The Dynamics of Population Ageing and FDI Inflows: A Multi-Country Study

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ABSTRACT

The neoclassical theory posits an inverse relationship between population ageing and FDI inflows. We investigate the short-run and long-run relationships between population ageing and net FDI inflows (% of GDP) for 20 OECD countries, controlling for national income, exchange rate, trade openness and domestic investment. The long-run effects of population ageing on net FDI inflows (% of GDP) are mixed and country-specific. The effects are significantly negative for Australia, Austria, Costa Rica, Denmark, Finland, Spain and Sweden; significantly positive for Colombia, Germany, Greece, Italy, Japan, Norway and Portugal, and insignificant for Belgium, Chile, France, Mexico, the UK and the USA.

Keywords: Bounds Testing, Cointegration, FDI, Unit Root.

JEL Classification Codes: F21, J11.

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1. Introduction

Most industrialized countries today are faced with a declining population. In OECD countries, the number of individuals aged 65 years and above as a percentage of total population is steadily increasing. The neoclassical theory of economic growth predicts that, as the working age population in the developed countries shrinks, the capital-labor ratio in those countries will rise. Due to diminishing returns to factor inputs, the returns to capital relative to labor will fall; consequently, capital will flow from the developed to the developing countries, and net FDI inflows into the developed countries will decrease. In other words, with fewer restrictions on cross-border capital flows, capital will flow from the industrialized countries with relatively more aged societies and high dependency ratios to developing countries with relatively younger population and low dependency ratios. Thus, according to the predictions of the neoclassical theory of economic growth, an increase in the proportion of elderly individuals in total population will most likely be associated with a decrease in FDI inflows. An increase in population ageing in a country is expected to reduce FDI inflows in that country.

The importance of foreign capital inflows for sustainable economic growth is well documented in macroeconomic literature; consequently, the relation between population ageing and international capital flows has attracted the attention of academicians and policymakers for many years. Population ageing is a pressing public policy concern for national governments of OECD countries because of continuously rising social expenditures and steadily declining tax revenues and foreign capital inflows. An ageing population may have significant negative effects on national saving and investment rates, per-capita GDP growth and national labor force.

According to the World Bank statistics database, from 1980-2019, the proportion of elderly in total population of Australia increased from 9.62% to 15.92%. For Austria, the increase has been from 15.19% in 1980 to 19.08% in 2019. For other OECD countries, from 1980-2019, the respective increase in the proportion of the elderly in total population has been as follows - 14.45% to 19.01% for Belgium, 4.91% to 11.88% for Chile, 3.54% to 8.77% for Columbia, 3.94% to 9.88% for Costa Rica, 14.43% to 19.97% for Denmark, 12.02% to 22.14% for Finland, 13.92% to 20.39% for France, 15.65% to 21.56% for Germany, 12.47% to 21.94% for Greece, 13.36% to 23.01% for Italy, 8.91% to 28.00% for Japan, 3.93% to 7.42% for Mexico, 14.73% to 17.28% for Norway, 11.53% to 22.36% for Portugal, 11.09% to 19.65% for Spain, 16.32% to 20.19% for Sweden, 14.95% to 18.51% for the UK, and 11.56% to 16.21% for the USA. Figure 1 shows that, from 1980-2019, the proportion of elderly in total population of all 37 OECD member countries increased from 10.62% to 17.08%.

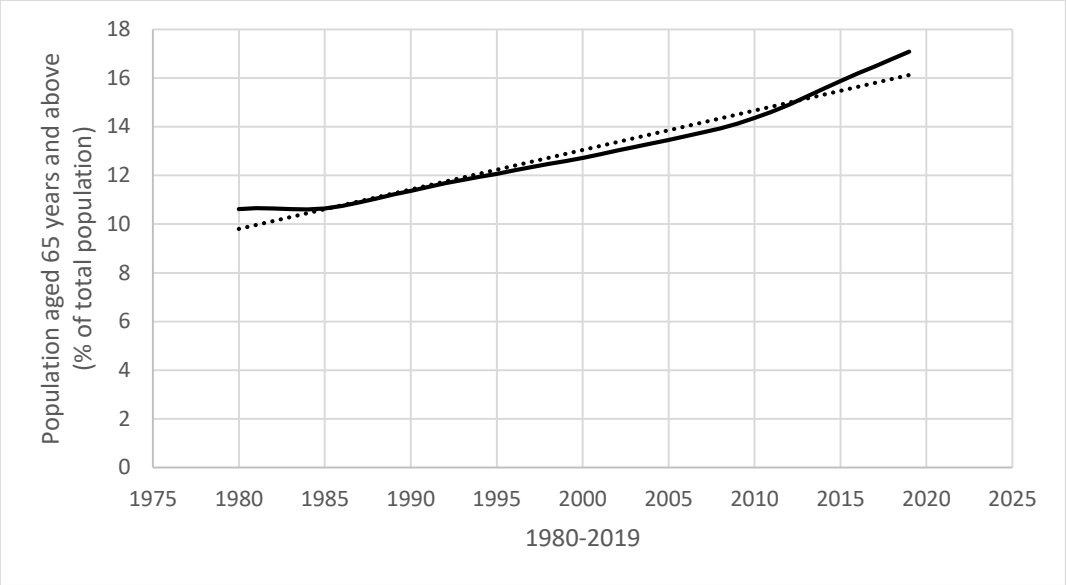

Figure 1. Proportion of Elderly in Total Population

In line with the predictions of economic theory, we would expect foreign investment inflows (% of GDP) in all OECD member countries to decrease. However, Figure 2 shows that, net FDI inflows (% of GDP) actually increased from 0.57% to 1.68%.

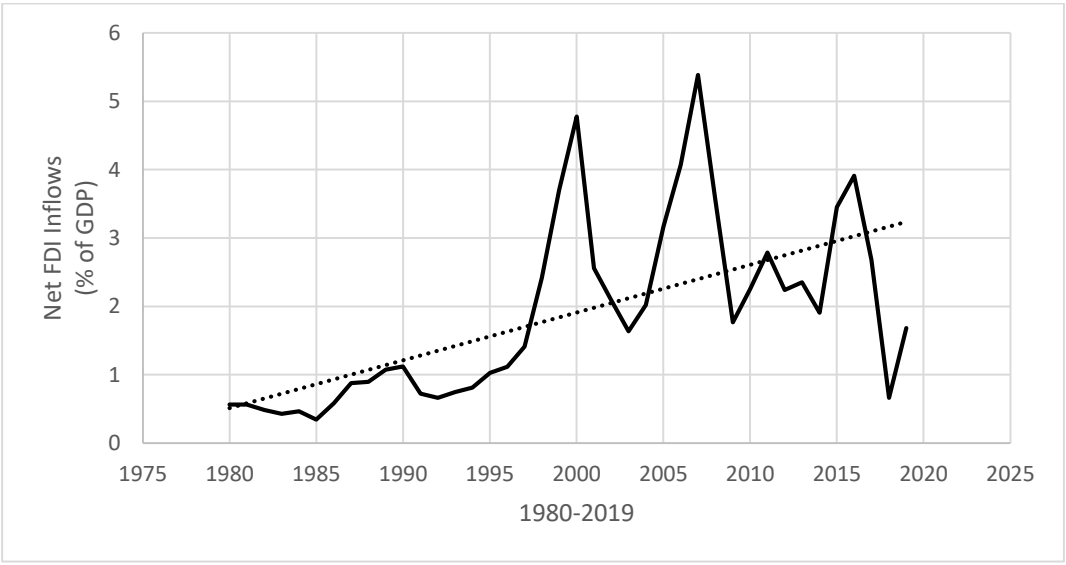

Figure 2. Net FDI Inflows in Proportion to GDP

The positive trend in the net FDI inflows (% of GDP), depicted in Figure 2, is a contradiction to the predictions of the neoclassical economic theory. But any interpretation of a potential positive association between population ageing and net FDI inflows (% of GDP) for all OECD member countries must be treated with caution due to aggregation bias. Secondly, demographic changes occur slowly over time. From a policy standpoint, a country-case analysis is more appropriate than

a cross-sectional or a panel study. Very little attention has been given to examining the existence of a cointegrating relationship between population ageing and net FDI inflows for the individual OECD economies, especially with structural breaks in time series data. This paper fills the gap in the literature by examining the short-run and long-run effects of an increase in the number of individuals aged 65 years and above (% of total population) on net FDI inflows (% of GDP) with structural breaks, individually, for 20 OECD countries, while controlling for national income, exchange rate, trade openness and domestic investment.

