] We calculate the world capital-output ratio as the GDP-weighted average of the Nehru-Dhareshwa World Bank capital-output ratios.

[3] We want preferences to be identical in all countries and prefer to allow for differences in depreciation rates.

[4] Maddison, Angus (1991), *Dynamic Forces in Capitalist Development*, Oxford University Press

identical to those with the benchmark specification – the estimated β:s are similar are the standard deviations and the fraction of the variance explained by the model data.

2.3 Country-Specific Pension Systems

In the baseline specification of the model, we also assume that pension systems are identical in all countries, and the initial social security tax rate is set to four percent of labor income. The motivation for calibrating identical pension systems in all countries is that we lack necessary country-specific information for more detailed specifications. In particular, we model a pay-as-you-go system and therefore would need data that excludes the funded parts of pension systems. Nevertheless, as a robustness check we here calibrate country-specific tax rates to match the size of pension systems in 1990. Table 5 shows the size of the public pension systems and the country-specific social security tax rates needed to match these observations. Figure 2 shows that the equilibrium interest rate path and capital-output ratios implied by this model specification are similar to the baseline scenario. The regression results reported in Table 6 also show that the baseline results are robust to this alternative calibration.

2.4 Economy Starts in 1950

The initial steady state is calibrated to match data (in particular demographic data) from 1950. Households in this steady state believe that population sizes and age structures will be constant forever. In the first model year, households learn about the demographic development from 1950 and onwards. Since the information about future demographics is potentially a large shock to households, in the baseline model calibration we replicated the 1950 data for 50 periods and assumed that the households already in year 1900 learnt about the demographic development after 1950. We have also solved the model under the assumption that households do not learn about the new demographics until in 1950. The results reported in Table 7 are almost identical to those with the baseline specification, indicating that our results do not depend on when this information shock is assumed to hit the economy.

In the baseline specification we also assume that countries are open in the initial steady state. This may not be a realistic assumption, in particular considering that we argue in the paper that international capital mobility may have improved during recent decades. We have therefore also examined the effects of assuming that countries were closed in the initial steady state. The results in Table 8 are based on a model calibration where we force the initial net foreign asset position in each country to be zero, and where households learn about the future demographic development in 1950. Again, the results are similar to those with the baseline specification.

3 Population Data and Forecasts

Figure 3 summarizes the demographic development for each country and for the world economy. Observations from 1950 to 2050 are based on U.N. data and forecasts. Observations after 2050 are based on our own projections. We assume that the number of newborns and survival probabilities are constant from 2050 and onwards, and calculate the implied future demographic development.

The most notable information in Figure 3 is the sharp fall in the fraction of the population in working age during the coming decades. The figure also shows population sizes, according to these forecasts, soon will stabilize or start falling in Japan and most European OECD countries.

Table 1: Regression results for current account, pooled OLS
Various model specifications

Variation	no adj. cost		high adj. cost		OECD		no pensions		$\mu = 1$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
time period	60-02	85-02	60-02	85-02	60-02	85-02	60-02	85-02	60-02	85-02
constant	−2.28	−2.91	−2.43	−3.26	−0.68	0.15	−2.28	−2.47	−2.10	−2.15
	(0.43)	(0.77)	(0.44)	(0.78)	(0.24)	(0.35)	(0.41)	(0.70)	(0.41)	(0.65)
β	0.39**	0.57**	0.40**	0.61**	0.35**	0.59**	0.43**	0.55**	0.48**	0.64**
	(0.08)	(0.12)	(0.08)	(0.12)	(0.09)	(0.13)	(0.08)	(0.12)	(0.10)	(0.14)
$\beta_{85-02} - \beta_{60-84}$		0.45**		0.50**		0.43*		0.38*		0.49*
		(0.16)		(0.16)		(0.17)		(0.17)		(0.20)
# obs.	159	72	159	72	159	72	159	72	159	72
R^2	0.14	0.24	0.14	0.28	0.09	0.24	0.15	0.24	0.13	0.23

Note: Standard deviations in paranthesis. * and ** denote significance at the 5 and 1 percent levels, respectively.

