# Population Aging, Foreign Direct Investment, and Tax Competition*

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**April 2005**

**This Version: May 25, 2006**

**Preliminary Version. Please do not cite without permission.**

**Abstract:** This paper studies the role of population aging for foreign direct investment and the strategic taxation of capital. Importantly, our theoretical model suggests that the labor market implications of aging differ from the financial market aspects. While population aging may be associated with a lower capital stock in the home country and less foreign direct investment, the effects through the labor market and employment tend to generate larger outbound capital flows. To quantify these aspects, we conduct regression analysis to empirically document how population aging affects FDI. To be specific, we use data on both US inbound and outbound FDI. Notably, the estimates between the US and other developed countries conform quite closely to the predictions of our theory. We conclude by studying the strategic taxation of capital. In particular, we examine this issue in light of the fiscal burden associated with older populations. In contrast to previous work on tax competition, we incorporate that old-age transfer programs are generally funded by labor taxes. In this manner, our framework introduces new insights regarding the incentives for governments to restrict capital outflows since doing so increases the labor income tax base used for intergenerational transfers.

**JEL Classification: F20, H87**

**Key Words: Population Aging, Fiscal Policy, Foreign Direct Investment**

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## 1. Introduction

In recent years, many countries have experienced a significant shift in population demographics towards increasingly older populations. Obviously, such changes will have important economic consequences. According to Federal Reserve Chairman Ben Bernanke, the effects are particularly acute for the United States:

> *"…over the past decade a combination of diverse forces has created a significant increase in the global supply of saving – a global saving glut – which helps to explain both the increase in the U.S. current account deficit and the relatively low level of long-term interest rates in the world today. The prospect of dramatic increases in the ratio of retirees to workers in a number of major industrial economies is one important reason for the high level of global saving… a particularly interesting aspect of the global saving glut has been a remarkable reversal in the flows of credit to developing and emerging market economies, a shift that has transformed these economies from borrowers on international capital markets to large net lenders."* (Bernanke, 2005)

As outlined by Bernanke, population aging is likely to have a substantial impact on economic activity across countries. Nevertheless, there has been relatively little work devoted towards understanding these critical issues. In an attempt to fill this gap, we study an important aspect of capital flows across countries: foreign direct investment (FDI). In doing so, we analytically derive changes in FDI with respect to aging, identify these patterns empirically using US FDI data, and then draw policy implications by examining how governments are likely to respond. In particular, we investigate the strategic taxation of the profits of multinational enterprises (MNEs) in light of the emerging demographic shifts.

In the discussion on the economic impact of aging, three distinct yet interrelated issues emerge. First, economies with older populations (a higher proportion of old individuals relative to the current young) will have lower levels of savings. Since older individuals are near the end of the lifecycle, they save less than young people do. Due to

the higher amount of current consumption, the stock of savings may be lower. Second, for a given population size, an older economy will have a smaller effective labor force. There are a number of reasons for this observation. Public pension programs in many countries explicitly encourage retirement by reducing benefits for those who continue working.[1] In addition, older individuals may have a higher value of leisure time than the young.[2] Finally, due to outdated skills and poorer health, older workers may be less productive than their younger counterparts, reducing the effective workforce. Consequently, for two economies with the same overall population size, the "older" economy would have a smaller workforce and a higher wage rate. Thus, aging influences the availability of factors and relative factor prices between countries, both of which alter international capital flows.[3]

Third, as has recently received a great deal of attention, older populations create severe financial burdens for governments due to the obligations for funding old-age transfer programs such as public pensions and old-age health insurance.[4] As an example, current projections for the United States indicate that social security payments will rise from 4.3% of GDP in 2004 to 6.4% in 2079 (SSA, 2005).

[1] See Gruber and Wise (1999). Although many governments attempt to use public pension programs to improve the allocation of workers to jobs, Bhattacharya, Mulligan, and Reed (2004) demonstrate that they generally provide inefficiently high retirement incentives. That is, they encourage too much retirement.
[2] For details, refer to Costa (1998), Parnes and Nestel (1981), Robinson et al. (1982), and Schulz (2001).
[3] The impact of relative factor prices on the level of FDI differs between the horizontal models of FDI (e.g. Markusen, 1984) and the vertical models (e.g. Helpman, 1984). In horizontal models, factor price differences discourage FDI whereas these differences encourage vertical FDI. When combined as in Markusen (2002), the net effect varies according to the degree of relative endowment differences as well as the relative size of countries. Carr, Markusen, and Maskus (2001) find empirical evidence supporting Markusen's (2002) approach. These differences provide us with another reason to separate the data in our empirical section along rich/poor and inbound/outbound lines.
[4] Profeta (2002) provides a cross-country comparison of the issues surrounding this fiscal burden.

All three of these aspects of population aging will certainly affect factor supplies across countries. Naturally, they will also have a significant impact on the flow of capital *between* countries. Consequently, population demographics are likely to affect the strategic taxation of capital.[5] It is also important to recognize that intergenerational transfer programs are almost exclusively "pay-as-you-go" programs which are funded by payroll taxes. Obviously, the more severe the fiscal obligations of the government to fund old-age transfers, the greater the distortions it might impose upon workers in the labor market. In order to offset these distortions, the fiscal burden resulting from increasing population aging provides governments with additional incentives to restrict capital outflows.

In order to address these important issues, our paper has three principal objectives. First, we set up a simple model of FDI in order to analytically derive predictions regarding the impact of aging. Given our goal of analyzing strategic tax policy, we choose a model similar to that used by Bond and Samuelson (1989) to derive the Nash equilibria under tax competition between a home and host country. In contrast to that group of models, we endogenize the supply of both labor and capital in the home and host countries. In particular, we show how the domestic supply of each factor affects the

[5] In our framework, we follow much of the tax competition literature by imposing that one country is the home country while the other is the host. As discussed in Wilson (1999) and Gresik (2001), tax competition can also occur between *potential* host countries that offer tax breaks in order to attract capital inflows. It can be argued that population aging can have an important impact in this manner. Although we do not consider such issues, the effect of population demographics would be ambiguous. As a potential host becomes older, the effective labor supply and domestic capital stock will fall. While the decline in labor supply hinders its ability to attract capital inflows, the resulting lower amount of savings would cause the return to capital to rise. Thus, the net impact of aging on a country's need to offer tax incentives depends on the relative magnitude of these effects. However, the nature of the competition – lowering taxes to increase the attractiveness of a location – would likely remain much the same. Furthermore, as our results in Section 4 show, the desirability of inbound FDI would likely increase as a country ages as this aids its struggle to provide intergenerational transfers.

amount of capital flows. Moreover, we demonstrate the effects of population aging on factor prices and FDI. Second, we empirically document the role of demographics for FDI. Interestingly, our estimates conform quite closely to the predictions of our theory, especially for FDI between the US and developed countries.

Finally, given the empirical support for our benchmark model, we extend our analysis to study how governments are likely to design international tax policy in light of aging demographic profiles.[6] This is especially significant since we incorporate that intergenerational transfer programs are funded by payroll taxes. Due to the severe financial burden imposed upon the working population, labor effort will be further distorted in older economies. One method of minimizing this distortion for capital-exporting governments is to restrict capital outflows. This occurs for two reasons. First, doing so exploits their market power in international capital markets and increasing earnings from capital. As a result, the elderly obtain higher amounts of consumption. Second, restricting capital outflows boosts domestic labor productivity, increasing the tax base that can be used for pay-as-you-go pension programs. This second effect is new to the literature and provides even small capital exporters with an incentive to tax FDI.

The rest of the paper proceeds as follows. Section 2 presents our benchmark model in which we examine the effects of aging on employment, the domestic stock of capital and labor in each country, and the amount of FDI. Compared to the multi-country, overlapping generations models of Boersh-Supan, Ludwig, and Winter (2001) or Brooks

[6]In our framework, we assume that FDI is driven by factor price differences across countries. Admittedly, we do not address how population aging affects the motivations for FDI, i.e. whether it affects the mix of horizontal versus vertical FDI. Although a detailed model of the multinational firm would shed some additional insight into the effects of aging demographics, the surveys of Markusen (2002) and Feenstra (2004) illustrate that such complexity would render our analysis to be intractable. Furthermore, it would not

(2003), our model is more simplistic.[7] However, this minimalism comes with the benefit of tractability, allowing us to analytically derive optimal tax policies rather than relying on simulated comparisons of various policy regimes. It is worth noting that in either case, the simulated effects of demographic changes on capital flows in their papers mirror the derived results of these changes on FDI in ours. We find three main results that correspond to the three aspects of aging discussed above. First, an increase in the age of an economy increases the cost of capital, driving up its rate of return in that country. Since FDI arises to exploit international differences in the return to capital across countries, an aging home country will tend to drive down capital outflows whereas an aging host country will stimulate capital exports from home.

Second, in contrast to the financial market effects of population aging, the labor market implications differ significantly. As discussed above, an older economy will have a smaller effective labor force. This aspect of aging in the home country lowers the return to capital. Thus, in contrast to the capital market effect of aging, FDI outflows will increase. Similarly, if the host economy is older, capital inflows to the host country will fall. Third, when pension payments require higher social security tax burdens this again reduces the available labor supply, creating comparable results to a reduction in the effective labor force. Thus, our results suggest that the overall impact of population aging on FDI – irrespective of the need for intergenerational transfers – will be ambiguous. The net impact of population aging depends on the quantitative significance of the labor market and financial market channels.

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be possible to derive conclusions regarding the effects of aging on tax competition. Consequently, we leave construction of a formal, firm-based trade model of FDI and population aging for future research.

Therefore, we proceed in Section 3 by conducting a statistical analysis of population aging and foreign direct investment between countries. Although our theoretic treatment of FDI yields results that would apply to international capital flows in general, we restrict ourselves to FDI in the empirical section to differentiate ourselves from the existing literature by illustrating the impact of aging through a particular component of capital flows. Furthermore, this allows us to draw better connections between our results and both the empirical work on FDI as well as the tax competition literature. Employing the modified knowledge-capital specification of Blonigen and Davies (2004), we examine the impact of various aspects of population aging on FDI flows. Utilizing data on US inbound and outbound FDI, we find, in particular for FDI with developed countries, empirical support for the three different aspects of aging that we conjecture.

Since the data appear to confirm the predictions of our framework, Section 4 turns to the final goal of our paper – the study of how governments are likely to design international tax policy in light of observed demographic trends in different countries. As emphasized above, higher dependency ratios place a significant financial burden on younger workers since payroll taxes are used for funding old-age government transfer programs. Therefore, in contrast to previous research on tax competition and foreign direct investment, we study a constrained maximization problem in which old-age transfers must be in part financed by labor taxes.

In the class of tax competition models such as Bond and Samuelson (1989), Janeba (1995) and Davies and Gresik (2003), most papers assume that governments tax capital flows in order to maximize national income. However, we incorporate the

[7] Helliwell (2004) provides a recent overview of this literature using computable general equilibrium

constraint that old-age transfers are partly funded by payroll taxes. Therefore, the older an economy, the greater the equilibrium labor market distortions imposed upon the working population. Since labor taxes reduce the private return to labor, higher taxes lead to less employment and more capital flight. As a result, the home government has significant reasons for restricting capital outflows. Obviously, the market power effects in Bond and Samuelson (1989) and Janeba (1995) occur. However, there are two additional channels present in our model due to the endogenous supply of labor and the effects of population aging.[8] First, for a given labor tax, capital exports exaggerate distortions in the labor market relative to a fixed capital allocation. Second, as capital outflows reduce the marginal productivity of labor in the home country, home wages fall. The smaller tax base forces the home government to increase the tax rate in order to satisfy financial obligations for old-age transfers. This exacerbates the distortions in the labor market. Consequently, aging increases the desire to tax capital outflows, leading to an increase in tax competition.

## 2. The Benchmark Model of Endogenous Factor Supplies in Each Country

We explore the implications of population aging in a simple model of FDI. There are two countries which we refer to as the home country and the host. In addition, there are two types of agents: individuals (workers) and entrepreneurs. In order to consider the effects of population aging on capital flows across countries, we study a setting in which

models to study population aging and international factor movements.

[8] If preferences are homothetic and non-distortionary taxes are available, national income maximization would be isomorphic to a problem with provision of a public good such as intergenerational transfers. However, we do not allow for these features since social security programs are funded by distortionary labor taxes.

individual agents differ according to their position along the lifecycle. For simplicity, we refer to these individuals as "young" and "old." In our benchmark model, individuals elastically supply labor and capital. In contrast, entrepreneurs are endowed with a production technology but do not have a time endowment for labor.