2. Literature Review

Modigliani and Brumberg (1954) and Ando and Modigliani (1963) developed the life cycle hypothesis to study the effects of population age cohorts on savings rate. The main idea is, consumption decisions are based not just on the current level of income, but also on resources that are available over one's lifetime. Individuals accumulate assets when they are young. When they retire, they use the stock of assets that they accumulated when they were young; therefore, we would expect to observe an increase in national savings when the population is young, and dissaving as the proportion of elderly in total population increases. It has also been observed that, an increase in the proportion of elderly in total population generally results in an increase in the preference for less risky assets; thus, a shift from a relatively "young" to a relatively "old" population would, most likely, result in a shift in preferences from assets that are relatively riskier to assets that are relatively less risky. Although Mason (1988) and Collins (1991), amongst others, confirmed the relation between population age cohorts and savings rate as predicted by the life cycle hypothesis, a major weakness of the hypothesis is that it does not account for international capital flows. The life cycle hypothesis would hold under the assumption of perfect capital mobility; however, studies by Feldstein and Horioka (1980), French and Poterba (1991), Frankel (1992), Obstfeld (1995), Kang and Stulz (1997) and Portes and Rey (1999) have shown that capital mobility across countries is largely imperfect. According to Higgins (1998), ignoring the degree of capital mobility across countries may hamper "demographically induced capital flows".

The overlapping generations (OLG) model, which follows from the life cycle hypothesis, is based on the premise that a population comprises of both young and elderly individuals who interact with one another in the market at any given point of time. Higgins and Williamson (1996) argued that investment is linked to labor force as workers need to be equipped with capital. In the relatively "young" economies, we may expect to observe a current account deficit, because of high investment demand. With population ageing, the current account deficit might change to a current account surplus, especially if the country has a large working age population.

Numerous studies have investigated the patterns of savings, investment and net capital flows. Brooks (2000) showed that demographic changes can have significant effects on financial markets. Lührmann (2006) argued that expectations of future demographic changes must be taken into account when explaining capital flows. Börsch-Supan et al. (2002, 2005) developed a multi-country OLG model and found that population ageing initially results in an increase that is followed by a decrease in capital stock in future periods. The study noted that saving rates and international capital flows may become less responsive to demographic changes if households account for the demographic shock by increasing the working period in their lives. A country with

a high proportion of working-age population is expected to become a net exporter of capital, and a country with a high old-age dependency ratio is expected to become a net importer of capital.

In line with Vernon (1966), Narciso (2010) argued that population ageing would induce capital to flow from the relatively "older" economies to the relatively "younger" economies. A reason could be the large market size of the "young" economy. The "market-seeking" investors would search for markets that have a large customer base. If the destination country has a relatively high youth dependency ratio, then its saving rate would be low, while its consumption rate would be high. Due to this investment gap and deficit in consumption, the destination country would encourage an inflow of foreign investment. From the perspective of "market-seeking" investors, one could, therefore, hypothesize a negative relationship between population ageing and FDI inflows.

A weakness of the life cycle hypothesis, as discussed earlier, is the ignorance of international capital mobility. When estimating the OLG model, according to Narciso (2010), most of the empirical studies have considered the effects of demographic changes either on foreign portfolio investment flows or on international capital flows in aggregate. Accounting for capital flows in aggregate might lead to aggregation bias in the results. Despite the strong theoretical underpinnings, academic literature has largely neglected an empirical investigation of the direct effects of population ageing on FDI inflows for individual OECD economies. Additionally, across empirical studies that have examined the relation between population ageing and FDI inflows, the results are mixed. For instance, with population ageing, Knickerbocker (1973) reported an increase in FDI flows to the relatively "younger" economies in the presence of oligopolistic competition. While Narciso (2010) also observed a negative effect of population ageing on foreign capital inflows in OECD countries, Tomohara (2017) argued that, if "migrant networks" increase business opportunities via FDI, then population ageing may be associated with an increase in FDI inflows. Similar to the findings of Tomohara (2017), in a country-case study based on cointegration analysis, Mitra and Abedin (2020) reported a significantly positive long-run effect of population ageing on net FDI inflows in Japan. In panel cointegration analysis based on the ARDL approach, Mitra and Abedin (2021) reported a significantly positive long-run effect of population ageing on net FDI inflows for 26 OECD countries. Mitra and Guseva (2021), based on Bayesian panel VAR estimates, reported lack of a significant relation between population ageing and FDI inflows; thus, although economic theory postulates a negative association between population ageing and FDI inflows, empirical literature provides mixed evidence of the relationship between the two variables.

The aim of this paper is not to test either the life-cycle hypothesis or the OLG model. We estimate a multivariate model and test the hypothesis derived from the neoclassical theory of economic growth discussed earlier, that population ageing in the OECD countries would be associated with a long-run decrease in net FDI inflows (% of GDP) for the 20 OECD countries. The cointegration technique with structural breaks allows us to not only distinguish the short-run effects of population ageing on the net FDI inflows (% of GDP) from its long-run effects, but also identify the significant breaks in the time series data for each of the 20 countries.

3. Data and the Model

3.1 Data: Annual data from the World Bank on Australia, Austria, Belgium, Chile, Columbia, Costa Rica, Denmark, Finland, France, Germany, Greece, Italy, Japan, Mexico, Norway, Portugal,

Spain, Sweden, the UK and the USA are obtained. The study period is 1980-2019. The dependent variable in our model is net FDI inflows (% of GDP). It is the difference between new investment inflows and disinvestment in the reporting economy from foreign investors (% of GDP). Population ageing is measured by the number of individuals aged 65 years and above (% of total population). The control variables are the potential determinants of net FDI inflows as identified in the literature: (a) real GDP as a measure of national income, (b) trade openness measured by the sum of exports and imports (% of GDP), (c) the real effective exchange rate index, and (d) domestic investment (% of GDP). An increase (decrease) in the exchange rate index would imply an appreciation (depreciation) of the domestic currency.

3.2 The Model: The effect of population ageing on net FDI inflows (% of GDP) for each country separately at time t is examined by estimating a model of the form

(1) $FDI_t = \alpha_0 + \alpha_1 OLD_t + \alpha_2 GDP_t + \alpha_3 OPN_t + \alpha_4 RER_t + \alpha_5 INV_t + \varepsilon_t$

FDI is the foreign direct investment, net inflows (% of GDP); OLD is the number of individuals aged 65 years and above (% of total population); GDP in real terms as a measure of national income; OPN is the trade-to-GDP ratio; RER is the real effective exchange rate index; INV is the domestic investment (% of GDP); ε_t is random error with mean zero; *t* represents the time suffix.

4. Main Results

4.1 Unit Root Tests: The results of the Zivot and Andrews (1992) unit root tests with a single structural break are reported in Tables 1.1 through 1.8. For the model in level form with intercept break only, [-5.34; -4.80; -4.58] are the asymptotic critical values at the 1%, 5%, and 10% significance level, respectively. For the model in level form with trend break only, [-4.93; -4.42; -4.11] are the asymptotic critical values at the 1%, 5%, and 10% significance level, respectively. For the model in level form with both intercept and trend breaks, [-5.57; -5.08; -4.82] are the asymptotic critical values at the 1%, 5%, and 10% significance level, respectively. For the model in first-difference form with intercept break only, [-5.34; -4.80; -4.58] are the asymptotic critical values at the 1%, 5%, and 10% significance level, respectively. For the model in first-difference form with trend break only, [-4.93; -4.42; -4.11] are the asymptotic critical values at the 1%, 5%, and 10% significance level, respectively. For the model in first-difference form with both intercept and trend breaks, [-5.57; -5.08; -4.82] are the asymptotic critical values at the 1%, 5%, and 10% significance level, respectively. The lag-length is selected by AIC and SBIC.

The results indicate a mixed order of integration for the FDI variable, which is not a matter of concern because the ARDL bounds testing approach does not require pretests for a unit root. The mixed results actually motivate us to apply the ARDL bounds testing approach to cointegration. The bounds testing approach proposed by Pesaran and Pesaran (1997), Pesaran and Shin (1999) and Pesaran et al. (2001) to investigate the existence of a long-run relationship between the variables can be applied within an ARDL framework regardless of whether the variables are I(0), I(1) or fractionally integrated.