Table 2: Regression results for savings and investment rates Pooled OLS

Dependent variable	Savings rate		Investment rate	
	(1)	(2)	(3)	(4)
time period	60-02	85-02	60-02	85-02
constant	22.45	-6.07	18.88	22.11
	(4.80)	(7.74)	(3.52)	(4.92)
β	0.03	1.11**	0.26	-0.02
	(0.20)	(0.30)	(0.19)	(0.26)
$\beta_{85-03} - \beta_{60-84}$		1.03		-0.61
		(0.54)		(0.35)
# obs.	159	72	162	72
R^2	0.00	0.16	0.01	0.00
R^2_X				

Note: R^2_X is the variance explained by X only (i.e. fixed effects not included). Standard deviations in paranthesis. * and ** denote significance at the 5 and 1 percent levels, respectively.

Table 3: Capital-Output Ratios and Calibration

	1990 K/Y Ratios			
	World Bank[a)]	Penn World Tables[b)]	Maddison[c)]	$\delta^{d)}$
Australia	3.5	1.8		2.5
Austria	3.4	1.8		2.9
Belgium	2.7	1.6		5.7
Canada	2.7	2.0		5.7
Denmark	3.0	2.0		4.4
Finland	3.5	2.4		2.6
France	3.0	1.7		4.3
Germany	3.1	1.9	4.4	3.9
Ireland	2.5	1.4		6.8
Italy	3.0	1.8		4.4
Japan	3.3	2.0	3.4	3.2
Netherlands	3.3	1.5		3.2
Portugal	3.5	1.4		2.6
Spain	2.9	1.9		4.9
Sweden	3.0	2.1		4.4
Switzerland	3.5	3.4		2.5
U.K.	2.7	1.2	2.9	5.8
USA	2.7	1.6	3.6	5.8
China	2.4	*n.a.*		–
India	2.3	0.8		8.1

Notes: [a)] Nehru-Dhareshwa, see www.worldbank.org/research/growth/ddnehdha.htm.

[b)] PWT Mark 5.6, capital stocks are not available in recent PWT.

[c)] Maddison (1991). Values refer to 1987.

[d)] Annualized depreciation rates (%) needed to match World Bank K/Y ratios.

Table 4: Regression Results
Economy with capital-output ratios calibrated to 1990 values

	Fixed effects		Pooled OLS	
time period	60-02	85-02	60-02	85-02
constant			-1.71	-2.14
			(0.37)	(0.62)
β	0.43**	0.96**	0.35**	0.60**
	(0.10)	(0.30)	(0.08)	(0.12)
$\beta_{85-02} - \beta_{60-84}$		0.61		0.52**
		(0.33)		(0.16)
# obs.	159	72	159	72
R^2	0.48	0.70	0.11	0.25
R^2_X	0.11	0.17		

Note: See Table 2.

Table 5: Size of Pension Systems and Calibration

	1990 P/Y$^{a)}$	$\tau_{ss}^{p\ b)}$	$\tau_{1990}^{p\ c)}$
Australia	2.9	3.30	4.52
Austria	9.5	10.40	14.81
Belgium	6.5	7.45	10.14
Canada	4.5	5.30	6.99
Denmark	6.3	6.00	9.81
Finland	6.4	5.50	10.03
France	9.2	11.65	14.34
Germany	8.5	9.10	13.24
Ireland	3.7	5.40	5.77
Italy	11.0	9.97	17.20
Japan	4.0	3.20	6.21
Netherlands	7.2	7.60	11.21
Portugal	4.2	3.60	6.55
Spain	7.1	6.05	11.06
Sweden	7.2	6.18	11.22
Switzerland	8.2	8.95	12.80
U.K.	8.5	8.63	13.25
USA	5.1	5.52	7.96
Korea	0.6	–	–
Mexico	0.3	–	–
R.O.W.	(1.0)	1.40	1.54

Notes: $^{a)}$ 'Old age cash benefits relative to GDP' (%), OECD Social Expenditures Database.
$^{b)}$ Pension tax (%) in initial steady state set to match 1990 P/Y ratios.
$^{c)}$ Pension tax (%) 1990 implied by the DB pension system.