The total population size of each country is given by $N$ and $N^*$.[9] In order to account for differences in the relative numbers of young and old across countries, we define an economy's dependency ratio as the number of old individuals divided by the size of the population of young. However, in our analysis below, it is convenient to assume that the population mass of the young is equal to one in each country. Therefore, any differences in dependency ratios ($\beta$) across countries are the result of differences in the population size of the old allowing us to refer to an increase in the dependency ratio as an increase in the age of a country. Consistent with the literature, labor is immobile across countries.

In each country, labor ($L$) and capital ($K$) are combined to produce a homogeneous consumption good with a constant price normalized to one.[10] Both factor and product markets are perfectly competitive. Since labor is immobile across countries, the productivity of each factor is dependent upon the location in which it is utilized. The home production function is represented by $F(K,L)$ and production in the foreign country is given by $F^*(K^*,L^*)$. Although labor is immobile, capital can costlessly flow across borders. We denote the flow of capital from the home to the host country as $Z$. By definition of the two countries, Z is non-negative. In this manner, the productivity of

[9] Host variables are denoted by *.
[10] Thus, both home and host are small in international goods markets. This assumption is standard in models of tax competition between home and host countries.

capital which originates in the home country but is used in the host depends on the foreign production technology. Finally, the production function in each country exhibits constant returns to scale and is strictly concave in each factor.

In contrast to standard models of tax competition for FDI, we consider that the supply of capital in each country is elastic. Moreover, we examine how the amount of capital supplied in each country depends on population demographics. One method of approaching the issue of population dynamics would be to specify an intertemporal utility maximization problem and solve for the relevant savings and consumption decisions. However, as noted by Higgins (1998) and Higgins and Williams (1996), this more detailed approach comes at the cost of intractability.[11] Since our goal is to analyze equilibria in a tax setting game that itself will have discontinuities in best-responses, it is necessary for us to sacrifice a detailed description of the consumer's utility maximization problem. In its place, we impose reduced form cost functions that reflect the main results that would arise from such a model. To this end, we posit a cost of capital function for each country given by $C(K;\beta)$ and $C^*(K^*;\beta^*)$.[12] Intuitively, the function *C* measures the aggregate utility loss from foregoing *K* units of initial consumption in units of final output produced by firms. Moreover, assuming that $\beta$ and $\beta^*$ represent the population mass of old individuals in each country, we contend that it is more difficult for an economy to

[11] In essence, aging dynamics eliminate steady states since otherwise the percentage of old in the economy converges to one in the limit, eliminating production.

[12] As an example, in dynamic models of FDI, new investments may be financed through retained earnings. Furthermore, as discussed by Hartman (1985) and Sinn (1993), there is an incentive for firms to underinvest and expand through retained earnings. Furthermore, under credits, firms have the ability to allocate excess credits across periods. Accounting for these features of FDI makes an analysis of the strategic interactions from international tax competition to be much less tractable and we therefore pursue our analysis in a static setting. An additional benefit of this approach is that it aids in comparing our results to those of static models such as Bond and Samuelson (1989).

attain a particular level of capital accumulation if the economy has a higher value of β.[13] We assume that the cost function is increasing and strictly convex in the capital stock of each country as the utility loss from providing additional capital to factor markets and sacrificing current consumption is increasing with the amount of capital supplied.[14]

As for the returns to capital across countries, we assume that in the absence of FDI that the home and host capital markets are segmented. In our discussion below, this implies that capital will flow across countries until the after-tax returns are the same in both the home and host countries.[15] Although we derive expressions for the endogenous stock of capital in each country below, we begin our analysis by studying a representative entrepreneur/firm in each country who chooses the amount of capital and labor to use in order to maximize profits.

Comparable to our assumptions on capital, our approach towards labor supply is geared towards a high degree of tractability. Rather than solving an explicitly dynamic model of intertemporal consumption choice and labor supply, we posit a cost of employment function for each country given by $E(L;d)$ and $E^*(L^*;d^*)$ where akin to β a higher *d* is associated with a higher age.[16] We use separate notation for these two in order to more easily separate the effect of aging on FDI through the capital market and labor

[13] Although we consider a static model, we view our analysis as representative of an explicit dynamic framework in which the young make consumption and savings decisions to maximize their lifetime utility.
[14] A long-standing literature finds a negative correlation between an economy's dependency ratio and its national savings (which implies a higher cost of capital). A handful of examples include Houthakker (1965), Modigliani and Sterling (1983), Horioka (1989), and Weil (1994).
[15] With no uncertainty regarding firm costs or revenues and no cost to enforcement, there is no role for transfer pricing.
[16] The primary advantage of using a model like those of Boersh-Supan, Ludwig, and Winter (2001) or Brooks (2003) with explicit population dynamics and savings decisions is that these would pin down the relationship between our variables *d* and β. However, the disadvantage is that this relationship is contingent on the functional forms chosen. One of the contributions of this paper is to show that the impact of aging found in those papers is similar to those found in this alternative, more general framework.

market channels.[17] In this manner, *E* represents the lost value of leisure time (measured in units of final output) in the economy when total employment is *L*. As is common, we assume that these functions are increasing, convex functions of labor. Moreover, we view that the lost value of leisure in the economy is increasing in the economy's dependency ratio.[18] For example, the opportunity cost of working for older individuals is likely to be higher due to their lower level of health. In addition, old individuals may simply have a higher value for leisure time than their younger counterparts in the labor market.[19] Furthermore, we assume that the home (host) country levies a tax rate of $\eta$ ($\eta^*$) on labor income, a tax which is paid by the worker. This formulation for funding a pay-as-you-go social security system is the same as that used in Schieber and Shoven's (1996) cross-country comparison of such programs.

*Factor Market Equilibria*

Since factor markets are assumed to be perfectly competitive, firms and workers take the prices of labor and capital as given in each market. We denote the gross return to capital in the home country as *r* and let $r^*$ be the gross return in the host. In addition, the gross return to labor in each market is given by *w* and $w^*$. Entrepreneurs in each country choose the amount of capital and labor to utilize in order to maximize profits:

$$\pi = F(K - Z, L) + (1 - \tau) r^* Z - wL - rK \qquad (1)$$

[17] In addition, by recognizing these separate effects of aging, it provides additional testable hypotheses for our empirical analysis.

[18] Public pension programs in many countries either explicitly or implicitly tax elderly work in order to discourage their participation in the labor market. In this manner, choosing to work implies a loss of pension benefits. Although we do not explicitly model how age-related government transfer programs impact labor supply across the lifecycle, we consider the effects of transfers on labor taxes in Section 4.

[19] Alternatively, this function could just as easily reflect a higher cost of achieving an effective amount of labor productivity from elderly workers due to poorer health, outdated training, and so forth. It is important to note that in this way, we assume that, at some point age becomes such a detriment to productivity that it dominates any learning by doing aspects of labor productivity.

where Z is the level of FDI and $\tau$ is the relative effective tax rate on foreign-earned profits.[20] The exact form of $\tau$ is dependent on the home and host statutory tax rates as well as the double tax relief method used by home. Since our goal at the moment is to derive how investment decisions depend on aging and relative effective taxes, we defer discussion on the details of the relative effective rate to Section 4 where we discuss optimal taxation. The profit-maximizing conditions for home labor and capital employment are given by:

$$w = F_L(K - Z, L) \tag{2}$$

$$r = F_K(K - Z, L) = (1 - \tau)r^*. \tag{3}$$

In the host country, the profit function of the representative entrepreneur is:

$$\pi^* = F^*(K^* + Z, L^*) - w^* L^* - r^* K^* \tag{4}$$

The profit-maximizing conditions for labor and capital employment in the host are:

$$w^* = F_L^*(K^* + Z, L^*) \tag{5}$$

and

$$r^* = F_K^*(K^* + Z, L^*). \tag{6}$$

In order for an individual to be willing to supply an additional unit of capital to firms in the home (host) country, individuals must receive the marginal cost of doing so. Similarly, for an individual to supply a unit of labor, they must receive an after-labor tax

[20] One advantage of our one-shot formulation of the model is that it allows us to avoid the complex dynamic profit maximization problem of a MNE that can repatriate or reinvest earnings. As shown by Hartman (1985) and Sinn (1993), incorporating these aspects into the model would be difficult. Furthermore, since in those models the multinational does not repatriate profits until it is mature (choosing instead to reinvest overseas earnings in the interim due to repatriation taxes), the transitional dynamics would make the model extremely opaque. Thus, it is perhaps best to think of our model as describing the response of mature MNEs to aging, an interpretation in line with the model's better fit to data between the US and other developed countries.

amount equal to the cost of providing labor. Thus, the capital supply conditions in each country satisfy:

$$r = C_K(K, \beta) \tag{7}$$

and

$$r^* = C_K^*(K^*, \beta^*) \tag{8}$$

while the labor supply conditions in each country are given by:

$$w = E_L(L, d) \tag{9}$$

and

$$w^* = E_L^*(L^*, d^*)\,. \tag{10}$$

Combining (2), (3), and (5) through (10) yields five factor market equilibrium equations.

$$F_K(K - Z, L) = C_K(K, \beta) \tag{11}$$

$$F_K(K - Z, L) = (1 - \tau)F_K^*(K^* + Z, L^*) \tag{12}$$

$$F_K^*(K^* + Z, L^*) = C_K^*(K^*, \beta^*)\,. \tag{13}$$

$$(1 - \eta)F_L(K - Z, L) = E_L(L, d) \tag{14}$$

and

$$(1 - \eta^*)F_L^*(K^* + Z, L^*) = E_L^*(L^*, d^*)\,. \tag{15}$$

From these equilibrium conditions, we may examine the impact of aging and government policies on international capital flows from the home to the host. This impact of aging through its effect on the cost of raising capital is summarized in our first proposition.

***Proposition 1.*** *(Impact of Aging on FDI through the Cost of Capital) An increase in home's dependency ratio (β), decreases FDI through the cost of capital. An increase in host's dependency ratio ($\beta^*$) increases FDI through the cost of capital.*

**Proof:** For notational convenience, it is useful to define the following three variables:

$$\Delta = f_{KK}E_{LL} + C_{KK}\left((1-\eta)f_{LL} - E_{LL}\right) < 0\,,$$

$$\Delta^* = f^*_{KK}E^*_{LL} + C^*_{KK}\left((1-\eta^*)f^*_{LL} - E^*_{LL}\right) < 0\,,$$

and

$$\Omega = -C_{KK}\,f_{KK}E_{LL}\Delta^* - (1-\tau)C^*_{KK}\,f^*_{KK}E^*_{LL}\Delta < 0\,.$$

For given tax rates, totally differentiating (11) through (15) allows us to calculate the following comparative statics:

$$\frac{dZ}{d\beta} = \Omega^{-1}C_{K\beta}\,f_{KK}E_{LL}\Delta^* < 0 \qquad (16)$$

and

$$\frac{dZ}{d\beta^*} = -\Omega^{-1}C^*_{K\beta}(1-\tau)\,f^*_{KK}E^*_{LL}\Delta > 0\,. \qquad (17)$$

**Q.E.D.**

The intuition behind these results is straightforward. When a country's dependency ratio ($\beta$ or $\beta^*$) rises, its supply of capital falls.[21] For given FDI flows, this increases the rate of return on capital in that country. FDI responds by shifting capital to the high return location. Thus, if home's age rises, FDI falls as capital returns home, while if host's age rises, FDI increases. This mirrors the results from studies of the current account by Higgins and Williamson (1996), Cutler et. al. (1990), and others who derive such savings effects from dynamic models of savings (and typically rely on computational examples to reach their results)

[21] The explicit presentation of the comparative statics for the capital and labor supplies are omitted for space. These are available upon request.

This effect, however, is only one aspect of the impact of aging on FDI since aging not only raises the cost of capital, but also increases the cost of labor. Since a key difference between FDI and financial flows is the productive nature of FDI, this is particularly important here. This effect of aging on FDI is discussed in Proposition 2.