Table 1.1 Unit Root Tests

Country	Variable	Intercept Break		Trend Break		Intercept and Trend Breaks	
		Test Statistic	Break Year	Test Statistic	Break Year	Test Statistic	Break Year
Australia	FDI	-9.18***	2006	-8.51***	1998	-9.32***	2006
	OLD	-1.32	2012	-3.42	2009	-4.95*	2006
	GDP	-4.11	1991	-4.19*	1995	-5.81***	1991
	OPN	-4.37	2010	-4.09	2001	-4.17	1993
	RER	-3.90	2003	-3.32	1993	-3.73	2010
	INV	-3.71	2003	-2.48	1992	-3.42	2003
Austria	FDI	-3.52	2010	-3.61	2007	-6.65***	2010
	OLD	-3.31	2006	-3.87	2000	-4.10	1997
	GDP	-4.44	2009	-3.89	2008	-4.04	2004
	OPN	-4.09	2000	-3.97	1993	-4.09	2000
	RER	-3.68	1986	-3.61	1988	-4.95*	1997
	INV	-3.44	2002	-3.56	1992	-4.27	2001
Belgium	FDI	-4.89**	2012	-4.14*	2009	-5.22**	2012
	OLD	-3.67	2005	-4.68**	1988	-3.93	1994
	GDP	-4.20	1999	-3.59	2008	-3.89	2004
	OPN	-4.70*	1986	-4.70**	1994	-4.87*	1997
	RER	-4.62*	1999	-4.44**	1991	-5.59***	1997
	INV	-4.81**	1988	-4.11	1990	-4.70	1988
Chile	FDI	-4.83**	1996	-4.79**	2013	-5.95***	2011
	OLD	-4.07	1993	-3.69	2010	-3.45	2010
	GDP	-4.43	2004	-4.13	1986	-3.59	2010
	OPN	-3.71	2012	-4.05	2008	-4.13	2004
	RER	-4.16	2004	-7.05***	1987	-5.53**	1986
	INV	-3.76	1987	-3.62	1990	-4.99*	1999
Colombia	FDI	-5.13**	2005	-4.58**	1989	-5.51**	2005
	OLD	-3.82	2007	-4.03	2008	-4.17	2008
	GDP	-3.28	2010	-4.39*	2004	-5.52**	1999
	OPN	-5.19**	1986	-5.43***	1993	-5.23**	1995
	RER	-3.63	2004	-4.77**	1987	-4.81	1991
	INV	-3.07	1997	-2.25	2000	-3.33	1997

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

Table 1.2 Unit Root Tests

Country	Variable	Intercept Break		Trend Break		Intercept and Trend Breaks	
		Test Statistic	Break Year	Test Statistic	Break Year	Test Statistic	Break Year
Costa Rica	FDI	-3.77	2004	-4.53**	2008	-5.60***	2005
	OLD	-3.55	1991	-4.02	2005	-3.99	2005
	GDP	-3.83	2006	-3.90	2001	-3.87	2001
	OPN	-6.48***	2009	-5.31***	2001	-6.39***	2009
	RER	-4.06	2010	-3.79	1988	-3.90	2003
	INV	-4.58	1998	-4.76**	2010	-5.26**	2007
Denmark	FDI	-4.78*	2003	-4.82**	2001	-5.48**	2003
	OLD	-5.61***	1989	-5.51***	1994	-5.66***	1987
	GDP	-4.03	2009	-3.53	2000	-3.51	2009
	OPN	-4.07	1986	-3.90	1988	-4.05	1986
	RER	-4.26	1986	-3.80	1989	-3.88	1986
	INV	-4.83**	2009	-3.92	2013	-4.78	2009
Finland	FDI	-4.30	1998	-4.41*	2001	-4.60	1998
	OLD	-3.79	2009	-7.87***	2008	-6.70***	2007
	GDP	-4.22	1999	-3.72	2008	-4.13	2000
	OPN	-3.55	1993	-3.95	2007	-3.79	1992
	RER	-5.47**	1992	-4.04	2001	-8.31***	1992
	INV	-6.70***	1991	-4.84**	1997	-6.69***	1991
France	FDI	-5.36***	2009	-5.89***	2002	-6.10***	2009
	OLD	-3.46	2012	-3.81	2009	-3.10	2006
	GDP	-4.19	2009	-3.67	2007	-3.88	2004
	OPN	-4.59*	1986	-3.95	1988	-4.53	1986
	RER	-4.08	2012	-4.03	2009	-4.13	1997
	INV	-5.19**	1992	-4.43**	1998	-5.02*	1992
Germany	FDI	-5.08**	2004	-4.73**	2001	-5.38**	2004
	OLD	-4.61*	2000	-4.05	1993	-4.21	1989
	GDP	-4.04	1989	-3.75	1992	-3.89	1990
	OPN	-4.14	2004	-3.90	1993	-4.05	1986
	RER	-3.56	1992	-4.11	1995	-4.53	1997
	INV	-4.54	2001	-3.65	2013	-4.51	2001

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

Table 1.3 Unit Root Tests

Country	Variable	Intercept Break		Trend Break		Intercept and Trend Breaks	
		Test Statistic	Break Year	Test Statistic	Break Year	Test Statistic	Break Year
Greece	FDI	-6.02***	2013	-5.52***	2012	-5.89***	1998
	OLD	-3.97	2012	-3.72	1987	-3.73	2012
	GDP	-4.54	2009	-3.83	2007	-4.09	2003
	OPN	-4.27	2011	-3.77	2010	-3.84	2009
	RER	-3.26	2012	-3.75	2011	-3.54	2008
	INV	-4.88	2010	-3.66	2004	-4.36	2010
Italy	FDI	-5.13**	2005	-4.58**	1989	-5.51**	2005
	OLD	-3.81	2007	-4.01	2008	-4.07	2008
	GDP	-4.28	2010	-4.39*	2004	-5.52**	1999
	OPN	-5.19**	1986	-5.43***	1993	-5.23**	1995
	RER	-3.63	2004	-4.77**	1987	-3.81	1991
	INV	-4.07	1997	-4.25*	2000	-4.03	1997
Japan	FDI	-4.99**	1999	-6.02***	2013	-6.98***	2014
	OLD	-4.17	2009	-4.02	1996	-4.09	2012
	GDP	-4.47	1987	-4.54**	1991	-4.45	1988
	OPN	-3.99	1986	-3.81	1993	-4.12	1986
	RER	-3.63	1991	-5.66***	1995	-5.74***	1993
	INV	-4.03	1997	-3.37	2011	-4.20	1997
Mexico	FDI	-6.59***	1994	-5.88***	2002	-6.50***	1994
	OLD	-4.30	2013	-5.45***	2013	-5.38**	2012
	GDP	-3.52	1986	-4.21*	1987	-4.11	1986
	OPN	-4.68*	2001	-4.52**	2013	-4.72	2001
	RER	-3.70	1999	-4.08	2003	-3.48	1999
	INV	-6.56***	1998	-6.49***	2013	-6.45***	2006
Norway	FDI	-4.51	2013	-3.42	2008	-3.45	2006
	OLD	-6.40***	2010	-5.34***	2003	-5.17**	2002
	GDP	-3.86	1996	-3.30	2005	-3.65	1996
	OPN	-4.97**	1987	-5.77***	1988	-5.50**	1989
	RER	-3.60	2002	-3.91	2012	-4.05	2002
	INV	-3.78	1989	-3.15	2002	-3.73	1989