Table 6: Regression Results
Economy with pension systems calibrated to 1990 levels

	Fixed effects		Pooled OLS	
time period	60-02	85-02	60-02	85-02
constant			-1.65	-1.82
			(0.42)	(0.71)
β	0.40**	0.81**	0.31**	0.48*
	(0.10)	(0.29)	(0.09)	(0.13)
$\beta_{85-02} - \beta_{60-84}$		0.46		0.49**
		(0.33)		(0.18)
# obs.	159	72	159	72
R^2	0.47	0.68	0.07	0.16
R_X^2	0.10	0.13		

Note: See Table 2.

Table 7: Regression Results
Economy starts in 1950

	Fixed effects		Pooled OLS	
time period	60-02	85-02	60-02	85-02
constant			-2.35	-3.19
			(0.44)	(0.79)
β	0.42**	0.81**	0.39**	0.60**
	(0.10)	(0.26)	(0.08)	(0.12)
$\beta_{85-02} - \beta_{60-84}$		0.50		0.49**
		(0.30)		(0.16)
# obs.	159	72	159	72
R^2	0.49	0.69	0.14	0.26
R_X^2	0.12	0.16		

Note: See Table 2.

Table 8: Regression Results
Economy starts in 1950 with NFA = 0 in all countries

	Fixed effects		Pooled OLS	
time period	60-02	85-02	60-02	85-02
constant			-2.21	-3.10
			(0.45)	(0.80)
β	0.39**	0.79**	0.32**	0.54**
	(0.09)	(0.25)	(0.07)	(0.11)
$\beta_{85-02} - \beta_{60-84}$		0.47		0.46**
		(0.28)		(0.15)
# obs.	159	72	159	72
R^2	0.48	0.69	0.12	0.25
R^2_X	0.12	0.16		

Note: See Table 2.

Figure 1: Annualized Interest Rate and Annualized K/Y Ratios
Economy with capital-output ratios calibrated to 1990 values

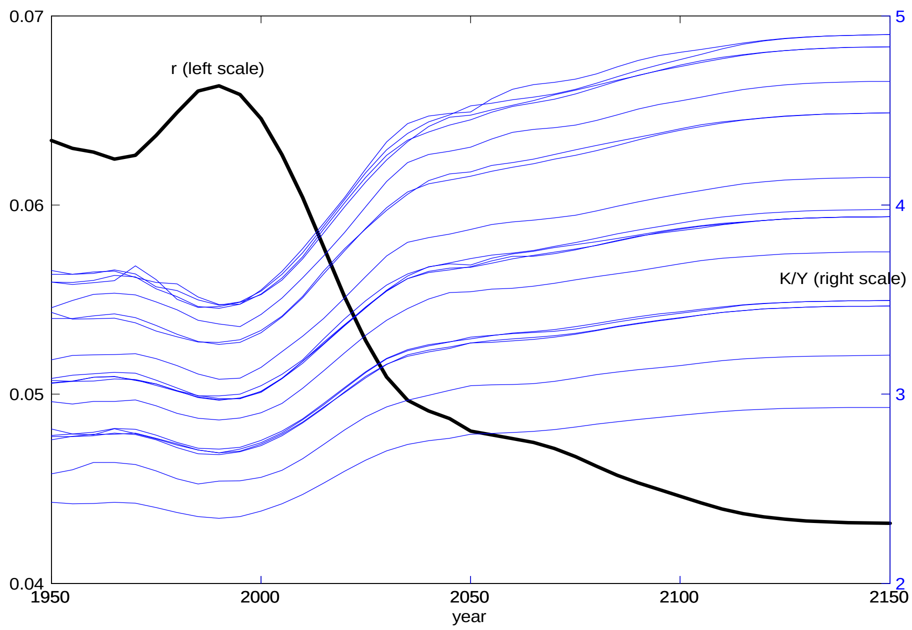


Figure 2: Annualized Interest Rate and Annualized K/Y Ratios Economy with pension systems calibrated to 1990 levels