***Proposition 2.*** *(Impact of Aging on FDI through the Cost of Labor) An increase in home's dependency ratio (d) increases FDI through the cost of labor. An increase in host's dependency ratio ($d^*$) decreases FDI through the cost of labor.*

**Proof:** Again, for given tax rates, totally differentiating (11) through (15) allows us to calculate the following comparative statics:

$$\frac{dZ}{dd} = \Omega^{-1} E_{Ld} f_{KL} C_{KK} \Delta^* > 0 \tag{18}$$

and

$$\frac{dZ}{dd^*} = -\Omega^{-1} E^*_{Ld} (1-\tau) f^*_{KL} C^*_{KK} \Delta < 0 \,. \tag{19}$$

**Q.E.D.**

Here too, the intuition is straightforward. As the marginal cost of labor rises due to an increase in the dependency ratio, the supply of labor falls.[22] Since the marginal rate of return on capital is rising in a country's labor supply, as a country ages, the rate of return to capital falls. Again FDI responds by shifting capital towards the higher rate of return. Thus, if $d$ rises, FDI rises as well whereas if $d^*$ rises, FDI falls.

[22] The comparative statics for $d$ and $d^*$ on $K$, $K^*$, $L$, and $L^*$ are available upon request.

Using these factor market equilibrium conditions, we can also establish the impact of capital and labor taxes on FDI and factor supplies. These results are contained in Propositions 3, 4, and 5.

***Proposition 3:*** *(Impact of the Relative Effective Tax Rate) An increase in the relative effective tax rate (τ) decreases FDI, the home capital supply, and the host labor supply. An increase in the relative effective tax rate increases the host capital supply and the home labor supply.*

**Proof:** Totally differentiating (11) through (15) yields the following comparative statics:

$$\frac{dZ}{d\tau} = \Omega^{-1} f_K^* \Delta\Delta^* < 0\,, \tag{20}$$

$$\frac{dK}{d\tau} = \Omega^{-1} f_K^* f_{KK} E_{LL} \Delta^* < 0\,, \tag{21}$$

$$\frac{dL^*}{d\tau} - \Omega^{-1} f_K^* (1-\eta^*) f_{KL}^* C_{KK}^* \Delta < 0\,, \tag{22}$$

$$\frac{dK^*}{d\tau} = -\Omega^{-1} f_K^* f_{KK}^* E_{LL}^* \Delta > 0\,, \tag{23}$$

and

$$\frac{dL}{d\tau} = \Omega^{-1} f_K^* (1-\eta) f_{KL} C_{KK} \Delta^* > 0\,. \tag{24}$$

**Q.E.D.**

***Proposition 4:*** *(Impact of Home's Labor Tax) An increase in home's labor tax ($\eta$) increases FDI and the host labor supply. An increase in home's labor tax decreases home's labor supply and both the home and host capital supplies.*

**Proof:** Totally differentiating (11) through (15) yields the following comparative statics:

$$\frac{dZ}{d\eta} = \Omega^{-1} f_L f_{KL} C_{KK} \Delta^* > 0, \tag{25}$$

$$\frac{dL^*}{d\eta} = -\Omega^{-1} f_L (1-\eta^*) C^*_{KK} f^*_{KL} f_{KL} C_{KK} > 0, \tag{26}$$

$$\frac{dL}{d\eta} = -\Omega^{-1} f_L \left[ (1-\tau) f^*_{KK} C^*_{KK} E^*_{LL} (C_{KK} - f_{KK}) - C_{KK} f_{KK} \Delta^* \right] < 0, \tag{27}$$

$$\frac{dK}{d\eta} = -\Omega^{-1} f_L (1-\tau) f^*_{KK} C^*_{KK} E^*_{LL} f_{KL} < 0, \tag{28}$$

and

$$\frac{dK^*}{d\eta} = -\Omega^{-1} f_L f^*_{KK} f_{KL} E^*_{LL} C_{KK} < 0. \tag{29}$$

**Q.E.D.**

***Proposition 5:*** *(Impact of Host's Labor Tax) An increase in host's labor tax ($\eta^*$) decreases FDI, the host labor supply, and the capital supplies of both countries. An increase in host's labor tax increases home's labor supply.*

**Proof:** Totally differentiating (11) through (15) yields the following comparative statics:

$$\frac{dZ}{d\eta^*} = -\Omega^{-1} (1-\tau) f^*_L f^*_{KL} C^*_{KK} \Delta < 0 \tag{30}$$

$$\frac{dL^*}{d\eta^*} = -\Omega^{-1} f^*_L \left[ f_{KK} C_{KK} E_{LL} (C^*_{KK} - f^*_{KK}) - (1-\tau) C^*_{KK} f^*_{KK} \Delta \right] < 0, \tag{31}$$

$$\frac{dL}{d\eta^*} = -\Omega^{-1} f_L^*(1-\tau)(1-\eta) f_{KL} f_{KL}^* C_{KK} C_{KK}^* > 0\,, \tag{32}$$

$$\frac{dK}{d\eta^*} = -\Omega^{-1} f_L^* f_{KK} f_{KL}^* C_{KK} E_{LL} < 0\,, \tag{33}$$

and

$$\frac{dK^*}{d\eta^*} = -\Omega^{-1} f_L^*(1-\tau) f_{KK} f_{KL}^* E_{LL} C_{KK}^* < 0\,. \tag{34}$$

**Q.E.D.**

Here too the intuition is straightforward. An increase in the relative effective tax reduces the after tax rate of return from FDI relative to domestic investment. As a result, FDI falls. This returning capital crowds out some domestic capital, but not totally, thereby increasing total capital usage at home. This raises the marginal productivity of home labor, increasing the wage and increasing its supply. In the host, as capital flows out, the rate of return to capital rises there, increasing the host supply of capital. Host capital does not increase by the same amount that FDI decreases, however, thereby lowering the host wage and the host supply of labor.

When a country's labor tax rises, its domestic labor supply falls. This effect is observed empirically by Gruber and Wise (1998), who also provide a review of numerous country studies documenting this relationship between social security taxes and labor supply.[23] This lowers the return to capital in that country relative to the other and FDI responds accordingly. Floden's (2003) dynamic model of capital flows yields a comparable result in simulations. It is worth noting that Ehrlich and Zhong (1998) find

[23] Alternatively, as posed by Pellechio (1979), higher taxes could imply higher benefits, lowering the opportunity cost of retirement and reducing work effort by the elderly. In our model, this would be a comparable effect to that of η and, if we impose a balanced budget on the government, there is a clear link between the two.

that increases in the labor tax also decreases human capital accumulation.[24] Given the importance of skilled labor to MNEs found in most empirical studies of FDI, this would suggest an additional reason for FDI to avoid locations with high labor taxes. Although we do not speak directly towards this in our presentation, we can certainly account for it by simply reinterpreting a country's labor stock as its effective human capital stock (which depends on both the number of workers and their skill level). When the world labor supply falls, so too does the world's supply of capital (since the capital supply of each country falls). Finally, in the country that capital shifts towards, its net change in capital is positive, increasing the productivity of its labor and therefore its labor supply.

Since capital is attracted to large labor pools, in our model, FDI will be largest when the host working-age population is large relative to that of home. Since FDI responds to labor supplies, which is reflected in the wage rate, this would suggest that FDI will be largest when, ceteris paribus, the host wage is much less than the home wage. As such, FDI more closely resembles that of Helpman's (1984) vertical model. It should be noted, however, that under our assumptions of constant returns to scale, exogenous prices, and no trade costs, that horizontal FDI should not be expected to emerge (Markusen, 1984). Evidence of vertical FDI is found by Feinberg and Keene (2001), Yeaple (2003), Walkirch (2003) and Hanson, Mataloni, and Slaughter (forthcoming) among others.

Thus, the net impact of aging on FDI is ambiguous in our model. As the home country ages, increases in the cost of raising capital reduces FDI whereas decreases in the labor supply, due to both aging and higher labor taxes to pay for benefits, increases FDI.

[24] This study builds off of the family growth model of Ehrlich and Lui (1998).

As the host ages, capital there becomes more scarce, increasing FDI. At the same time, host labor falls due to aging and higher labor taxes, decreasing FDI. Therefore, the impact of aging on FDI depends on the relative importance of these channels both within and across countries. Before proceeding to optimal taxation of FDI, in the next section we present some empirical analysis that suggests, in particular for US FDI with the other developed countries, the above predictions on the impact of aging on FDI hold true.

## 3. Empirical Effects of Population Aging on Foreign Direct Investment

In this section, our goal is to present empirical results estimating the response of FDI to the three aspects of aging identified above. We do this in order to frame our discussion on optimal taxation in Section 4.

### *3.1 Empirical Specification and Data*

Our theoretical model in the previous section demonstrated the effects of aging when FDI results from differences in the return on capital (which is positively related to the supply of labor). In this manner, our benchmark model captures "vertical" motivations for FDI as introduced by Helpman (1984) in which FDI occurs due to factor price differences. Beyond vertical FDI, there is also the market-access driven, "horizontal" model of the multinational firm. Developed by Markusen (1984), this model is one in which a firm exploits economies of scale and avoids trade costs by producing the same good in multiple locations. Notably, the horizontal model generates incentives for firms to produce in larger countries in order to avoid trade costs associated with servicing that market.

More recently, these motivations have been integrated in the knowledge capital model developed by Carr, Markusen, and Maskus (2001) and Markusen (2002), which asserts that both horizontal and vertical aspects are important. Here, the impact of factor differences is ambiguous since these increase vertical FDI but create disadvantages for horizontal MNEs. This is further complicated by scale effects since skill differences are less important if the host country is relatively small.

As the existing theory produces somewhat conflicting insights regarding the determinants of FDI, our empirical specification attempts to avoid mis-specification bias by allowing for both to be observed in the data. To be specific, our regression analysis builds off of the so-called "gravity" model which has been widely used in the empirical literature on FDI.[25] In this manner, our baseline specification for FDI from a home country *i* to a host country *j* in year *t* is given by:

$$FDI_{ijt} = \xi_0 + \xi_1 GRAVITY_{it} + \xi_2 GRAVITY_{jt} + \xi_3 X_{ijt} + \xi_4 AGE_{it} + \xi_5 AGE_{jt} + \varepsilon_{ijt}. \qquad (35)$$

We follow many papers by using the real value of sales by affiliates from country *i* operating in country *j* in year *t* as a proxy for the amount of FDI from *i* to *j*. Our data set covers US inbound and outbound FDI from 1983-1998 for 55 countries.[26] We obtained the real value of sales from the Bureau of Economic Analysis and converted it into real 1996 dollars using the chain-type price index for gross domestic investment from the Economic Report of the President.[27] Although our theoretical model examines FDI flows from *i* to *j*, we use sales because this measure of activity helps to control for variation in

[25] See Eaton and Tamura (1994), Brainard (1997), and Blonigen and Davies (2004) for examples.
[26] Poterba (1998) uses US data to study the effect of aging on asset prices. Although he does not consider the effect of aging on capital flows, he points to this as one potential area in which aging will have important effects.

technology and other differences in affiliates that are unobservable. Thus, our measure represents the current value of FDI activity in the host.[28, 29] Our objective was to obtain data for a broad spectrum of countries. However, the search for a richer cross-section limited the time-series dimension of our analysis. Thus, although our data only spans sixteen years, it represents information for a large number of countries.[30]

As a benchmark for determining how aging affects the flow of capital between countries, we begin by discussing the different variables which are standard in the FDI literature. The GRAVITY terms are vectors that control for various standard characteristics of the home and host countries. For both the home and host we include log real GDP (GDP), log real per capita GDP (SKILL), log investment as a share of GDP (INVEST), and a proxy for trade costs (TCOST). The proxy for skill is the same as that used by Slaughter (2000).[31]

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[27] The BEA's FDI data can be found at http://www.bea.doc.gov/bea/di/di1usdbal.htm. The price deflator can be found at http://www.gpoaccess.gov/usbudget/fy05/sheets/b7.xls.

[28] Note that affiliate sales are total affiliate sales, not just those in the local market. Given the assumptions of zero trade costs and exogenous output prices in our model, this measure of sales comes closest to that in the theory.

[29] An alternative to using affiliate sales would be the stock of FDI. The advantage of the stock data is that these data start earlier than do the sales data, especially for US outbound FDI to the developed countries. However, as discussed by Blonigen and Davies (2004) there are issues with the time series properties of the stock measure as well as using historical-cost based measures of FDI. In addition, the available time series of our aging variables limited the usefulness of these earlier stock observations. Nevertheless, we find very similar estimates for the aging variables when using the real stock of FDI as our measure of FDI activity. These alternative regressions are available upon request.