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

Table 1.4 Unit Root Tests

Country	Variable	Intercept Break		Trend Break		Intercept and Trend Breaks	
		Test Statistic	Break Year	Test Statistic	Break Year	Test Statistic	Break Year
Portugal	FDI	-6.17***	1998	-6.36***	2013	-7.40***	1998
	OLD	-3.66	2012	-4.49**	2009	-4.58	2007
	GDP	-4.65*	2011	-3.89	2005	-3.78	2004
	OPN	-3.87	1991	-3.98	2006	-4.01	2002
	RER	-3.96	1990	-3.87	2004	-3.78	2003
	INV	-5.81***	2011	-5.29***	2002	-5.82***	1997
Spain	FDI	-5.14**	2009	-4.70**	2002	-5.60***	2009
	OLD	-7.57***	2001	-6.08***	1996	-7.19***	2001
	GDP	-4.40	2009	-4.59**	2007	-4.02	2003
	OPN	-3.89	1995	-4.52**	1988	-4.55	1994
	RER	-3.91	1988	-4.43**	1990	-5.52**	1993
	INV	-4.71*	2009	-4.13*	2006	-4.38	2002
Sweden	FDI	-4.60*	2009	-4.49**	2000	-5.21**	1998
	OLD	-5.43***	2007	-5.03***	1987	-3.96	1991
	GDP	-3.64	1991	-3.26	1994	-5.13**	1989
	OPN	-3.96	1997	-3.77	1988	-3.61	1993
	RER	-5.09**	1988	-5.07***	1991	-7.23***	1993
	INV	-5.78***	1991	-4.27*	1998	-6.19***	1991
UK	FDI	-5.64***	1998	-4.61**	2006	-5.54**	2009
	OLD	-3.71	2010	-4.37*	2008	-3.87	2007
	GDP	-3.74	2009	-3.50	2006	-3.52	1997
	OPN	-4.02	1986	-3.57	1992	-4.23	1986
	RER	-5.48***	1997	-3.85	2005	-5.17**	1997
	INV	-4.07	1991	-3.66	2010	-4.55	1990
USA	FDI	-3.89	1997	-3.61	2000	-3.99	1997
	OLD	-7.34***	2010	-8.12***	2003	-7.49***	2002
	GDP	-3.79	2008	-3.99	2005	-3.77	2009
	OPN	-4.43	2013	-4.46**	2013	-4.98**	2011
	RER	-4.49	1990	-3.90	1991	-4.11	1996
	INV	-4.39	1998	-3.78	1991	-4.37	1998

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

Table 1.5 Unit Root Tests

Country	Variable	Intercept Break		Trend Break		Intercept and Trend Breaks	
		Test Statistic	Break Year	Test Statistic	Break Year	Test Statistic	Break Year
Australia	△FDI	-6.54***	2000	-6.26***	2009	-6.67***	1989
	△OLD	-5.66***	2009	-4.83**	2007	-5.39**	2010
	△GDP	-5.75***	1993	-5.51***	2000	-5.71***	1993
	△OPN	-7.32***	2002	-6.69***	1987	-7.19***	2010
	△RER	-5.28**	2013	-4.96***	2011	-5.22**	2013
	△INV	-5.97***	1993	-5.68***	2006	-6.01***	1993
Austria	△FDI	-16.80***	2006	-15.36***	2006	-16.45***	2006
	△OLD	-6.18***	2003	-6.17***	2009	-5.62***	2005
	△GDP	-6.87***	2009	-5.52***	1991	-8.02***	2009
	△OPN	-6.63***	2009	-6.26***	2001	-6.54***	2009
	△RER	-7.05***	1996	-6.17***	1999	-6.93***	1996
	△INV	-6.37***	2001	-7.70***	1987	-8.20***	1992
Belgium	△FDI	-7.66***	2001	-7.27***	2000	-7.73***	2012
	△OLD	-5.80***	1997	-6.58***	2010	-6.53***	2012
	△GDP	-6.80***	2008	-5.79***	1989	-6.82***	2008
	△OPN	-6.18***	1996	-5.87***	2007	-6.35***	1988
	△RER	-6.21***	1996	-5.47***	1987	-5.95***	1988
	△INV	-6.26***	1991	-5.83***	2013	-6.47***	1991
Chile	△FDI	-7.79***	2013	-7.34***	2009	-7.66***	2013
	△OLD	-6.12***	1997	-6.93***	2009	-6.88***	1997
	△GDP	-6.14***	1987	-5.73***	1989	-5.59***	1989
	△OPN	-7.02***	2009	-6.03***	2005	-7.12***	2009
	△RER	-6.05***	1989	-6.34***	1990	-6.10***	1989
	△INV	-7.33***	1998	-6.66***	2001	-7.34***	1990
Colombia	△FDI	-6.82***	2008	-6.68***	1988	-6.87***	1989
	△OLD	-6.35***	2010	-5.77***	2008	-6.43***	2006
	△GDP	-5.37***	2003	-5.75***	2012	-6.30***	2003
	△OPN	-7.24***	2007	-7.73***	1987	-8.39***	1987
	△RER	-6.33***	1991	-5.02***	1995	-6.40***	1987
	△INV	-6.02***	2001	-5.18***	2007	-5.92***	2001

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

Table 1.6 Unit Root Tests

Country	Variable	Intercept Break		Trend Break		Intercept and Trend Breaks	
		Test Statistic	Break Year	Test Statistic	Break Year	Test Statistic	Break Year
Costa Rica	△FDI	-8.72***	2008	-7.70***	2006	-8.59***	2008
	△OLD	-6.45***	2009	-4.97***	2003	-6.07***	2002
	△GDP	-6.71***	2009	-6.44***	2008	-6.96***	2006
	△OPN	-8.96***	1987	-8.41***	1990	-8.66***	1999
	△RER	-14.32***	2006	-13.89***	2013	-14.54***	2010
	△INV	-7.81***	2009	-7.55***	1988	-7.74***	1991
Denmark	△FDI	-10.61***	2001	-8.58***	1999	-10.46***	2001
	△OLD	-9.13***	2004	-9.52***	1992	-9.50***	1989
	△GDP	-5.78***	2013	-4.96***	2013	-6.42***	2008
	△OPN	-6.87***	2009	-6.22***	2001	-6.88***	2009
	△RER	-6.55***	2010	-6.53***	1987	-7.27***	1988
	△INV	-6.51***	1987	-5.17***	2011	-6.51***	2008
Finland	△FDI	-13.62***	2001	-13.05***	1999	-13.42***	2001
	△OLD	-5.94***	2009	-5.29***	2003	-5.70***	2002
	△GDP	-5.30**	2008	-5.44***	2000	-6.47***	2009
	△OPN	-6.75***	1992	-6.41***	1994	-6.88***	2009
	△RER	-7.00***	1991	-6.06***	1993	-7.04***	1991
	△INV	-6.06***	1990	-5.57***	1992	-6.38***	1990
France	△FDI	-7.76***	2002	-7.22***	2010	-7.86***	2007
	△OLD	-6.39***	2009	-6.19***	2007	-5.98***	2012
	△GDP	-6.22***	2008	-6.54***	1989	-5.64***	2008
	△OPN	-6.50***	2002	-6.22***	1998	-6.48***	2001
	△RER	-6.10***	2002	-5.61***	1987	-5.94***	1987
	△INV	-6.74***	2009	-6.09***	1987	-6.06***	1990
Germany	△FDI	-10.04***	2001	-8.07***	2000	-9.90***	2001
	△OLD	-6.13***	2007	-6.70***	2004	-6.12***	2000
	△GDP	-6.29***	1993	-6.04***	2010	-6.82***	1993
	△OPN	-6.49***	1995	-6.28***	2006	-6.41***	2008
	△RER	-7.07***	1996	-6.21***	2013	-7.04***	1996
	△INV	-5.96***	1993	-6.35***	2003	-6.18***	1993

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

Table 1.7 Unit Root Tests

Country	Variable	Intercept Break		Trend Break		Intercept and Trend Breaks	
		Test Statistic	Break Year	Test Statistic	Break Year	Test Statistic	Break Year
Greece	△FDI	-11.03***	2012	-10.93***	2011	-11.21***	2010
	△OLD	-6.36***	1988	-6.25***	1996	-6.57***	2003
	△GDP	-6.25***	2008	-6.44***	2013	-6.10***	2009
	△OPN	-6.32***	2001	-5.69***	2010	-6.20***	2001
	△RER	-5.75***	1987	-5.23***	1991	-5.86***	1987
	△INV	-6.65***	2008	-5.77***	1987	-6.97***	2008
Italy	△FDI	-6.83***	2008	-6.68***	1988	-6.87***	1989
	△OLD	-6.35***	2010	-6.04***	2008	-6.43***	2006
	△GDP	-5.37***	2003	-5.75***	2012	-6.30***	2003
	△OPN	-7.42***	2007	-7.73***	1987	-8.39***	1987
	△RER	-5.39***	1991	-5.02***	1995	-6.41***	1987
	△INV	-6.02***	2001	-5.18***	2007	-5.92***	2001
Japan	△FDI	-10.07***	2013	-9.78***	2012	-10.47***	2009
	△OLD	-9.01***	1992	-6.29***	2013	-6.87***	2012
	△GDP	-6.32***	1992	-5.76***	2010	-6.48***	1992
	△OPN	-6.74***	2009	-6.26***	2006	-6.65***	2009
	△RER	-6.31***	1996	-6.03***	2006	-6.21***	1996
	△INV	-5.05**	1991	-5.21***	2002	-6.01***	1991
Mexico	△FDI	-9.21***	2003	-8.64***	1996	-9.68***	2013
	△OLD	-6.82***	1998	-6.33***	2013	-6.62***	2011
	△GDP	-6.90***	2001	-6.70***	1992	-6.97***	2001
	△OPN	-6.49***	1995	-5.24***	1992	-6.64***	1994
	△RER	-7.81***	1988	-7.33***	1992	-7.67***	1994
	△INV	-6.52***	1988	-7.62***	1987	-7.49***	1987
Norway	△FDI	-12.40***	2009	-12.02***	2013	-13.56***	2013
	△OLD	-7.91***	2008	-6.65***	1998	-6.61***	1997
	△GDP	-5.65***	2008	-6.98***	1997	-5.59***	2008
	△OPN	-7.25***	1989	-6.65***	1991	-7.35***	1989
	△RER	-5.58***	2001	-6.20***	2003	-5.62***	2001
	△INV	-5.36***	1989	-6.09***	1990	-6.28***	1992