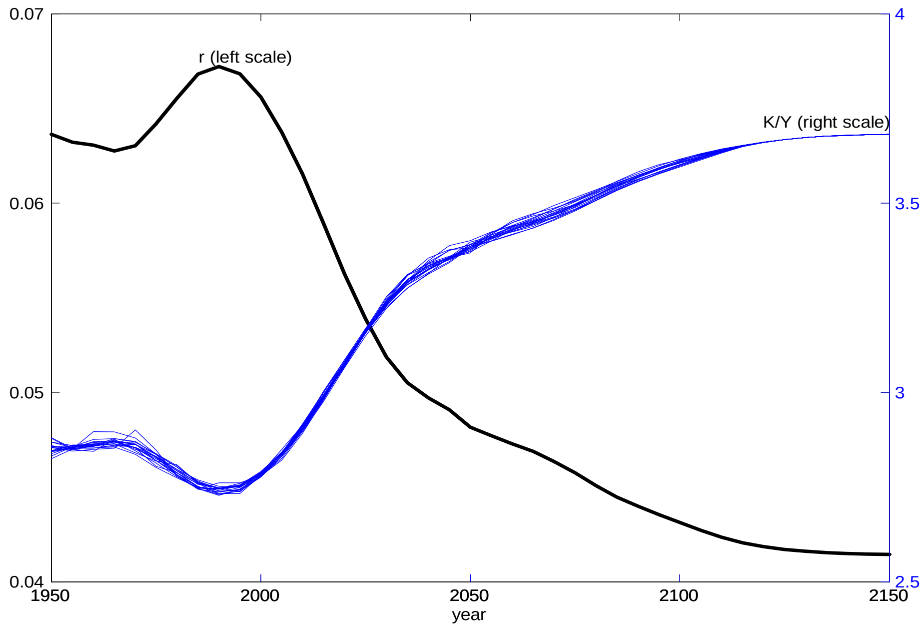
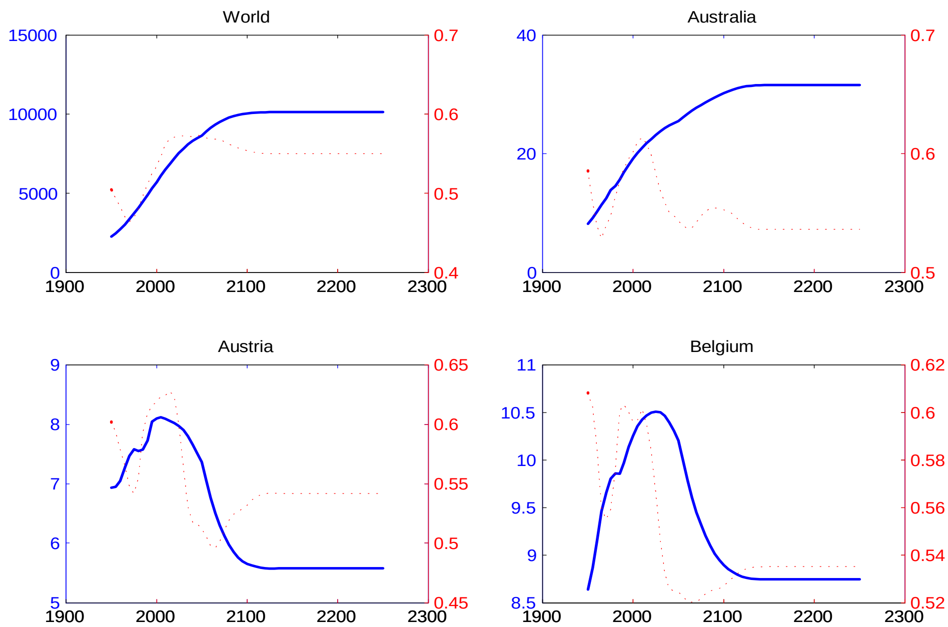
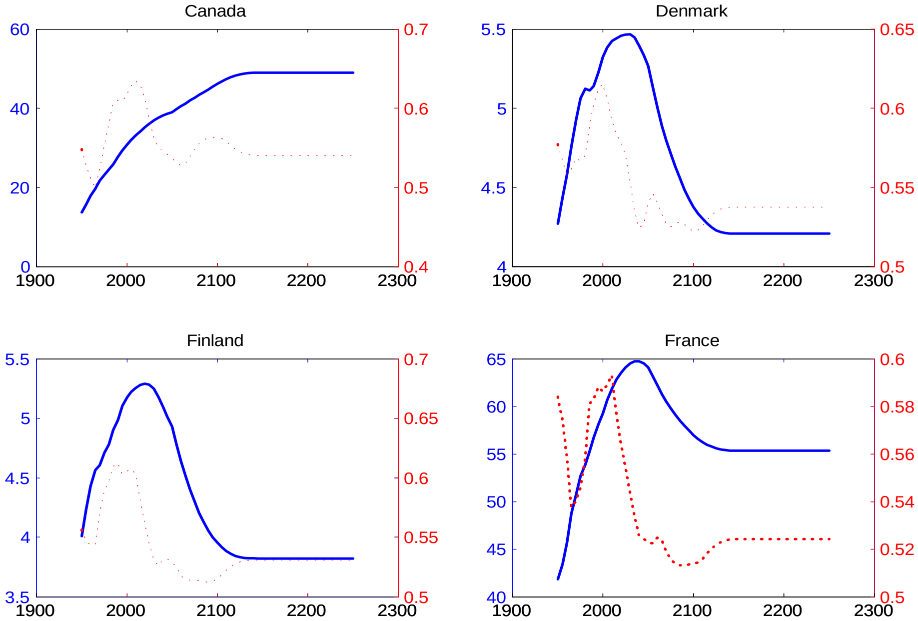