[30] An alternative dataset would be to use data on outbound FDI from OECD countries, data which are available from the OECD's *International Direct Investment Statistics Yearbook*. The advantage of these data is that they do not always have the U.S. as one of the two countries in an observation. There are, however, two disadvantages. First, the definition of FDI and the collection of the data differ across source countries, leading to potential compatibility problems. Second, they are available for a far narrower set of countries. In particular, this latter problem led us to use the U.S. data a choice that also eases the comparison of our results to existing results.

[31] Although other measures of skill are available, they limit the countries that we could include in our sample. Nevertheless, when these alternates were used, comparable results were found.

Our measure of trade costs is $1/(1+OPENNESS)$ where OPENNESS is the sum of a country's imports plus exports over its GDP. All of these were obtained from Penn World Tables, Version 6.1 (PWT 6.1)[32]. In addition, for the host, we include a measure of investment costs (ICOSTS). This is measured as the log of one over one plus the BERI index which is a composite of operations risk index, political risk index and remittance and repatriation factor index. These indices are developed by Business Environment Risk Intelligence S.A.[33]

In addition, $X_{ijt}$ controls for other factors that potentially influence FDI between the US and another country. The first of these, DISTANCE, is common in gravity model specifications. We measure this as the log of the distance between capital cities measured in kilometers.[34] The second is a dummy variable RICH that is equal to one for the developed countries. The third is a trend term. We also include each country's investment rate (INVEST) to control for the overall investment conditions in the country in addition to those related to aging. This is measured by investment as a percentage of GDP and comes from the Penn-World Tables. To control for overall macroeconomic conditions, we include FX, the log of the bilateral exchange rate with the US obtained from the Penn-World Tables. Finally, in some specifications, as we discuss further below, we also include fixed effects.

[32] The PWT data is available online at http://pwt.econ.upenn.edu/php_site/pwt_index.php and are described by Summers and Heston (1991).
[33] For more information see http://www.beri.com.
[34] This was gathered from the distance calculator at http://www.indo.com.

We now turn to the principal variables of interest, $AGE_{it}$ and $AGE_{jt}$, vectors that contain variables representing aspects of aging for the home and host countries.[35] We include three separate terms in each. The first of these is DEPENDENCY which is the log of the ratio of the population 65 and over relative to the population 15 to 64. This is equivalent to the *d* term in our theory. The second aging variable is NATLSAVINGS, which is the log of a country's gross national savings as a percentage of its GDP. This is equivalent to the opposite of the $\beta$ term in our model since older (higher $\beta$) countries would have lower savings rates. The third aging variable is *SS*, which is the log of the percentage of GDP collected in social security taxes. This represents the effect of $\eta$ in the previous section. All of these variables come from the World Bank's *World Development Indicators* (2004).

Finally, $\varepsilon_{ijt}$ is a standard i.i.d. error term. Summary statistics for all of our variables are found in the data appendix. The appendix also includes the list of countries used in the data set, as well as a list of those designated as developed countries.

Before proceeding to the discussion of our results, we offer some comments regarding how our specification contrasts with the existing empirical literature. Although Carr, Markusen, and Maskus (2001) conduct their analysis by studying the various data in levels, Blonigen and Davies (2004) find that this often leads to estimated coefficients with implausible magnitudes. This occurs because of the skewed nature of FDI data across countries. The skewness is easily observed by reviewing the summary statistics in

[35] Higgins (1998) considers the impact of aging on the current account (which includes net financial flows and net FDI). He finds the effects of aging on investment differ from savings. On the basis of his analysis, Higgins predicts that aging developing countries should observe higher current account balances. However, he does not explicitly focus on the determination of FDI activity. Consequently, he does not include many of the standard gravity variables in his specification potentially biasing his estimates.

the data appendix – the mean for affiliate sales is two-thirds as large as its maximum value. We therefore use logs of our variables rather than levels to offset the problem. In some specifications, we also separate the data into two different subsamples: U.S. FDI with rich and poor countries. This further alleviates the skewness problem.

As mentioned above, our empirical specification attempts to avoid mis-specification problems by allowing for both vertical and horizontal motives for FDI to be observed in the data. Notably, the knowledge capital model highlights the importance of relative factor endowments between countries. According to Carr, Markusen, and Maskus (2001), greater skill differences between two countries should be associated with larger factor price differentials and more FDI. As discussed by Blonigen, Davies, and Head (2003), however, this applies only to the vertical aspect of FDI with an opposite relationship between skill differences and horizontal FDI. As a result, estimation based upon skill differences can be sensitive to whether the variable is positive or negative. Moreover, there are difficulties in using negatives because of our log-linear specification.

Therefore, we choose to include the log-levels of skill for both home and host countries rather than their differences. For a fixed level of skill in the home country, an increase in labor productivity in the host country should be associated with a higher amount of FDI activity. Analogously, we should find an increase in skill in the home country would be associated with less FDI.

However, according to the knowledge capital model, skill differences are less relevant if the host country is small. In order to capture these aspects, the model requires complex interactions since the effect of relative endowments is non-linear. Note that in our data, US per capita income is almost always the highest. Thus, as in Blonigen,

Davies, and Head (2003), for some specifications we choose to separate the data into two subsamples: one in which the home country is relatively skill abundant and another in which the host is. In the data in our sample, this amounts to using inbound and outbound FDI separately, where US inbound FDI is the skill-abundant home subset and US outbound FDI makes up the skill-abundant host subset.

*3.2 Results*

Table 1 presents our baseline estimates where, in addition to the standard gravity model variables, we include the dependency ratio of the home and host countries. As for the standard determinants of FDI, the gravity controls have their commonly found signs and are frequently statistically significant. Thus, our results suggest that FDI is higher between large, wealthy economies with low trade barriers. In addition, FDI is lower when the host country has higher investment costs. Moreover, distance is negatively correlated with sales of affiliates.

We turn to the principal variables of interest, the effects of population aging. In particular, we are interested in determining the extent to which our empirical results are consistent with the predictions of our theoretical model in Section 2. Notably, our model suggests that the financial market effects of aging will differ from their labor market effects. Since our model does not tell us which effect is likely to be *quantitatively* more important, we begin by considering the net impact of aging on FDI. In Column (1) of Table 1, we combine US inbound and outbound FDI. Here, we find significant negative coefficients on both the home and host dependency ratios.[36] This suggests that aging by

[36] Domeij and Floden (2004) calibrate a dynamic, overlapping-generations model with endogenous international factor prices and find that their simulations match those experienced by the OECD, i.e. capital

either the home or the host reduces FDI, suggesting that for the home country capital market effects dominate whereas for the host, labor market effects are paramount.

Noting that a great deal of the variation in the data is due to the non-US country, we proceed by considering inbound and outbound FDI separately in Columns (2) and (3) respectively. This also aids with the skill-abundance problem noted above. In Column (2), the US is always the host. After including the trend term, US variables (those in $GRAVITY_{jt}$) were insignificant and are therefore excluded in column 2 with their variation absorbed by the trend term. Similarly, the home country variables are excluded in the estimates on US outbound FDI in Column (3) and again their variation is again absorbed by the trend. In Column (2), our results confirm those from Column (1), i.e. FDI inflows are significantly negatively impacted by the dependency ratio of the home country. This suggests that a one percent increase in the dependency ratio of the home country reduces FDI by around .6 percent. At the sample mean, this is a decrease in the sales of affiliates of about 2.4 million dollars.

In Column (3), we find a similar sign on the host dependency variable, although it falls outside the standard significance levels. Since there are omitted variables that may potentially bias our results, we repeat these three regressions but include country fixed effects. These results are reported in Columns (4) through (6) of Table 1. Once again, the home dependency ratio has a negative coefficient. The host variable, however, now has a positive coefficient. In no case, however, are these coefficients significant. There are a number of reasons why this might occur. First, our data set only covers a sixteen year time span. It is unlikely that each country would have significant variation in its

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flows from old to young economies. They do not, however, test the significance of this mechanism relative

dependency ratio over such a short period. In addition, the dependency variable captures a number of aspects of aging. As our model in Section 2 demonstrates, these may have a conflicting impact on FDI. Consequently, this insignificance could be due to the agglomeration of the different aspects of aging. Our results below suggest this is indeed the case, highlighting the need to separately consider the various aspects of aging.

In Table 2, we separately consider the three aspects of aging identified in our theoretical model. Therefore in these results, we use the dependency ratio (DEPENDENCY), national savings (NSAVING), and social security taxes (SS).[37] Given our theoretical results, we expect positive coefficients for all of the home aging variables and negative ones for all of the host aging variables.[38] The results of our statistical analysis are presented in Table 2. As shown, these results initially appear to be inconsistent with our theory since the home aging variables are significantly negative and the host dependency ratio is significantly positive. Inclusion of fixed effects only aids this issue by eliminating the significance of many of the aging variables. This latter is consistent with Weil (1994) who studies the impact of aging on savings across countries. He also finds that age variables become insignificant in fixed effects regressions.

One possible issue with these results, however, is that they combine data on rich and poor countries. There are a number of reasons why the underlying motivations for FDI may differ between these groups. As noted by Blonigen and Davies (2004), FDI data are often skewed with far greater amounts of FDI going into and coming from the developed countries creating data issues when combining these. Moreover, Markusen

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to others.

[37] Note that limited data on SS reduces our sample size.

(2002) contends that the motivation for FDI differs between developed and developing countries. While scale effects are generally more significant for capital flows between two developed countries, factor price differentials appear more relevant for FDI between a rich and a poor country. Consequently, one should expect that horizontal FDI is observed for rich economies and vertical FDI occurs between a rich and a poor country. Thus, the underlying data generating process differs, influencing estimates from our regressions. Furthermore, economic activity in developed countries is likely to differ from behavior in poor countries. As Table 3 illustrates, the dependency ratio is one example – developed countries (due to lower birth rates and higher life expectancies) have higher values. For these reasons, we break our sample into two groups: rich (Table 4) and poor (Table 5).[39] The list of rich countries is provided in the appendix. We also note that Ehrlich and Zhong (1998) in their study of fertility and savings also split their data between rich and poor countries because of large differences in the data generating process.

Table 4 presents our results for the rich country subsample. The estimates conform quite closely to those predicted by our theoretical model. For the inbound data, all three aging variables are positive without fixed effects and two are significant. When controlling for fixed effects only DEPENDENCY is significantly positive.[40] For outbound FDI, the results that are most consistent with our framework occur when controlling for fixed effects. In that case we find negative coefficients on all three aging variables with significant coefficients on two of them.

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[38] Recall that SS is a proxy that is inversely related to the cost of raising capital, implying that this should have a positive coefficient for the home country and a negative coefficient for the host country.

[39] Separating the poor countries may also help with the possibility that FDI into this group is driven by the availability of natural resources (although to the extent that these do not vary over time the use of fixed effects also helps to alleviate this concern).

Looking across the columns of Table 4, the home country dependency variable has a positive coefficient and it is significant when controlling for fixed effects. Using the value for the coefficient in column (5), we find that a one percent rise in the (non-U.S.) home dependency ratio increases capital exports to the United States by 1.6%. At the sample mean, this corresponds to a $247 million increase in FDI. As predicted by our framework, we find that population aging in the host country has a negative impact on FDI. The host dependency ratio has a negative coefficient that is significant in the absence of fixed effects. Using the estimate from column (3), this suggests a 1 percent rise in the host's dependency ratio leads to a decrease in U.S. affiliate sales by .1 percent. At the sample mean, this translates to a decline just under $251 million.

Similar results appear in terms of the effects of the social security tax burden. Our model predicts that higher social security obligations in the home country should increase outbound capital flows whereas higher obligations in the host country should be associated with lower capital imports. Using the results from column (2), a 1% increase in the parent country's burden generates a .3% increase in capital flows to the United States. When controlling for fixed effects, we find that the same increase in the host country is associated with a .1% decrease in outbound FDI. Interestingly, the results in column (1) show the combined impact on FDI with the United States. Evaluating at the sample mean, a one percent rise in home's SS burden is associated with a $40 million increase in total FDI with the United States. A comparable increase for the host lowers FDI by $29 million.

[40] As noted by Floden (2003), the US is young relative to the rest of the rich countries suggesting that this subsample may conform more closely to our model.