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

Table 1.8 Unit Root Tests

Country	Variable	Intercept Break		Trend Break		Intercept and Trend Breaks	
		Test Statistic	Break Year	Test Statistic	Break Year	Test Statistic	Break Year
Portugal	△FDI	-7.30***	2013	-7.13***	2013	-7.18***	2010
	△OLD	-5.79***	2009	-5.47***	2004	-5.56**	2008
	△GDP	-5.67***	2001	-5.61***	2013	-6.06***	2011
	△OPN	-6.27***	2010	-6.18***	1987	-6.34***	1994
	△RER	-5.44***	1988	-5.63***	1991	-7.67***	1993
	△INV	-5.60***	2002	-5.09***	1989	-5.58***	2001
Spain	△FDI	-9.09***	2001	-8.56***	2000	-8.98***	2001
	△OLD	-8.09***	1999	-6.98***	2007	-6.34***	2001
	△GDP	-6.02***	2008	-5.84***	2013	-6.95***	2008
	△OPN	-5.82***	2001	-6.16***	1997	-5.74***	2001
	△RER	-6.04***	1992	-6.88***	1987	-5.99***	1991
	△INV	-6.62***	2007	-8.99***	2012	-6.50***	2008
Sweden	△FDI	-9.18***	2000	-7.54***	2011	-9.10***	2000
	△OLD	-6.41***	2004	-6.41***	1991	-7.30***	1989
	△GDP	-5.99***	2008	-6.22***	2001	-6.12***	2008
	△OPN	-6.13***	1993	-5.49***	1987	-6.32***	1993
	△RER	-6.12***	1993	-5.44***	2013	-6.44***	1993
	△INV	-5.39***	1990	-5.83***	1993	-6.65***	1994
UK	△FDI	-8.65***	2001	-8.43***	1999	-8.59***	2013
	△OLD	-6.36***	2008	-6.49***	1998	-6.92***	1992
	△GDP	-5.68***	2008	-6.09***	2010	-6.11***	2008
	△OPN	-6.09***	2012	-6.03***	1987	-6.21***	1989
	△RER	-5.37***	2008	-6.25***	1998	-6.43***	1999
	△INV	-7.69***	1990	-5.63***	1993	-8.16***	1990
USA	△FDI	-6.64***	2001	-5.99***	1987	-6.55***	2001
	△OLD	-5.54***	1989	-5.59***	1997	-6.36***	1995
	△GDP	-5.81***	2007	-5.11***	2010	-5.58***	2008
	△OPN	-7.14***	2013	-7.01***	1988	-7.04***	2013
	△RER	-5.66***	2002	-5.27***	1987	-5.87***	1988
	△INV	-6.39***	2006	-5.26***	2010	-5.72***	1992

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

4.2 Multiple Break Tests: The multiple break test proposed by Bai and Perron (1998, 2003) is performed for each of the 20 OECD countries. A maximum of five breaks is allowed, and the significant break year is selected using the Schwarz criterion and the modified Schwarz (LWZ) criterion. The results are reported in Table 2.

Table 2. Multiple Break Test

	Schwarz Criterion	LWZ	Break Year(s)
Australia	1	1	2006*
Austria	2	0	2004, 2010*
Belgium	2	2	1999, 2012*
Chile	1	1	1996*
Colombia	2	2	1996, 2005*
Costa Rica	3	3	1996, 2004*, 2010
Denmark	2	0	1997, 2003*
Finland	2	1	1998*, 2009
France	3	3	1989, 1999, 2009*
Germany	2	1	1998, 1999, 2004*
Greece	3	1	1997, 2003, 2013*
Italy	2	2	1996, 2005*
Japan	2	1	1999*, 2014*
Mexico	1	1	1994*
Norway	2	2	1996, 2013*
Portugal	1	1	1998*
Spain	2	2	1999*, 2009*
Sweden	2	2	1998, 2009*
UK.	2	0	1998*, 2009
USA	1	1	1997*

Note: * denotes the significant break year(s).

4.3 Cointegration Test: The equation of interest is modelled as a conditional ARDL framework as specified below

$$(2)\ \Delta FDI_t = \alpha_0 + \alpha_1 DUM + \sum_{h=1}^{p} \alpha_{2h}\, \Delta FDI_{t-h} + \sum_{j=0}^{q} \alpha_{3j}\, \Delta OLD_{t-j} + \sum_{k=0}^{r} \alpha_{4k}\, \Delta GDP_{t-k} + \sum_{l=0}^{s} \alpha_{5l}\, \Delta OPN_{t-l} + \sum_{m=0}^{v} \alpha_{6m}\, \Delta RER_{t-m} + \sum_{n=0}^{w} \alpha_{7n}\, \Delta INV_{t-n} +$$

$$\beta_1 FDI_{t-1} + \beta_2 OLD_{t-1} + \beta_3 GDP_{t-1} + \beta_4 OPN_{t-1} + \beta_5 RER_{t-1} +$$

$$\beta_6 INV_{t-1} + \omega_t$$

We perform the F-test for cointegration for each country with the corresponding significant break year indicated in Table 3. If the computed F-statistic is greater than the upper bound of the critical values, then the null hypothesis of no cointegration is rejected. If the computed F-statistic is less than the lower bound of the critical values, then there is no cointegration. If the computed F-statistic falls between the upper and the lower bounds, then the decision on cointegration will be inconclusive at the chosen level of significance. The results are reported in Table 3.

Table 3. Cointegration Tests

	Significant Break Year	F-statistic
Australia	2006	23.98***
Austria	2010	22.31***
Belgium	2012	6.95***
Chile	1996	11.92***
Colombia	2005	7.65***
Costa Rica	2004	9.21***
Denmark	2003	4.60***
Finland	1998	32.60***
France	2009	4.78***
Germany	2004	9.59***
Greece	2013	106.15***
Italy	2005	9.59***
Japan	1999	16.40***
Japan	2014	10.89***
Mexico	1994	6.78***
Norway	2013	15.41***
Portugal	1998	99.29***
Spain	1999	19.16***
Spain	2009	129.69***
Sweden	2009	11.20***
UK	1998	11.58***
USA	1997	4.96***

Note: *** denotes significant at 1% significance level. The lower and the upper bounds corresponding to 1% significance level for Italy and Columbia are (3.27, 4.39) and (3.15, 4.43), respectively. For all other countries, the lower and the upper bounds corresponding to 1% significance level are (2.88, 3.99).

The results in Table 4 indicate whether or not a cointegrating relationship exists when FDI is the dependent variable. The computed values of the F-statistic for Australia, Austria, Belgium, Chile, Costa Rica, Denmark, Finland, France, Germany, Greece, Japan, Mexico, Norway, Portugal, Spain, Sweden, the UK and the USA are greater than the upper bound of the critical values (3.99) at the 1% significance level. For Colombia, the computed value of the F-statistic is greater than the upper bound of the critical values (4.43) at the 1% significance level. For Italy, the computed value of the F-statistic is greater than the upper bound of the critical values (4.39) also at the 1% significance level. The results, therefore, provide evidence of a long-run relationship in the model with FDI as the dependent variable for each of the 20 OECD countries.