Figure 3a: Population Data and Forecasts



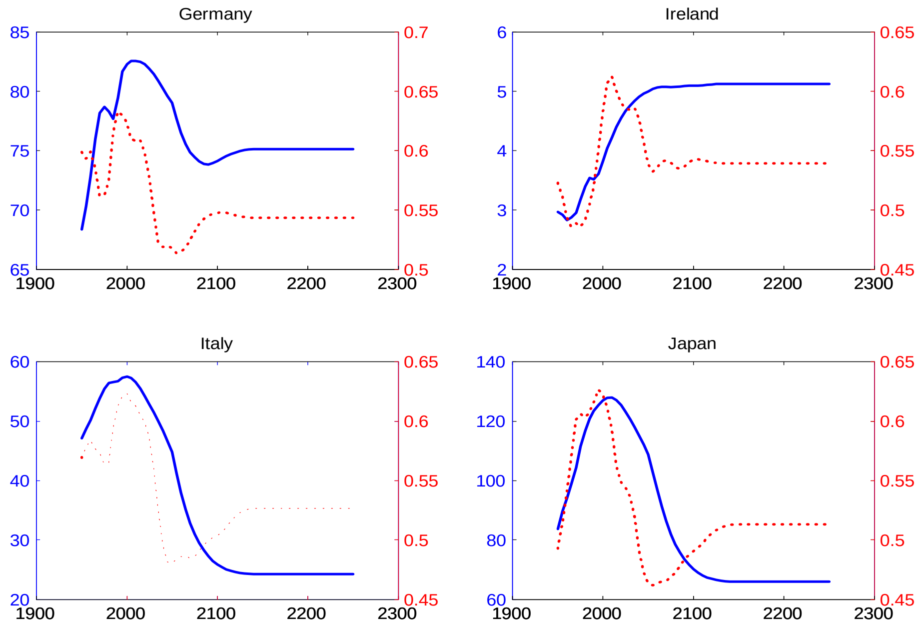
Note: Solid lines (left scale) show the total population in millions. Dotted lines (right scale) show the fraction of the population in ages 20-64.