The capital market effects are also found in the data. According to the theory, home's national savings rate should be positively correlated with FDI. We find that this is in fact the case in three of the four specifications. Furthermore, this coefficient is significant when excluding fixed effects. The host savings rate should be negatively correlated with FDI and we find that this too holds in three of the four regressions and is negative whenever the coefficient is significant. To give an idea of the magnitudes of these at the sample mean for Column (1), a one percent rise in home's national savings rate increases FDI by $298 million whereas a one percent rise in host's national savings rate decreases FDI by $262 million.

Finally, in Table 5, we present results using only the poor country subsample. Here, as in the combined sample, the coefficients are often inconsistent with theory. According to the results without fixed effects, FDI is declining in the home dependency ratio, either country's social security burden, and the savings rate of either country. These estimates contradict the predictions for the home country. Likewise, the estimated coefficient on the host dependency ratio is positive, not negative. For the inbound results in Column (2), in each case the estimates run counter to our model's predictions, even after controlling for fixed effects. This suggests that the data on FDI into the US from developing countries differs considerably from our theory. In Column (3), the estimates for US outbound FDI to developed countries matches the theory with the exception of the dependency ratio. That coefficient indicates that US FDI to developing countries is attracted to older economies. Life expectancy, health care, and so forth are likely to increase longevity and therefore the dependency ratio. These same items are also likely to be correlated with stable, growing economies, i.e. features attractive to FDI. This suggests

that these results may suffer from omitted variable bias. One method of dealing with this is to add fixed effects. Doing so brings the US outbound results in Column (6) in line with theory.

Before proceeding to the following section, we summarize the findings of our statistical analysis. The data suggests that the results for FDI with rich countries, either coming from or going to the US, conform very closely to the theory. This is particularly important since the rich countries have the most FDI with the United States. For example, in 1998, these countries comprised 73 percent of US affiliate sales abroad and 93 percent of foreign-owned affiliate sales in the United States. In addition, especially after accounting for unobserved heterogeneity, we find the predicted results for US outbound FDI to the developing countries. The one shortcoming is in the match between the data on FDI in the US from developing countries and our theory. However, since these countries accounted for less than 7% of foreign-owned affiliate sales in the US, this shortcoming is relatively slight. Thus, the empirical results provide support for our theoretical framework. Importantly, our estimates show that when considering the impact of different population demographics for FDI between countries, it is necessary to account for both the labor market and financial market effects, something not done in earlier work.

**4. Implications of Population Aging for International Tax Competition**

Our benchmark model describes distinct channels in which population aging is likely to affect FDI and financial market activity across countries. In particular, due to the smaller effective labor force, the domestic rate of return to capital will be lower. In this manner, the model demonstrates that aging can lead to greater capital outflows.

Moreover, the results from regression analysis conform quite closely to the predictions of our theory.

Consequently, we have shown that changing demographic patterns will have a significant impact on the flow of capital between countries. In light of these important observations, policymakers must seek appropriate action. That is, in confronting the challenges of the emerging demographic crisis, how should governments attempt to regulate the extent of FDI? The academic literature has not yet addressed the connections between foreign direct investment and population aging, however, some in the popular press and government have proposed that policy should encourage capital outflows. For example, Bernanke (2005) suggests that FDI is a beneficial route towards providing individuals with greater income in their golden years: [41]

> "*…one well-understood source of the saving glut is the strong saving motive of rich countries with aging populations, which must make provision for an impending sharp increase in the number of retirees relative to the number of workers...As a consequence of high desired saving and the low prospective returns to domestic investment, the mature industrial economies as a group seek to run current account surpluses and thus to lend abroad."* (Bernanke, 2005)

At the same time, governments substantially rely on intergenerational transfer programs such as public pensions to *directly* raise the income of the old. In recent years, this had led to a significant fiscal burden in many economies. For example, the Commission on Global Aging (2006) reports that payroll taxes would need to increase by more than 25% in developed countries in order to pay for the increased expenditures.

Since both FDI and public pension programs may be used to raise retirees' incomes, we contend that policies in both areas should be carefully constructed. That is,

[41] In addition, see the recent Senate testimony of Hewitt (2003). Siegel (2002) and Rothkopf (2004) advance similar arguments.

in order to confront the current problem of population aging, governments must balance taxation of multinational activity against the domestic tax burden on the current working population.

To address these important issues, we return to our benchmark model introduced in Section II. In particular, we incorporate a budget constraint in which intergenerational transfer programs are funded by domestic payroll taxes. For simplicity, we assume that all capital is owned by the old and that all labor is provided by the young.[42] The income of home's old is therefore:

$$I = rK + r^{*}Z - C + T \tag{36}$$

where $T$ are transfers from the government. Note that the old take these transfers as given and therefore do not internalize the impact of their decisions on the equilibrium value of transfers. In contrast to old agents, young individuals earn income through working. Consequently, their income is given by:

$$Y = (1-\eta)wL - E\,. \tag{37}$$

The government is constrained to run a balanced budget, implying that transfers are equal to the sum of labor and capital tax revenue (if any as discussed below). Although we assume that the government's budget may be partially financed by tax revenues from capital, they are not a source of intergenerational transfers since capital taxes are imposed upon the old. Thus, on net, the transfers are strictly funded by labor taxes imposed on the working population.

We next introduce the income constraints for the host country:

[42] If we instead assume that each group owns a fixed portion of each of these, we obtain the same optimal taxation strategies for the countries, leading to the same qualitative Nash equilibrium.

$$I^* = r^* K^* - C^* + T^* \tag{38}$$

and

$$Y^* = w^* L^* - E^* . \tag{39}$$

Unlike home, host capital taxes do act as a net income transfer to their old since the transfers are from the owners of capital at home. Thus, host transfers are given by:[43]

$$T^* = \eta^* f_L^* L^* + t^* f_K^* Z \tag{40}$$

Consistent with most tax policies, we assume that the home government offers its MNEs some form of relief from double taxation of its overseas profits. As a result, the relative effective tax paid on overseas profits (τ) may well differ from the statutory tax rate of either country. Specifically,

$$\tau = \begin{cases} \max\{t, t^*\} & \text{if home offers credits} \\ t^* & \text{if home offers exemptions} \end{cases} \tag{41}$$

In practice, these two methods are by far the most widely used relief methods.[44] Note that we are assuming that the home government has the ability to discriminate against foreign-earned profits (since *t* does not apply to domestic capital earnings) and that host has the ability to discriminate between repatriated earnings and those earned by its own investors.[45] Although many countries claim to use non-discriminatory or uniform

[43] In general, intergenerational transfer programs are pay as you go programs in which payroll taxes are used to pay benefits to the old. In our setup, transfers in the host country are *partially* funded by earnings from taxation of capital. Although this deviates from standard practice in most countries, we retain the pay as you go feature in the home country. Moreover, from our perspective, the home economy is older than the host. Consequently, this provides motivation for capital to flow to the host country in our framework.

[44] See Price Waterhouse Coopers (2004) for a detailed list of the relief methods used by various countries. A small number of developing countries use a third method: foreign tax deductions in which $\tau = t + t^* - tt^*$. Given the rare use of deductions, we do not analyze them here for space.

[45] Since taxes on domestic capital cannot be used for intergenerational transfers, the distortions they cause in the capital market would lead governments to set them to zero with the possibility of discrimination. Janeba (1995) and Davies (2003) consider uniform taxation and find that this does limit the size of the tax

taxation, evidence presented by Hines (1988) and Hufbauer (1992) shows that this is rarely true in practice.

*4.1 Exemptions*

We begin to investigate the impact of population aging on international tax policy by studying the case of exemptions. Under exemptions, the home government does not impose any taxes on the earnings from its citizens' capital in the foreign country. Since this implies that the home government does not restrict capital outflows, this would be consistent with a policy supporting the use of FDI to raise retirees' incomes. However, in this setting, there are limits to the aging country's ability to promote capital outflows because the relative effective tax rate is entirely driven by the host country's capital tax rate. Consequently, exemptions provide a useful benchmark for comparison to other relief methods. In particular, the smaller strategy space (compared to credits) renders its analysis to be fairly tractable.

Beginning with the home country, under exemptions transfers are determined by the government's budget constraint: $T = \eta F_L L$. How then does FDI affect the ability of the home government to provide these transfers? To see this, consider how transfers respond to home's only policy instrument, the labor tax rate $\eta$:

$$\frac{dT}{d\eta} = f_L L + \eta L\left(F_{LL}\frac{dL}{d\eta} + F_{KL}\frac{dK}{d\eta}\right) - \eta L F_{KL}\frac{dZ}{d\eta} \tag{42}$$

For a given supply of capital and labor, the higher tax rate allows the government to provide higher transfers to old individuals as indicted by the first term above. However, as emphasized in the social security literature, the higher payroll tax rate exacerbates

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on outbound FDI. However, given the evidence cited above, we feel that the discriminatory case is more

factor market distortions. As an example, since the higher tax rate lowers the amount of employment, it also causes the amount of transfers to fall. In addition, since the decline in employment lowers the domestic return to capital, the stock of capital in the home country will be lower. In turn, this causes transfers to fall since labor productivity falls.

Moreover, the final term above demonstrates that the increase in payroll taxes induces capital flight. Again, this lowers the tax base in the labor market since workers will be less productive. We view this observation to be particularly important in light of recent arguments that support increasing capital outflows to raise retirees' incomes. Although foreign direct investment can provide the old with higher returns from their investments, it can also lower their income since it hampers the ability of the government to raise payroll tax revenues. Consequently, this capital flight effect provides motivation for capital-exporters to restrict outbound FDI in order to minimize the labor market distortion. Interestingly, we will turn to this issue when analyzing the case of foreign tax credits. In particular, in the credit case, home taxes on overseas earnings will act as a restriction on capital flight.

The capital flight effect from higher labor taxes, however, is only part of the total change in old income. We therefore next consider how the labor tax affects old income through earnings from capital, which is given by:

$$-(1-\tau)\Omega^{-1} f_L f_{KL} f^*_{KK} C^*_{KK} E^*_{LL} \left(K + C_{KK} Z\right) + (1-\tau) f^*_K \frac{dZ}{d\eta}. \qquad (43)$$

appropriate.

The first term here is negative and represents the fall in the productivity of capital as the amount of home labor declines. The final term demonstrates that these losses to home capital owners are partially offset because capital can seek overseas labor through FDI.

Given these insights, we ask whether FDI helps alleviate the increasing financial burden from population aging. As suggested by a number of studies, population aging is likely to raise the tax burden imposed on the working population. However, do capital outflows exacerbate the problem? They might. As shown above, capital flight lowers the productivity of the workforce and public transfers. In this manner, FDI leads to less income for old-age individuals. On the other hand, in response to the smaller domestic workforce, FDI allows owners of capital to earn higher returns abroad. The net impact of *FDI* on old-age income is given by:

$$\left((1-\tau) f_K^* - \eta L F_{KL}\right)\frac{dZ}{d\eta}. \tag{44}$$

To the extent that social security taxes add to the natural, demographic-driven decline in labor, FDI is a boon. At the same time, however, the capital flight decreases the tax base generated by the remaining labor, decreasing the effectiveness of social security taxes as a policy instrument.[46] Interestingly, equation (44) demonstrates that the net impact crucially depends on the policies adopted by the *host* government. If the host chooses to encourage capital flows, it will assess a low tax rate on inbound FDI. As a result, FDI may help alleviate the demographic crisis in the home country.

Putting these effects together, the total change in old income is:

[46] One implication that we do not address is that if some old derive their income primarily from government transfers while others derive it more from the return on investment, then FDI will have differential impacts on the income of different groups of the old.

$$\frac{dI}{d\eta} = (1-t^*)\Omega^{-1} f_L \left\{ f_K^* f_{KL} C_{KK} \Delta^* - f_{KK}^* C_{KK}^* E_{LL}^* \left( f_{KL} \left( K + C_{KK} Z \right) + f_{LL} C_{KK} L \right) \right\} + f_L \,. \quad (44)$$

The change in young income is:

$$\frac{dY}{d\eta} = -f_L L \left( 1 + (1-\eta)(1-t^*)\Omega^{-1} f_{KK}^* C_{KK}^* E_{LL}^* f_{LL} C_{KK} \right) < 0 \quad (45)$$

since the second term lies between zero and -1.