4.4 Short-Run Effects: The short-run model has the following ARDL (p, q, r, s, v, w, z) specification

$$(3)\ \Delta FDI_t = \alpha_0 + \sum_{g=1}^{p} \alpha_{1g}\,\Delta FDI_{t-g} + \sum_{h=0}^{q} \alpha_{2h}\,\Delta OLD_{t-h} + \sum_{j=0}^{r} \alpha_{3j}\,\Delta GDP_{t-j} + \sum_{k=0}^{s} \alpha_{4k}\,\Delta OPN_{t-k} + \sum_{l=0}^{v} \alpha_{5l}\,\Delta RER_{t-l} + \sum_{m=0}^{w} \alpha_{6m}\,\Delta INV_{t-m} + \sum_{n=0}^{z} \alpha_{7n}\Delta DUM_{t-n} + \lambda ECM_{t-1} + \mu_t$$

In equation (3), λ denotes the speed of adjustment toward long-run equilibrium, if there is any shock to net FDI inflows (% of GDP) due to changes in the number of individuals aged 65 and above (% of total population) and the covariates. The short-run results are reported in Table 4.

Table 4. Short-Run Coefficients

	ΔOLD	ΔGDP	ΔOPN	ΔRER	ΔINV	ΔDUM	ECM_{t-1}
Australia	7.62	9.23e-11***	-0.29**	-0.16***	-0.79***	7.15***	-0.84***
	(0.25)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)
Austria	0.60	-8.13e-12	0.64***	1.65***	-9.03***	70.84***	-0.78***
	(0.96)	(0.95)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Belgium	74.66***	-4.77e-11	-0.61***	-1.21***	15.41***	-1.51***	-0.85***
	(0.00)	(0.88)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Chile	-3.45	2.64e-10***	0.39***	-0.28***	0.05	-0.29***	-0.51***
	(0.70)	(0.00)	(0.00)	(0.00)	(0.62)	(0.00)	(0.00)
Colombia	-40.45**	-1.20e-11***	0.26**	0.04***	0.17	-0.42***	-0.18***
	(0.02)	(0.00)	(0.02)	(0.00)	(0.15)	(0.00)	(0.00)
Costa Rica	33.16***	1.17e-10	0.14***	-0.05***	-0.08***	2.29***	-0.47***
	(0.00)	(0.31)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Denmark	-3.74	4.41e-10***	-0.10	-0.37	-2.14***	-8.75***	-0.09***
	(0.78)	(0.00)	(0.60)	(0.24)	(0.00)	(0.00)	(0.00)
Finland	-33.25***	3.78e-10***	-0.35***	-0.19***	-1.16***	-1.20***	-0.78***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
France	-0.55	1.33e-11***	-0.03	-0.09**	-0.12	-2.03***	-0.17***
	(0.24)	(0.00)	(0.59)	(0.03)	(0.52)	(0.00)	(0.00)
Germany	38.63***	-5.34e-11*	1.06*	0.15***	1.14***	-27.99***	-0.59***
	(0.00)	(0.09)	(0.08)	(0.00)	(0.00)	(0.00)	(0.00)
Greece	0.88***	1.21e-10***	0.10***	0.01***	-0.26***	-1.68***	-0.24***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Italy	-77.19***	-1.27e-10***	0.33*	0.02	0.09	-1.07***	-0.38***
	(0.00)	(0.00)	(0.09)	(0.11)	(0.22)	(0.00)	(0.00)
Japan	-5.97***	4.01e-12***	-0.11***	0.05***	0.17***	0.14***	-0.53***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Japan	-5.57***	4.94e-12***	-0.03***	0.01***	0.02***	-0.57***	-0.97***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Mexico	19.65***	5.80e-12***	0.07***	0.02***	-0.37***	1.44***	-0.74***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Norway	6.91***	6.63e-11***	0.27***	0.11	0.37***	-5.03***	-0.51***
	(0.00)	(0.00)	(0.00)	(0.28)	(0.00)	(0.00)	(0.00)
Portugal	-345.8***	1.53e-09***	-1.91**	-2.93**	-20.60***	69.70***	-0.72***
	(0.00)	(0.00)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)
Spain	-11.42***	1.89e-12	0.25***	-0.04	0.35***	2.32***	-0.41***
	(0.00)	(0.74)	(0.00)	(0.12)	(0.00)	(0.00)	(0.00)
Spain	-9.71***	1.86e-12***	0.11***	-0.19***	1.94***	7.62***	-0.93***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sweden	-141.4***	-3.73e-10***	-0.31***	-0.002	3.78***	52.40***	-0.04***
	(0.00)	(0.00)	(0.00)	(0.95)	(0.00)	(0.00)	(0.00)
UK	39.99***	4.86e-11***	0.26***	-0.14***	-0.81***	-4.83***	-0.50***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
USA	-0.69	1.96e-12***	0.16***	-0.005	-0.27***	1.17***	-0.59***
	(0.14)	(0.07)	(0.00)	(0.68)	(0.00)	(0.00)	(0.00)

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

The short-run effects of population ageing on net FDI inflows (% of GDP) are significantly positive for Belgium, Costa Rica, Germany, Greece, Mexico, Norway and the UK; significantly negative for Colombia, Finland, Italy, Japan, Portugal, Spain and Sweden. The effects are insignificant for Australia, Austria, Chile, Denmark, France and the USA. The short-run effects of national income, trade openness, exchange rate, domestic investment and the break year dummy are also mixed; thus the short-run effects are, overall, mixed and country-specific. The adjustment coefficients have the expected negative sign and are statistically significant at the 1% significance level for all 20 countries, indicating convergence toward long-run equilibrium.

4.5 Long-Run Effects: The long-run model has the ARDL (p, q, r, s, v, w, z) specification

$$(4)\ FDI_t = \alpha_0 + \sum_{h=0}^{p} \alpha_{1h}\, FDI_{t-h} + \sum_{j=0}^{q} \alpha_{2j}\, OLD_{t-j} + \sum_{k=0}^{r} \alpha_{3k}\, GDP_{t-k} + \sum_{l=0}^{s} \alpha_{4l}\, OPN_{t-l}$$

$$+ \sum_{m=0}^{v} \alpha_{5m}\, RER_{t-m} + \sum_{n=0}^{w} \alpha_{5n}\, INV_{t-n} + \sum_{u=0}^{z} \alpha_{6u}\, DUM_{t-u} + \varphi_t$$

The long-run coefficients of net FDI inflows (% of GDP) with respect to the number of individuals aged 65 and above (% of total population) and the covariates are reported in Table 5.