Figure 3b: Population Data and Forecasts



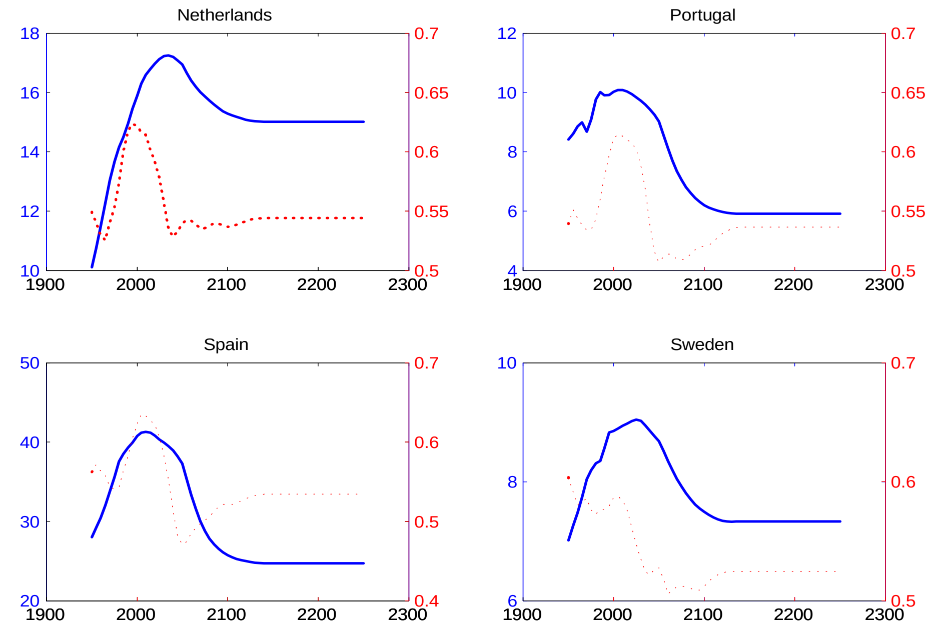
Note: Solid lines (left scale) show the total population in millions. Dotted lines (right scale) show the fraction of the population in ages 20-64.

Figure 3c: Population Data and Forecasts



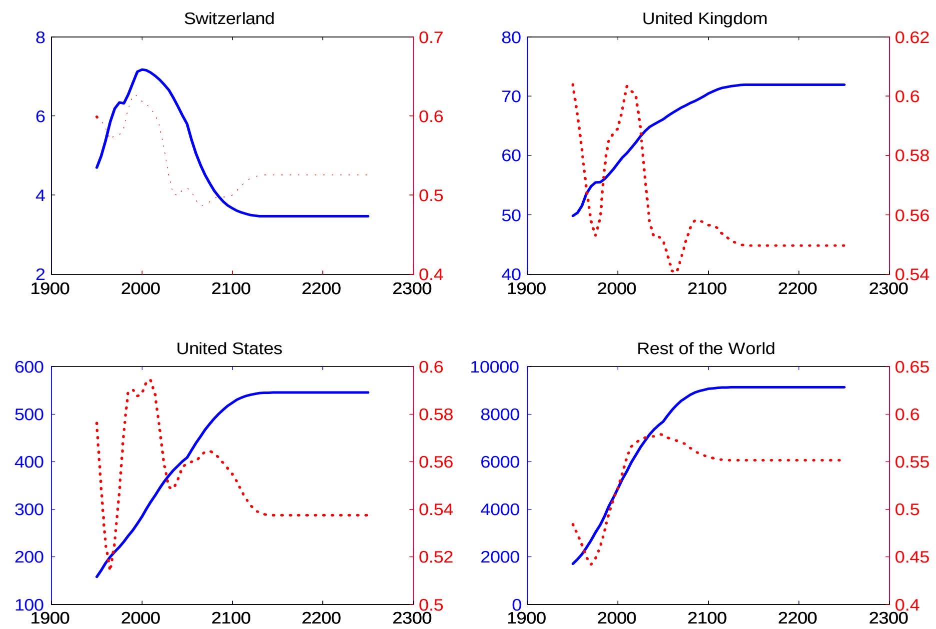
Note: Solid lines (left scale) show the total population in millions. Dotted lines (right scale) show the fraction of the population in ages 20-64.

Figure 3d: Population Data and Forecasts



Note: Solid lines (left scale) show the total population in millions. Dotted lines (right scale) show the fraction of the population in ages 20-64.

Figure 3e: Population Data and Forecasts



Note: Solid lines (left scale) show the total population in millions. Dotted lines (right scale) show the fraction of the population in ages 20-64.