We now turn to the effects of policies adopted by the host government. As emphasized in the discussion earlier, taxation imposed in the host country can determine whether FDI alleviates the fiscal burden from aging in the home country. Following the discussion for home, we begin by considering the impact of aging on intergenerational transfers. In this analysis, it is useful to note that Equation (12) can be rewritten so that:

$$C_K = (1-\tau) C_K^* \quad (46)$$

This implies:

$$C_{KK} \frac{dK}{d\eta^*} = (1-\tau) C_{KK}^* \frac{dK^*}{d\eta^*} \quad (47)$$

Consequently, the income of host's old moves with the host labor tax according to:

$$\frac{dI^*}{d\eta^*} = -K^* \Omega^{-1} f_L^* f_{KL}^* f_{KK} C_{KK} E_{LL} C_{KK}^* f_L^* + t^* f_K^* \frac{dZ}{d\eta^*} + \eta^* f_L^* \frac{dL^*}{d\eta^*} - \Omega^{-1} f_L^* f_{KK} C_{KK} E_{LL} C_{KK}^* \left( t^* Z f_{KL}^* + \eta^* L^* f_{LL}^* \right) \quad (48)$$

The first term is negative and represents the fall in capital income as higher labor taxes reduce the amount of host labor supplied. The final three terms reflect the total impact of higher labor taxes on government transfers. This consists of two parts. First, as labor taxes rise, FDI falls, reducing the amount of capital tax revenue provided to the old (the second term in (48)). Second, as the labor tax rises, this impacts the level of

intergenerational transfers (the final two terms). The net effect is naturally ambiguous since as the labor tax rate rises, the labor income tax base shrinks. Finally, the impact of the payroll tax on young income is:

$$\frac{dY^*}{d\eta^*} = -f_L^* L^* - (1-\tau)(1-\eta^*)\Omega^{-1} f_L^* L^* f_{KL}^* C_{KK}^* \left( f_{KK} f_{KL}^* E_{LL} + f_{KL}^* \Delta + (1-\eta) f_{KL} f_{LL}^* C_{KK} \right) < 0 \quad (49)$$

As host labor taxes rise, this reduces the after-tax equilibrium value of host labor income.

Finally, we turn to the effects of host's additional policy instrument – the tax rate applied to inbound FDI. In the host country, capital inflows have the opposite impact on the income of the old. There, inbound FDI decreases the rate of return on capital and increases the return on labor. The impact of the higher tax rate on retirees' income is:

$$\frac{dI^*}{dt^*} = f_K^* Z + t^* f_K^* \frac{dZ}{dt^*} - (K^* + t^* Z)\left(\Omega^{-1} f_K^* f_{KK}^* C_{KK}^* E_{LL}^* \Delta\right) + \eta^* f_L^* \frac{dL^*}{dt^*} - \eta^* L^* \Omega^{-1} f_K^* f_{KL}^* C_{KK}^* E_{LL}^* \Delta$$

(50)

The first two terms partially capture the effect of higher taxes on tax revenues, essentially a tradeoff between the size of the tax base and host's share of that tax base. The rest of this effect is found in the third term which also includes the impact of higher taxes on host-owned capital income. The third term is positive, reflecting that as FDI is driven out, this raises the rate of return on domestic capital, benefiting the old.

The final two terms are negative and represent the total effect on host labor tax revenue from increasing the tax on inbound FDI. Since increasing the tax rate reduces the productivity of host labor along with the supply of host labor, raising the tax on inbound FDI reduces the ability of the host government to raise money for intergenerational transfers through labor market taxation.

Turning to host's young, we find that the effect of the host tax is:

$$\frac{dY^*}{dt^*} = -(1-\eta^*)L^*\Omega^{-1} f_K^* \Delta f_{KL}^* C_{KK}^* E_{LL}^* < 0 \tag{51}$$

i.e. as higher host capital taxes drives out FDI, the income derived from host labor falls.

While the preceding analysis demonstrates the numerous channels which affect employment and foreign direct investment, we conclude the exemptions case by studying the strategic behavior between both governments as in previous work on tax competition. To begin, we assume that the home government seeks to maximize national welfare:

$$W = U(I) + V(Y) \tag{52}$$

where *U* and *V* are increasing, concave functions that satisfy the Inada conditions.[47] Similarly, host national welfare is:

$$W^* = U^*(I^*) + V^*(Y^*) \tag{53}$$

First, home's optimal labor tax is such that:

$$\frac{dW}{d\eta} = U' \frac{dI}{d\eta} + V' \frac{dY}{d\eta} = 0 \tag{54}$$

i.e. home distributes income between the two groups while internalizing whatever factor market distortions this may cause. For the old, their income moves with the labor tax both because this tax affects the amount of transfers and because it affects the income they earn from capital. Plugging these into home's first-order condition, it is then possible to solve for home's optimal labor tax. In what follows, we assume that this optimal tax is positive, consistent with the common practice of implementing such taxes.

[47] An alternative interpretation of this social welfare function is one that is additively separable in the returns to two factors, capital and labor. Thus, our results for tax competition also provide new results on the effect of tax competition in a model in which the tax authority cares about the distribution of income between factors, results that are not obtained in the models with pure national income maximization.

We proceed to analyze the choice of the host's taxes:

$$\frac{dW^*}{d\eta^*} = U^{*\prime}\frac{dI^*}{d\eta^*} + V^{*\prime}\frac{dY^*}{d\eta^*} = 0 \tag{55}$$

and

$$\frac{dW^*}{dt^*} = U^{*\prime}\frac{dI^*}{dt^*} + V^{*\prime}\frac{dY^*}{dt^*} = 0\,. \tag{56}$$

The host capital tax will therefore balance out these various effects, taking into account the relative weights given to the two groups in Equation (53). Denote the best response capital tax rate as $t_e^*(\eta)$.

Combining together the three equilibrium tax equations, one for home and two for host, yields the equilibrium under exemptions. Denote the equilibrium values by $\eta_e$, $\eta_e^*$, and $t_e^*$. Note that since the host will not find it desirable to choke off capital flows, $t_e^* < 1$. Also, it is important to recognize that as the host becomes increasingly reliant on intergenerational transfers as a method of supporting the old (such as would occur if the cost of raising capital were to increase from an increase in $\beta^*$), FDI will become more desirable because it increases the productivity of the host labor force.

The primary lesson is that higher taxes discourage inbound FDI, hindering the ability of the host government to raise income through labor taxes. Therefore, it may even be that the optimal capital tax is non-positive. This differs from standard results in tax models in which the host country is large, i.e. does not face a perfectly elastic capital supply function. Therefore, as host countries age, implying an increase in the need for intergenerational transfers, it may well be the case that taxes on inbound capital will fall,

a result consistent with the results of Slemrod (2004). Furthermore, one might expect an increase in the incentives given to FDI (i.e. $t^* < 0$).

*4.2. Credits*

In this section, we introduce the home capital tax by investigating the use of credits as a tax relief method. In particular, this allows us to draw insights into whether aging is likely to affect the design of international tax relief methods. Under foreign tax credits, the relative effective tax is equal to the greater of the two country's tax rates. This creates two differences in optimal taxation relative to the exemptions case. First, the home capital tax creates a lower bound on the effective tax, whereas in the exemptions case, the host could achieve any effective tax it desired. Second, the home country can influence the effective tax by setting its tax rate above the host's.

We begin by analyzing how these factors affect the host capital tax. For a given pair of home tax rates, host can match home's capital tax without impacting factor supplies since doing so does not alter the effective tax and therefore does not affect factor market equilibria. Matching the home tax does however increase host's capital tax revenue. Therefore, when $t^* < t$,

$$\frac{dW^*}{dt^*} = U^{*\prime} f_K^* Z > 0 \tag{57}$$

implying that host will at least match the home tax.

In contrast, if $t^* \geq t$, the tradeoffs become identical to those host faced in the exemption case. At $t \geq t_e^*(\eta)$, where the exact host capital tax under exemptions depends on the home labor tax under consideration, then host will choose to merely match the home tax. On the other hand, for $t < t_e^*(\eta)$, then host will prefer to increase its tax, and

therefore the effective tax, to the level it would choose under exemptions that corresponds to the home labor tax under consideration. Therefore host's best response capital tax is:

$$t_c^*(t,\eta) = \begin{cases} t_e^*(\eta) & \text{if } t < t_e^*(\eta) \\ t & \text{otherwise.} \end{cases} \tag{58}$$

As for host's labor tax, its tradeoffs are the same as in the exemptions case, although naturally the equilibrium value may well differ depending on the effective tax and the home labor tax.

Turning now to the home country's choice of capital tax, we find that it is similar to that of the host's under exemptions in that it affects the old both through the income derived from capital and through the level of intergenerational transfers. Comparable to host, we assume that all home capital tax revenue is distributed to the old as a lump sum transfer that the old take as given. Although the collection and return of taxes by the home government does not create a transfer as in the host case, if the home government affects the effective tax, this does alter FDI and the income derived from capital. If home chooses a $t \le t^*$, it does not affect the effective tax and therefore has no impact on the equilibrium. It turns out, however, that home will find it desirable to set $t > t^*$ because this both increases capital income and the level of intergenerational transfers.

To see the first of these, recall that in equilibrium, firms choose FDI such that:

$$F_K = (1-\tau)F_K^* . \tag{12}$$

However, the choice of FDI that maximizes home capital income is:

$$F_K = (1-t^*)\left[F_K^* + F_{KK}^* Z\right]. \tag{59}$$

The last term in this equation represents the extent to which the capital-exporting home country influences the rate of return on capital overseas. Individual investors consider themselves small in the host capital market and therefore equate the rate of return at home to the after-tax rate of return overseas. The home government, however, recognizes the cumulative impact of its investors on the overseas rate of return. When home neither encourage nor discourages FDI, i.e. $\tau = t^*$, home investors over export capital relative to the level dictated by (59). Thus, just as a large country can benefit by intervening and increasing the terms of trade price for its exported good, the home country can increase national income by restricting exports of capital.[48]

In addition, the impact of the capital tax on labor tax revenue is:

$$\frac{d\eta F_L L}{d\tau} = \eta\Omega^{-1}F_K^* F_{KL} C_{KK}\Delta^* \left((1-\eta)F_L + E_{LL}L\right) > 0 . \qquad (60)$$

By restricting capital outflows, for a given home labor tax, both domestic labor productivity and employment will be higher. Both raise intergenerational transfers and reduce the need for high home labor taxes. Combining these, we see that at $t = t^* = \tau$,

$$\frac{dI}{dt} = \eta f_L \frac{dL}{d\tau} - (1-\eta)L\left( f_{KL}\frac{dK}{d\tau} + f_{KL}\frac{dZ}{d\tau} + f_{LL}\frac{dL}{d\tau}\right) - \Omega^{-1} f_K^* f_{KK}^* C_{KK}^* E_{LL}^* \Delta > 0 \qquad (61)$$

where the first two terms represent the increase in intergenerational transfers and the third term captures the boost to capital income from exploiting home's terms of trade power in world capital markets. In terms of the income of young workers in the home country, at $t = t^* = \tau$, we observe that:

[48] The strategy, initially identified by Bond and Samuelson (1989), is an extension of the importation of labor argument put forth by Ramaswami (1968). Davies and Gresik (2003) extend this to a many goods, many factors setting and find conditions under which this strategy can still be employed by a capital exporter.

$$\frac{dY}{dt} = C_{KK}(1-\eta)L\Omega^{-1} f_K^* f_{KL} E_{LL} \Delta^* > 0 \tag{62}$$

This demonstrates that restricting capital outflows more than the host tax already does also raises the income of young individuals in the home country.

Notably, higher payroll taxes lead to an intergenerational conflict – as they potentially raise the income of the old by providing them with greater transfers, the higher taxes impose a cost on the working population. In contrast, in the case of credits, imposing a higher tax rate on foreign capital earnings raises the income of both the young and the old. Together, this implies:

$$\left.\frac{dW}{dt}\right|_{t=t^*} > 0 \tag{63}$$

As stated above, it has been suggested that governments should encourage FDI to contend with the aging crisis. However, we find that a capital exporter would prefer to restrict such outflows. This occurs for two reasons. First, a higher effective tax rate allows the home government to exploit its influence in world capital markets which can help fund intergenerational transfers. Moreover, even small capital exporters have incentives to tax outbound capital flows – in order to minimize factor market distortions from aging, governments need to restrict capital flight in order to maintain a productive domestic labor force. This provides the home government with a larger tax base to fund old-age transfer programs. Interestingly, our insights are new to the literature on tax competition where small countries do not have incentives to tax FDI (e.g. Mintz and Tulkins, 1996).