Table 5. Long-Run Coefficients

	OLD	GDP	OPN	RER	INV	DUM
Australia	-7.16*** (0.00)	3.37e-11*** (0.00)	-0.14 (0.12)	-0.17*** (0.00)	-0.82*** (0.00)	3.47*** (0.00)
Austria	-33.93*** (0.00)	1.23e-10 (0.17)	1.10*** (0.00)	3.09*** (0.00)	-11.03*** (0.00)	58.21*** (0.00)
Belgium	2.77 (0.72)	2.58e-10 (0.21)	-2.01*** (0.00)	-3.51*** (0.00)	14.01*** (0.00)	-19.81*** (0.00)
Chile	3.82 (0.11)	-4.75e-11 (0.37)	0.44*** (0.00)	0.001 (0.95)	0.97*** (0.00)	-6.39*** (0.00)
Colombia	1.12* (0.08)	4.97e-11** (0.03)	0.16** (0.01)	0.04*** (0.00)	0.06 (0.26)	-2.14*** (0.00)
Costa Rica	-3.86** (0.02)	-9.23e-11 (0.82)	0.25** (0.01)	0.09 (0.13)	-0.32 (0.20)	5.27*** (0.00)
Denmark	-1.21* (0.06)	8.34e-11** (0.03)	0.02 (0.91)	-0.27 (0.27)	0.14 (0.74)	-6.13*** (0.00)
Finland	-1.75*** (0.00)	1.55e-10*** (0.00)	-0.01 (0.77)	-0.12*** (0.00)	0.02 (0.84)	-6.38*** (0.00)
France	-0.09 (0.68)	3.13e-12** (0.02)	-0.06 (0.49)	-0.12* (0.08)	-0.04 (0.66)	-2.35*** (0.00)
Germany	1.08*** (0.00)	-2.77e-12*** (0.00)	0.11*** (0.00)	-0.04** (0.02)	0.35*** (0.00)	-5.78*** (0.00)
Greece	3.33*** (0.00)	-9.00e-11*** (0.00)	-0.34*** (0.00)	-0.01 (0.49)	0.69*** (0.00)	-0.20*** (0.00)
Italy	4.01*** (0.00)	3.72e-11 (0.56)	0.15*** (0.00)	0.03*** (0.03)	0.12 (0.29)	-2.91*** (0.00)
Japan	0.02*** (0.00)	7.73e-14** (0.01)	-0.03*** (0.00)	-0.01*** (0.00)	0.04*** (0.00)	0.16*** (0.00)
Japan	0.08*** (0.00)	4.16e-14*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	0.02*** (0.00)	-0.27*** (0.00)
Mexico	-1.97*** (0.00)	8.86e-12*** (0.00)	-0.02 (0.40)	0.002 (0.72)	-0.13*** (0.00)	1.24*** (0.00)
Norway	1.14*** (0.00)	2.73e-11*** (0.00)	0.20*** (0.00)	0.01 (0.84)	0.33*** (0.00)	-5.99*** (0.00)
Portugal	3.01*** (0.00)	-5.39e-10*** (0.00)	0.19*** (0.00)	1.10*** (0.00)	2.74*** (0.00)	17.88*** (0.00)
Spain	-1.58*** (0.00)	-6.20e-12 (0.24)	0.32*** (0.00)	0.01 (0.86)	0.54*** (0.00)	6.80*** (0.00)
Spain	-1.13*** (0.00)	-8.46e-12* (0.06)	0.17*** (0.00)	0.05** (0.01)	0.52*** (0.00)	15.97*** (0.00)
Sweden	-1.83*** (0.00)	-7.46e-11*** (0.00)	1.02*** (0.00)	0.21*** (0.00)	1.05*** (0.00)	11.61*** (0.00)
UK	1.67 (0.27)	1.36e-11*** (0.00)	-0.56*** (0.00)	0.31*** (0.00)	-0.41*** (0.00)	-11.44*** (0.00)
USA	0.40 (0.16)	-4.16e-12* (0.07)	0.20** (0.02)	-0.02 (0.23)	0.25** (0.02)	1.70*** (0.00)

Note: ***, **, and * denote significant at 1%, 5%, and 10% significance level, respectively.

For Australia, Austria, Costa Rica, Denmark, Finland, Spain and Sweden, an increase in the number of individuals aged 65 and above (% of total population) is found to have a significantly negative long-run effect on net FDI inflows (% of GDP); thus, population ageing is expected to result in a decrease in FDI inflows in those five OECD countries. This is consistent with the predictions of the neoclassical theory. For Belgium, Chile, France, Mexico, UK and the USA, the long-run relationships are insignificant. For Colombia, Germany, Greece, Italy, Japan, Norway and Portugal, the long-run relationships are significantly positive. Therefore, the long-run effects of population ageing on net FDI inflows (% of GDP) are mixed, and that is a contradiction to the predictions of the neoclassical theory of economic growth. The long-run effects of increases in the national income, trade openness, exchange rate, domestic investment and the break year dummy are also mixed and country-specific.

For Finland, Spain and Sweden, the short-run and long-run effects of population ageing on the net FDI inflows (% of GDP) are both significantly negative. For Germany, Greece and Norway, the short-run and long-run effects are both significantly positive. For Colombia, Italy, Japan and Portugal, a significantly negative short-run effect is offset by a significantly positive long-run effect, thereby giving rise to a J-curve phenomenon.

The significantly positive long-run coefficients of population ageing are a contradiction to what the neoclassical economic theory postulates, but consistent with the stylized facts discussed in Figure 1 and Figure 2. There could be several reasons why the association between population ageing and net FDI inflows (% of GDP) is significantly positive for some OECD countries. As discussed in Mitra and Abedin (2000), when old people dissave, there could be a shortage of domestic capital, which might strengthen the need for foreign investment. A second reason could be that, as the proportion of elderly in total population increases, the size of the labor force shrinks; consequently, the price of labor increases. Capital becomes relatively cheaper, and the demand for foreign capital, and net FDI inflows (% of GDP), increases. There have been efforts to increase the retirement age. An increase in the retirement age might mitigate the negative effects of population ageing on the net FDI inflows (% of GDP). An increase in the retirement age combined with efforts to equip the elderly workers with superior technology would increase productivity. An increase in productivity would attract foreign capital. Tomohara (2017) argues that Japan, in order to counteract the negative effects of population ageing, have implemented "inward FDI-promotion and immigration enhancement" policies in order to attract foreign capital and makeup for shortages in domestic capital and labor. Trade barriers in some industrial sectors have either been lowered or removed. Head and Ries (2005) and Hibbard et al. (2009) argue that the new legislation in Japan may facilitate "the acquisition of Japanese firms by foreign investors". Taking initiatives to make information about investment opportunities available to the foreign investors, and the introduction of new corporate governance rules would make the domestic companies more attractive to the foreign companies that engage in FDI. The immigration rules in some OECD countries are being revised with a view to attract more foreign labor and capital; for instance, the introduction of a fast track permanent residence program in Japan. Large-scale investment in health and education may also attract foreign capital and counteract the negative effects of population ageing. From a policy perspective, the factors discussed above could be considered plausible to counteract the negative and even the insignificant long-run effects of population ageing on the net FDI inflows (% of GDP).

4.6 Diagnostic Tests: The chi-square statistics for the diagnostic tests are reported in Table 6. The model fails to reject the null hypothesis of (a) no autocorrelation at lag order, (b) no conditional heteroskedasticity, (c) normally distributed errors, and (d) correct model specification. The CUSUM and CUSUMSQ test results indicate that the model is stable.

Table 6. Model Diagnostics

	$\chi^2_{Autocorrelation}$	χ^2_{ARCH}	$\chi^2_{Normality}$	$\chi^2_{Misspecification}$	$CUSUM$	$CUSUMSQ$
Australia	1.27 (0.33)	0.17 (0.68)	0.07 (0.96)	1.72 (0.21)	S	S
Austria	1.16 (0.32)	0.81 (0.37)	0.11 (0.94)	5.41 (0.11)	S	S
Belgium	1.82 (0.19)	0.32 (0.57)	12.72*** (0.00)	1.95 (0.16)	S	S
Chile	1.83 (0.25)	0.03 (0.86)	0.26 (0.88)	2.27 (0.18)	S	S
Colombia	2.46 (0.12)	0.04 (0.85)	0.20 (0.91)	1.96 (0.18)	S	S
Costa Rica	2.36 (0.16)	1.90 (0.17)	1.28 (0.53)	2.26 (0.17)	S	S
Denmark	1.55 (0.24)	0.02 (0.88)	78.23*** (0.00)	3.31 (0.23)	S	S
Finland	1.83 (0.21)	0.04 (0.84)	1.02 (0.60)	0.90 (0.34)	S	S
France	5.35 (0.16)	1.64 (0.19)	0.01 (0.99)	0.07 (0.79)	S	S
Germany	1.61 (0.24)	0.06 (0.80)	4.01 (0.13)	2.15 (0.14)	S	S
Greece	9.51 (0.20)	7.70 (0.18)	4.30 (0.11)	0.27 (0.61)	S	S
Italy	28.29 (0.13)	1.55 (0.21)	0.57 (0.75)	4.07 (0.20)	S	S
Japan	9.97 (0.22)	0.02 (0.88)	1.02 (0.60)	0.03 (0.85)	S	S
Japan	1.37 (0.31)	0.15 (0.70)	3.67 (0.16)	0.32 (0.57)	S	S
Mexico	4.42 (0.11)	1.33 (0.25)	0.09 (0.96)	1.86 (0.17)	S	S
Norway	3.67 (0.16)	0.0005 (0.98)	0.60 (0.74)	1.72 (0.19)	S	S
Portugal	1.73 (0.20)	0.04 (0.84)	1.44 (0.49)	2.52 (0.11)	S	S
Spain	5.45 (0.30)	6.69 (0.15)	0.36 (0.83)	1.40 (0.24)	S	S
Spain	0.78 (0.54)	2.47 (0.11)	0.29 (0.87)	4.14 (0.29)	S	S
Sweden	4.13 (0.14)	2.32 (0.13)	0.90 (0.64)	0.73 (0.45)	S	S
UK	1.77 (0.18)	4.55 (0.11)	3.29 (0.19)	0.001 (0.99)	S	S
USA	0.08 (0.78)	1.04 (0.31)	0.12 (0.94)	1.74 (0.19)	S	S

Note: ***denotes significant at 1% significance level.