Thus, under credits, home's best response is:

$$t_c(t^*, \eta^*) \geq t^* \tag{64}$$

with equality only when $t^* = 1$, i.e. $Z = 0$ and there is no further impact of raising the effective tax. Combining home and host's best response capital taxes yields the unique Nash equilibrium:

$$t_c = t_c^* = 1 \tag{65}$$

Consequently, in the equilibrium under credits, FDI does not occur. This result is similar to that found by Bond and Samuelson (1989) and Davies and Gresik (2003). However, we demonstrate that the financial burden from increasing population aging leads to stiffer tax competition on the part of the home government.

Floden (2003) also finds that capital outflows will exacerbate the problems that an aging workforce places on its government's obligation to provide benefits. However, he notes that his results "do not provide an argument for [aging] European countries to actually restrict capital mobility (pg. 11)". This is a result of his small country assumption. By way of contrast, we allow for endogenous factor prices and show that for the capital exporter, the desire to reduce outflows due to budgetary reasons is bolstered by incentives to manipulate international factor prices.

As for home's labor tax, its tradeoffs remain the same as those in the exemption case, although the factor market equilibria differs considerably. To calculate this equilibrium value, as well as that for host, one would simply set $Z = 0$ and $\tau = 1$ in the appropriate first-order conditions from the exemption case and solve for these taxes.

At this juncture, we would like to make some remarks about the links between population aging, foreign direct investment, and the design and incidence of international tax relief methods. We begin with the host country. Under exemptions, the host would not seek to completely cut off capital flows. Since FDI does not take place under credits,

host retirees' incomes from capital will be lower. *As a result, the credit relief method unambiguously hurts the host country's ability to provide for its elderly*.

Moreover, as mentioned, the results under exemptions provide an explanation for recently declining corporate tax rates pointed out by Slemrod (2004). As host countries encounter increasing population aging, there will be a greater need to fund intergenerational transfers. If countries lower the tax rate on inbound capital flows, the productivity of the domestic workforce will improve. This allows the government to fund higher levels of transfers without increasing the tax burden on the working population.

Similarly, although home would prefer to restrict its capital outflows relative to those in the exemption equilibrium, it would not unilaterally eliminate outbound FDI. Therefore for it too credits are less preferable than exemptions. However, this does not in itself imply that credits hinder home's ability to provide for its old since the lower capital income under credits may be offset by the relative ease of imposing higher payroll taxes, raising the income of home's old. What remains true, however, is that any such benefits to the old come at such costs to the young that national welfare falls. Because of these difficulties created by mobile capital and the conflict across countries as they attempt to provide intergenerational transfers, we conclude that there will be a greater need for policy coordination across countries to contend with the aging crisis.

## 5. Conclusions

Concerns over the sustainability of pay-as-you-go social security programs in the face of aging populations are long-standing, with Pellechio (1979) providing just one early example. Among the various methods that have been proposed for dealing with the

fiscal implications of this demographic shift has been the promotion of FDI. In an endogenous model of factor supplies and factor prices, we find that FDI should naturally be expected to react to these changes and that – particularly among the developed countries – FDI does indeed appear to respond as our theory predicts. We then extend our analysis to ask whether in such a setting outbound FDI is likely to be encouraged by the capital exporter. We find that the result is much the opposite. Because aging places increasing demands on raising intergenerational transfers through labor income taxation, restricting FDI and thereby increasing domestic labor income seems to be a capital exporter's preferred strategy. In the tax competition game under credits, this reinforces the previously recognized forces that drive FDI to inefficiently low equilibrium levels.

One interesting comparison involves immigration as an alternative to promoting outbound FDI. Storesletten (2000) constructs a calibrated general equilibrium model with overlapping generations to examine this possibility. In particular, the author finds that allowing immigration of medium and high-skilled workers may indeed resolve many of the problems of aging in the United States. Although these workers do not bring additional physical capital, the increase in productivity they bring outweighs any adverse effects of higher interest rates (and therefore capital available for public debt). Consequently, Storesletten calculates that the immediate gains outweigh the future costs of pension benefits to these immigrants.

Interestingly, in our tractable framework based upon constant returns to scale in production, perfect competition, and identical technologies (as is standard in the Hecksher-Ohlin tradition of trade theory), immigration and FDI work in the same fashion. There is, however, a key difference – inbound labor represents an increase in the tax base

for intergenerational transfers. Rather than FDI, suppose there is a small immigration of young foreign workers (who are by definition more productive than the average worker since the old do not work). This immigration increases labor income in home, increasing the level of intergenerational transfers without needing to increase the home labor tax. In addition, the boost in labor supply increases home's domestic capital income which is host-tax free. Thus, allowing immigration instead of FDI provides many of the benefits to home that outbound FDI achieves. In this manner, our results also suggest that aging capital exporters may well find it desirable to import labor. According to Jackson (2002), such policies are already under consideration by aging economies such as Japan and Germany. Nevertheless, Helliwell (2004) casts doubt on whether these international factor movements alone will be enough to overcome the fiscal crises.

An important caveat to our analysis is that technology is constant in our model. One of the attractive features of FDI is that it promotes technological diffusion and may increase the growth rate of productivity. Although the magnitude of such spillovers is still open to debate, evidence for them has been found in both inbound and outbound FDI (see Blomström and Kokko (1998) for a survey of this literature). Of particular interest here are the results of Braconier and Ekholm (2000) who find that more FDI by Swedish multinationals in high-wage countries tends to boost wages in Sweden. Thus, if allowing outbound investment spurs productivity of domestic workers, this may partially counter the factor price and revenue effects noted above. In any case, the challenges posed by the aging of the world's population clearly warrant continued research and we hope that this paper begins a debate on the role of foreign direct investment in resolving the crisis.

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**Table 1: OLS Results for U.S. FDI**

| | All | Inbound | Outbound | All | Inbound | Outbound |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| hm_DEPENDENCY | -0.516*** | -0.646*** | | -0.070 | -0.270 | |
| | (3.35) | (4.02) | | (0.20) | (0.81) | |
| ht_DEPENDENCY | -0.381** | | -0.146 | 0.304 | | 0.369 |
| | (2.49) | | (0.97) | (0.82) | | (0.77) |
| hm_INVEST | 0.080 | 0.214 | | -0.303 | -0.288 | |
| | (0.37) | (1.00) | | (1.46) | (1.47) | |
| ht_INVEST | 0.100 | | -0.505** | 0.119 | | -0.110 |
| | (0.52) | | (2.54) | (0.49) | | (0.50) |
| hm_GDP | 1.132*** | 1.122*** | | -0.273 | 1.032 | |
| | (20.19) | (18.38) | | (0.38) | (1.25) | |
| ht_GDP | 0.663*** | | 0.678*** | -0.579 | | -1.926*** |
| | (8.71) | | (9.36) | (0.80) | | (3.26) |
| hm_SKILL | 2.032*** | 1.672*** | | 3.059*** | 2.240** | |
| | (12.84) | (10.00) | | (3.85) | (2.36) | |
| ht_SKILL | 0.459** | | 1.025*** | 1.560* | | 2.709*** |
| | (2.34) | | (4.65) | (1.92) | | (3.22) |
| hm_TCOST | -0.344*** | -0.316** | | -1.388*** | -0.553 | |
| | (2.60) | (2.33) | | (3.95) | (1.55) | |
| ht_TCOST | -0.047 | | -0.027 | -1.143*** | | -2.508*** |
| | (0.27) | | (0.18) | (3.14) | | (7.15) |
| ht_ICOST | -2.280*** | | -3.935*** | -0.063 | | -0.830 |
| | (3.51) | | (5.95) | (0.13) | | (1.47) |
| FX | 0.019 | -0.100*** | 0.068*** | 0.001 | 0.009 | -0.008 |
| | (1.28) | (3.77) | (4.69) | (0.06) | (0.11) | (0.63) |
| DISTANCE | -0.516*** | -0.478*** | -0.594*** | | | |
| | (7.66) | (4.59) | (8.10) | | | |
| TREND | -0.042*** | 0.014 | 0.008 | -0.073** | 0.010 | -0.007 |
| | (2.63) | (0.90) | (0.57) | (2.16) | (0.58) | (0.55) |
| RICH | 1.608*** | 2.541*** | -0.331** | | | |
| | (11.45) | (13.78) | (2.16) | | | |
| Constant | -62.547*** | -30.176*** | -22.701*** | -26.637 | -35.645*** | 9.658 |
| | (19.29) | (14.71) | (12.30) | (1.56) | (4.15) | (1.52) |
| Observations | 1462 | 815 | 647 | 1462 | 815 | 647 |
| R-squared | 0.78 | 0.79 | 0.59 | 0.92 | 0.96 | 0.95 |
| Fixed Effects | | | | Yes | Yes | Yes |

Robust t-statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.
hm=home; ht=host.

**Table 2: OLS Results for U.S. FDI**

| | All | Inbound | Outbound | All | Inbound | Outbound |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| hm_DEPENDENCY | -1.257*** | -1.255*** | | -0.481 | 0.068 | |
| | (7.55) | (7.18) | | (1.31) | (0.11) | |
| ht_DEPENDENCY | 0.126 | | 0.269*** | 0.522 | | -0.374*** |
| | (1.26) | | (2.75) | (1.44) | | (2.74) |
| hm_SS | -0.372*** | -0.274*** | | -0.048 | 0.097 | |
| | (4.36) | (3.34) | | (0.56) | (1.09) | |
| ht_SS | -0.173*** | | -0.301*** | 0.119** | | -0.007 |
| | (2.74) | | (4.53) | (1.97) | | (0.23) |
| hm_NSAVING | -1.026*** | -0.770** | | -0.146 | -0.476* | |
| | (3.00) | (2.19) | | (0.54) | (1.83) | |
| ht_NSAVING | -1.211*** | | -0.967*** | -0.566** | | -0.147 |
| | (4.98) | | (4.25) | (2.42) | | (1.47) |
| hm_INVEST | -1.546*** | -0.969*** | | -0.512 | -0.149 | |
| | (5.02) | (2.67) | | (1.40) | (0.52) | |
| ht_INVEST | 0.199 | | -0.438* | 1.043*** | | 0.535*** |
| | (0.79) | | (1.67) | (3.17) | | (3.04) |
| hm_GDP | 1.447*** | 1.387*** | | -1.209 | 0.196 | |
| | (22.52) | (19.67) | | (1.30) | (0.15) | |
| ht_GDP | 0.922*** | | 0.957*** | -1.622* | | -2.227*** |
| | (12.58) | | (16.46) | (1.69) | | (3.78) |
| hm_SKILL | 4.001*** | 3.178*** | | 4.361*** | 3.052** | |
| | (15.98) | (10.43) | | (3.91) | (2.03) | |
| ht_SKILL | 0.150 | | 0.835*** | 1.526 | | 3.491*** |
| | (0.62) | | (3.21) | (1.35) | | (4.46) |
| hm_TCOST | -1.228*** | -1.032*** | | -1.682*** | -0.710 | |
| | (6.60) | (5.13) | | (2.67) | (1.30) | |
| ht_TCOST | -0.069 | | -0.202 | -0.679 | | -1.315*** |
| | (0.33) | | (1.05) | (1.09) | | (5.02) |
| ht_ICOST | -3.827*** | | -4.634*** | -1.192** | | 1.119** |
| | (6.88) | | (8.40) | (2.36) | | (2.37) |
| FX | 0.049*** | -0.137*** | 0.120*** | 0.004 | -0.129 | -0.010 |
| | (2.73) | (4.50) | (6.15) | (0.32) | (1.37) | (0.94) |
| DISTANCE | -0.662*** | -0.553*** | -0.702*** | | | |
| | (7.98) | (3.81) | (10.20) | | | |
| TREND | -0.113*** | -0.027 | -0.004 | -0.039 | 0.008 | 0.022** |
| | (5.67) | (1.44) | (0.24) | (0.84) | (0.33) | (2.13) |
| RICH | 0.499*** | 1.327*** | -0.743*** | | | |
| | (2.71) | (4.88) | (3.74) | | | |
| Constant | -83.981*** | -44.340*** | -23.273*** | -2.853 | -26.272** | 16.621*** |
| | (19.17) | (12.95) | (11.35) | (0.14) | (1.97) | (2.66) |
| Observations | 974 | 491 | 483 | 974 | 491 | 483 |
| R-squared | 0.78 | 0.81 | 0.67 | 0.92 | 0.97 | 0.98 |
| Fixed Effects | | | | Yes | Yes | Yes |

Robust t-statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.
hm=home; ht=host.