5. Conclusion

We test the hypothesis that is derived from the neoclassical theory of economic growth, that population ageing significantly reduces net FDI inflows (% of GDP) in the OECD countries. In contrast to the predictions of the neoclassical theory, the short-run and long-run effects are mixed; therefore, policy implications would be country-specific. No single policy instrument to counteract the negative effects of population ageing can be commonly suggested for all 20 OECD countries.

In the case of Colombia, Italy, Japan and Portugal, the central tenet of the neoclassical theory appears to have just a short-run validity. The immediate (short-run) effect of population ageing on net FDI inflows (% of GDP) in those four OECD countries is significantly negative; however, as the government implements policies to counteract the negative effects, population ageing is expected to be associated with an increase in net FDI inflows (% of GDP) in the long-run. Generally speaking, as a country's population ages, raising the retirement age and increasing labor force participation, investing in capital and increasing labor productivity of the elderly workers, reforming the immigration laws and hiring more foreign workers for employment in industrial sectors for which domestic labor is not readily available, could be some of the policy measures that may be applied to mitigate the negative long-run effects of population ageing on the net FDI inflows (% of GDP).

Most studies have focused on economic factors as determinants of FDI inflows. Little attention has been given to demographic factors as potential determinants of FDI inflows, especially in cointegration analysis with structural breaks. This study has identified demographic trend as a significant determinant of FDI inflows for each of the 20 OECD countries. The sign and the statistical significance of the coefficients are country-specific. The results of our study could be used to design a macroeconomic policy framework aimed to attract FDI for sustainable economic growth in the OECD countries that are faced with the problem of population ageing.

References

Ando, A. and F. Modigliani (1963) "The Life-Cycle Hypothesis of Saving: Aggregate Implications and Tests", American Economic Review 53, 55-84.

Bai, J., Perron, P. (1998). Estimating and Testing Linear Models with Multiple Structural Changes. Econometrica, Vol. 66, No. 1, 47-78.

Bai, J., Perron, P. (2003). Computation and Analysis of Multiple Structural Change Models. Journal of Applied Econometrics, Vol. 18, 1-22.

Börsch-Supan, A., A. Ludwig, and J. Winter (2002): "Ageing and International Capital Flows". Working Paper 02-27. MEA, University of Mannheim.

Börsch-Supan, A., A. Ludwig, and J. Winter (2005): "Aging, Pension Reform, and Capital Flows: A Multi-Country Simulation Model". NBER Working Paper 11850.

Brooks, R. (2000): "What Will Happen to Financial Markets When Baby Boomers Retire?". Discussion paper WP/00/18. International Monetary Fund.

Collins, S. M. (1991): "Saving Behavior in Ten Developing Countries". In D.B. Bernheim and J.B. Shoven (Eds), National Saving and Economic Performance, A National Bureau of Economic Research Project Report: pp. 349-375. Chicago: University of Chicago Press.

Dickey, D. A. and W. A. Fuller, 1979, Distribution of the estimators for the autoregressive time series with a unit root, Journal of the American Statistical Association, 79, 355–367.

Feldstein, M. and C. Horioka (1980): "Domestic saving and international capital Flows". Economic Journal 90: pp.314-329.

Frankel, J. A. (1992): "Measuring International Capital Mobility: A Review". American Economic Association – Papers and Proceedings 82(2): pp. 197-202.

French, K. R. and J. M. Poterba (1991): "Investor diversification and International Markets". American Economic Association – Papers and Proceedings 81(2): pp. 222-226.

Head, K. and J. Ries (2005) "Judging Japan's FDI: The verdict from a dartboard model" Journal of the Japanese and International Economies 19, 215–232.

Hibbard, S., Shultz, F., Wouters, L., and J. Zelezny (2009) "How the environment for foreign direct investment in Japan is changing – for the better" Knowledge@Whartonhttp://knowledge.wharton.upenn.edu/article.cfm?articleid=2212.

Higgins, M. D. (1998): "Demography, National Savings, and International Capital Flows". International Economic Review, 39(2): pp. 343-369.

Higgins, M. and J. G. Williamson (1996): "Asian Demography and Foreign Capital Dependence". NBER Working Paper 5560.

Kang, J.-K. and R. Stulz (1997): "Why Is There a Home Bias? An Analysis of Foreign Portfolio Equity Ownership in Japan". Journal of Financial Economics, 46: pp. 3-28.

Knickerbocker, F. T. (1973) "Oligopolistic Reaction and Multinational Enterprise" Boston: Harvard University Press.

Kwiatkowski, D., Phillips, P., Schmidt, P., & Shin, Y. (1992). Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. Journal of Econometrics, 54, 159-178.

Lührmann, M. (2006): Essays on the Impact of Demographic Change on Capital, Goods and Labor Markets. PhD Dissertation, Inauguraldissertation zur Erlangung des akademischen Grades eines Doktors der Wirtschaftswissenschaften der Universität Mannheim, University of Mannheim.

Mason, A. (1988): "Saving, Economic Growth and Demographic Change". Population and Development Review 14(1): pp. 113-144.

Mitra R., Guseva M.E. (2021) Does Population Ageing Reduce FDI Inflows in OECD Countries? Evidence from Bayesian Panel VAR Estimates. In: Mishra A.K., Vinzé A.S., Gupta R.S., Menon R. (eds) Advances in Innovation, Trade and Business. Contributions to Management Science. Springer, Cham. https://doi.org/10.1007/978-3-030-60354-0_6.

Mitra, R., and T. Abedin. 2020. "Population Ageing and FDI Inflows in Japan: ARDL Approach to Cointegration Analysis." *Economics Bulletin*. 40(2):1814–1825.

Mitra, R. and Abedin, M.T. (2021), "Population Ageing and FDI Inflows in OECD Countries: A Dynamic Panel Cointegration Analysis", Applied Economics Letters, forthcoming.

Modigliani, F. and R. Brumberg (1954) "Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data" in Post-Keynesian Economics by K.K. Kurihara, Eds., Rutgers University Press, New Brunswick, 388-436.

Narayan, P.K. (2004a) "Do public investments crowd out private investments? Fresh evidence from Fiji" Journal of Policy Modelling 26, 747-53.

Narayan, P.K. (2004b) "Reformulating critical values for the bounds F-statictics approach to cointegration: an application to the tourism demand model for Fiji" Department of Economics Discussion Papers No. 02/04, Monash University, Melbourne.

Narayan, P.K. (2005a) "The saving and investment nexus for China: evidence from cointegration tests" Applied Economics 37, 1979-1990.

Narciso, A. 2010. "The Impact of Population Ageing on International Capital Flows." MPRA Paper 26457, Germany: University Library of Munich.

Obstfeld, M. (1995), “International Capital Mobility in the 1990s”. In P.B. Kenen (Ed.), Understanding Interdependence – The Macroeconomics of the Open Economy. Princeton: Princeton University Press, pp. 201-261.

Pesaran, H.M. and B. Pesaran, B (1997) Microfit 4.0. Oxford University Press, Oxford.

Pesaran, M.H. and Y. Shin (1999) An autoregressive distributed lag modelling approach to cointegration analysis, Econometrics and Economic Theory in the 20th Century, the Ragnar Frisch Centennial Symposium, Cambridge University Press.

Pesaran, M. H., Shin, Y. and R. J. Smith (2001) “Bounds testing approaches to the analysis of level relationships” Journal of Applied Econometrics 16, 289-326.

Portes, R. and H. Rey (2005): "The Determinants of Cross-Border Equity Flows". Journal of International Economics, vol. 65(2): pp. 269-296.

Tomohara, A. 2017. “Does Immigration Crowd Out Foreign Direct Investment Inflows? Tradeoff between Contemporaneous FDI-immigration Substitution and Ethnic Network Externalities.” *Economic Modelling*. 64 (C): 40–47.

Vernon, R. (1966) “International Investment and International Trade in the Product Cycle” Quarterly Journal of Economics 80, 190-207.

Zivot, E. and D. Andrews, (1992), Further evidence of great crash, the oil price shock and unit root hypothesis, Journal of Business and Economic Statistics, 10, 251-270.