**Table 3: 1998 Dependency Ratios**

| Country | Dependency Ratio | | Dependency Ratio |
|---|---|---|---|
| Jordan | 4.9 | Argentina | 15.4 |
| Bangladesh | 5.4 | Netherlands | 15.8 |
| Korea, Rep. | 5.5 | Barbados | 15.9 |
| Morocco | 6.4 | Israel | 15.9 |
| Guatemala | 6.6 | Luxembourg | 16.4 |
| South Africa | 6.6 | Ireland | 17.1 |
| Malaysia | 6.7 | Russian Federation | 17.7 |
| Indonesia | 6.9 | Iceland | 17.9 |
| Iran, Islamic Rep. | 6.9 | Australia | 18.1 |
| Peru | 6.9 | Canada | 18.2 |
| Egypt, Arab Rep. | 7 | Romania | 18.8 |
| Colombia | 7.5 | Slovenia | 18.9 |
| Brazil | 7.6 | Poland | 19.1 |
| El Salvador | 7.7 | USA | 19.3 |
| Venezuela, RB | 7.7 | Finland | 21.8 |
| India | 7.9 | United Kingdom | 22.2 |
| Thailand | 7.9 | Switzerland | 22.3 |
| Turkey | 8.2 | Denmark | 22.4 |
| Yemen, Rep. | 8.8 | Austria | 22.7 |
| Trinidad and Tobago | 9 | Germany | 23.1 |
| Ukraine | 9.1 | Japan | 23.4 |
| China | 9.8 | Spain | 23.8 |
| Chile | 10.7 | France | 24 |
| Kazakhstan | 10.9 | Belgium | 24.6 |
| New Zealand | 11.3 | Italy | 25.8 |
| Jamaica | 11.7 | Sweden | 27.2 |
| Norway | 12.3 | | |
| Uruguay | 13.9 | | |
| Hong Kong, China | 14.7 | | |

**Table 4: OLS Results for US FDI with Rich Countries**

| | All | Inbound | Outbound | All | Inbound | Outbound |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| hm_DEPENDENCY | 0.005 | 0.048 | | 0.859** | 1.615*** | |
| | (0.05) | (0.54) | | (2.58) | (7.30) | |
| ht_DEPENDENCY | -0.275*** | | -0.097* | 0.477 | | -0.061 |
| | (3.26) | | (1.70) | (1.44) | | (0.53) |
| hm_SS | 0.200** | 0.284*** | | 0.076 | 0.115 | |
| | (2.17) | (4.21) | | (0.83) | (1.37) | |
| ht_SS | -0.143*** | | -0.010 | -0.031 | | -0.111*** |
| | (3.25) | | (0.30) | (0.48) | | (5.68) |
| hm_NSAVING | 1.481*** | 1.239*** | | 0.527 | -0.447* | |
| | (2.99) | (2.81) | | (1.59) | (1.67) | |
| ht_NSAVING | -1.293*** | | 0.377 | -0.860*** | | -0.274** |
| | (3.47) | | (1.55) | (2.72) | | (2.36) |
| hm_INVEST | -2.474*** | -2.535*** | | -0.811*** | -0.328 | |
| | (7.16) | (7.07) | | (2.62) | (0.90) | |
| ht_INVEST | -0.075 | | 0.493** | 1.016*** | | 0.451*** |
| | (0.22) | | (2.15) | (3.41) | | (3.21) |
| hm_GDP | 1.287*** | 1.271*** | | -4.563*** | -6.211*** | |
| | (13.37) | (15.85) | | (3.55) | (3.21) | |
| ht_GDP | 1.297*** | | 1.378*** | -4.517*** | | -1.452* |
| | (23.21) | | (35.37) | (3.52) | | (1.88) |
| hm_SKILL | 2.137*** | 2.922*** | | 5.729*** | 7.335*** | |
| | (6.72) | (8.45) | | (4.78) | (3.96) | |
| ht_SKILL | -0.040 | | -0.328 | 4.719*** | | 1.955** |
| | (0.11) | | (1.28) | (4.00) | | (2.57) |
| hm_TCOST | -1.190*** | -0.602*** | | -0.294 | 0.233 | |
| | (4.74) | (2.87) | | (0.76) | (0.42) | |
| ht_TCOST | -1.258*** | | -1.499*** | -0.407 | | -1.432*** |
| | (8.30) | | (13.74) | (1.01) | | (6.74) |
| ht_ICOST | -4.095*** | | -0.852* | -0.095 | | -0.619** |
| | (8.82) | | (1.93) | (0.22) | | (2.50) |
| FX | -0.179*** | -0.402*** | 0.098*** | -0.114*** | -0.118 | 0.291*** |
| | (8.95) | (19.37) | (4.70) | (9.76) | (0.62) | (4.54) |
| DISTANCE | -0.563*** | -0.097 | -0.437*** | | | |
| | (11.52) | (1.57) | (9.08) | | | |
| TREND | -0.099*** | -0.008 | -0.006 | 0.075* | 0.083*** | 0.009 |
| | (5.40) | (0.50) | (0.70) | (1.89) | (3.64) | (1.09) |
| Constant | -79.052*** | -41.969*** | -21.935*** | 95.155*** | 63.295*** | 11.308 |
| | (15.68) | (12.13) | (13.22) | (2.89) | (3.11) | (1.33) |
| Observations | 474 | 229 | 245 | 474 | 229 | 245 |
| R-squared | 0.84 | 0.88 | 0.93 | 0.95 | 0.98 | 0.99 |
| Fixed Effects | | | | Yes | Yes | Yes |

Robust t-statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.
hm=home; ht=host.

**Table 5: OLS Results for US FDI with Poor Countries**

| | All | Inbound | Outbound | All | Inbound | Outbound |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| hm_DEPENDENCY | -1.636*** | -1.763*** | | -1.216* | -1.623** | |
| | (6.56) | (7.36) | | (1.94) | (2.53) | |
| ht_DEPENDENCY | 0.526*** | | 0.480*** | 0.890 | | -0.974** |
| | (3.12) | | (2.92) | (1.46) | | (2.54) |
| hm_SS | -0.695*** | -0.626*** | | 0.194 | 0.043 | |
| | (4.79) | (4.45) | | (1.01) | (0.19) | |
| ht_SS | -0.578*** | | -0.570*** | 0.328** | | -0.091 |
| | (4.65) | | (4.60) | (2.34) | | (0.93) |
| hm_NSAVING | -1.614*** | -1.321*** | | -0.511* | -0.528* | |
| | (3.66) | (3.21) | | (1.69) | (1.72) | |
| ht_NSAVING | -0.918*** | | -1.249*** | -0.026 | | -0.208* |
| | (3.06) | | (3.67) | (0.11) | | (1.72) |
| hm_INVEST | -1.396*** | -1.103** | | -0.652 | -0.256 | |
| | (3.26) | (2.43) | | (1.48) | (0.74) | |
| ht_INVEST | -0.076 | | -0.409 | 0.569 | | 0.652*** |
| | (0.22) | | (1.07) | (1.45) | | (2.82) |
| hm_GDP | 1.302*** | 1.306*** | | 0.521 | 0.209 | |
| | (11.50) | (9.31) | | (0.36) | (0.12) | |
| ht_GDP | 0.377** | | 0.772*** | -0.571 | | -3.551*** |
| | (2.29) | | (4.75) | (0.39) | | (3.70) |
| hm_SKILL | 4.442*** | 4.035*** | | 2.745 | 3.410* | |
| | (13.03) | (11.25) | | (1.55) | (1.69) | |
| ht_SKILL | 0.773* | | 0.727* | -0.656 | | 4.979*** |
| | (1.92) | | (1.72) | (0.35) | | (3.71) |
| hm_TCOST | -0.573* | -0.769** | | -2.349*** | -0.954 | |
| | (1.68) | (2.13) | | (3.29) | (1.53) | |
| ht_TCOST | 0.473 | | 0.031 | -0.998 | | -1.176*** |
| | (1.29) | | (0.08) | (1.38) | | (3.57) |
| ht_ICOST | -4.906*** | | -6.784*** | -5.237*** | | 2.543*** |
| | (6.75) | | (8.25) | (5.55) | | (3.26) |
| FX | 0.120*** | -0.063 | 0.185*** | 0.064*** | -0.176 | -0.001 |
| | (4.75) | (1.29) | (5.19) | (4.14) | (1.50) | (0.06) |
| DISTANCE | -1.016*** | -1.144*** | -1.426*** | | | |
| | (4.63) | (3.41) | (3.74) | | | |
| TREND | -0.057* | -0.007 | 0.038 | -0.077 | 0.025 | 0.071*** |
| | (1.74) | (0.23) | (1.37) | (1.09) | (0.50) | (2.72) |
| Constant | -72.378*** | -42.288*** | -17.652*** | -45.941 | -34.766** | 33.114*** |
| | (11.41) | (9.39) | (5.82) | (1.46) | (1.98) | (3.13) |
| Observations | 500 | 262 | 238 | 500 | 262 | 238 |
| R-squared | 0.70 | 0.61 | 0.52 | 0.90 | 0.92 | 0.96 |
| Fixed Effects | | | | Yes | Yes | Yes |

Robust t-statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.
hm=home; ht=host.

**Data Appendix**

Table A1: Countries in Sample

| | | | | |
|---|---|---|---|---|
| Argentina | Austria* | Bahrain | Barbados | Belgium* |
| Belize | Brazil | Bulgaria | Canada* | Chile |
| Colombia | Costa Rica | Cyprus | Czech Republic | Denmark* |
| Dominican Republic | Egypt | El Salvador | Finland* | France* |
| Germany* | Greece* | Haiti | Hungary | Iceland |
| Indonesia | Iran | Ireland* | Israel | Italy* |
| Jamaica | Japan* | Kazakhstan | Korea, Rep. | Luxembourg* |
| Malaysia | Morocco | Netherlands* | Norway* | Peru |
| Poland | Portugal | Romania | Russian Federation | Slovak Republic |
| Slovenia | South Africa* | Spain | Sweden* | Switzerland* |
| Thailand | Trinidad and Tobago | United Kingdom* | Uruguay | Venezuela |

* Designates "rich" country.

Table A2: Summary Statistics

| Variable | Obs | Mean | StdDev. | Min | Max |
|---|---|---|---|---|---|
| rsales | 974 | 8.018266 | 3.127511 | 0 | 12.81306 |
| hm_DEPEND | 974 | -1.886473 | .476284 | -3.945959 | -1.285129 |
| ht_DEPEND | 974 | -1.885472 | .4848221 | -3.945959 | -1.285129 |
| hm_SS | 974 | 5.60079 | .9815657 | .4990857 | 7.09223 |
| ht_SS | 974 | 5.582027 | 1.004756 | .4992171 | 7.033479 |
| hm_NSAVING | 974 | 2.922749 | .2383355 | .8527774 | 3.67128 |
| ht_NSAVING | 974 | 2.930462 | .2388065 | .8527774 | 3.67128 |
| hm_INVEST | 974 | 2.978351 | .2772368 | 1.420696 | 3.729301 |
| ht_INVEST | 974 | 2.998218 | .2710202 | 1.421551 | 3.729302 |
| hm_GDP | 974 | 20.71473 | 2.116007 | 13.50381 | 22.85291 |
| ht_GDP | 974 | 20.9542 | 1.823801 | 17.39531 | 22.85291 |
| hm_SKILL | 974 | 9.729492 | .6447428 | 6.849034 | 10.54315 |
| ht_SKILL | 974 | 9.755236 | .6202961 | 7.862764 | 10.34466 |
| hm_TCOST | 974 | -3.523585 | .6381226 | -5.390213 | -2.623218 |
| ht_TCOST | 974 | -3.46925 | .609518 | -5.218287 | -2.314134 |
| ht_ICOST | 974 | -4.105966 | .2168483 | -4.414816 | -3.3889 |
| FX | 974 | .3088777 | 3.950176 | -9.211701 | 22.28391 |
| DISTANCE | 974 | 8.330199 | .5415427 | 6.120297 | 9.226509 |
| TREND | 974 | 10.84908 | 4.433686 | 3 | 18 |
| RICH | 974 | .486653 | .5000786 | 0 | 1 |