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The Impact of Financial Openness on the Size of Utility-enhancing Government

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Abstract
In this paper, we employ a portfolio approach based on a two-country world to study the impact of financial openness on the size of government and on other key economic variables, including the consumption-wealth ratio, the growth rate of wealth, and welfare (assuming that public spending is utility enhancing). The model suggests that the size of government, the consumption-wealth ratio, and welfare should be greater in an open economy because of higher productivity and/or less volatility because of risk sharing. The theoretical results for the growth rate depend on differences in productivity and in consumption-wealth ratios. The empirical evidence — based on a sample of 49 countries from 1970 to 2009—broadly supports the main theoretical results of the model.

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Keywords Financial openness, productivity, volatility, consumption-wealth ratio, growth, welfare, size of government

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1 Introduction

The current economic and financial crisis has reignited fundamental concerns about financial integration. As Aizenman et. al. (2013: 372) note, "the relationship between financial openness and economic growth is the subject of heated controversy. In contrast to the largely positive perception of trade integration, economists differ sharply about the effect of financial integration on growth." These doubts apply equally to the impact of financial openness on the size of government in the global economy. In his oft-cited seminal paper Rodrik (1998) wondered why economies that are more open have bigger governments. In his own words, "government expenditures are used to provide social insurance against external risk" (Rodrik, 1998: 997).[1] Recent evidence confirms that the positive association between trade openness and government size is robust across countries and over time for a large dataset of 143 countries from 1950 to 2000 (Epifani and Gancia, 2009), although other studies have cast doubts on the robustness of the original results.[2] However, the recent tremendous change in the magnitude of cross-border holdings of both assets and liabilities[3] has rarely been examined in terms of its consequences for the size of government.

Instead, previous studies have focused on the relationship between financial openness and economic performance, and international risk sharing has played a predominant role in such analyses. In a key reference, Obstfeld (1994: 1327) found that "the mechanism linking global diversification to growth is the attendant world portfolio shift from safe, but low-yield, capital into riskier, high-yield capital", which has led to greater welfare. Greenwood and Jovanovic (1990) analyzed how financial intermediation can also help collect information to evaluate projects and thus allocate savings more efficiently: risky and high-yield capital generates higher growth. Bencivenga and Smith (1991) studied how financial intermediaries increase productivity when funds are directed to illiquid and high-yield technology, which promotes higher growth. Risk sharing through the stock market also induce producers to specialize, which raises productivity and growth (when external effects

[1] The pioneering work on the "compensation hypothesis" (as it is now known) goes back at least to Cameron (1978).

[2] Liberati (2007) and Epifani and Gancia (2009) provide quality reviews of the literature.

[3] See Lane and Milesi-Ferretti (2007).

are considered) (Saint-Paul, 1992). Levine (1991) found that risk sharing via the stock market encourages investing in less liquid and higher-yielding investments, which increases productivity and growth. However, Devereux and Smith (1994) determined that integrating financial markets internationally might promote or reduce growth and welfare, depending on the external effects on human capital.[4] Pagano (1993) crafted a high-quality survey of these issues.

The literature on the relationship between openness and the size of government suggests that openness may be associated theoretically with a larger or smaller public sector.[5] According to the compensation hypothesis, economies that are more open have larger public sectors to compensate for higher external risk.[6] In contrast, the efficiency hypothesis (or conventional wisdom) posits that economies that are more open are associated with a smaller public sector because of an increased mobility of inputs and tax competition.[7] However, the theoretical analyses have usually been restricted to trade openness, whereas the impact of financial openness on the size of government has received little attention in the theoretical literature.[8] In addition, Liberati (2007: 218–219) concluded that "as it stands, [...] the empirical literature on the relationship between capital openness and government size is not

[4] See also Devereux and Saito (1997) when international assets markets are incomplete.

[5] See Liberati (2007) and Schulze and Ursprung, for instance (1999). Tridimas and Winer (2005) offered a recent survey on the vast literature about the determinants of the size of government. Other interesting issues related to the size of government have been presented, such as why it is measured in terms of spending rather than taxes, and why spending refers to the central government rather than to the government in general (Liberati, 2007: 220).

[6] Alesina and Wacziarg (1998) showed that the link between the size of the public sector and openness may be explained, in the alternative, on the grounds that a larger public sector is associated with small economies because of the economies of scale involved in the provision of public goods and that small economies are usually more open to trade, such that country size is the variable that can account for the positive relationship between the size of the public sector and openness to trade. Recent research by Ram (2009) has suggested, however, that country size cannot explain the positive relationship between openness and the size of government for a sample of 150 countries over 41 years. We address this issue by controlling for country size below.

[7] However, recent research by Koethenbuerger and Lockwood (2010) has shown that economies that are more open (that suffer more tax competition) may be associated with bigger governments because setting higher capital tax rates in the domestic economy may not create a greater amount of capital outflow if countries want to hold a well-diversified portfolio.

[8] An important exception is Turnovsky (1999), as we note later.

conclusive, as different studies support a positive relation, the absence of any relation or a negative relation". In fact, Liberati (2007: 216) has shown that capital openness and the size of government "are persistently negatively associated", and the positive association between trade openness and the size of government is "hardly justified" in a sample of 20 developed countries from 1967 to 2003. Recent research by Kimakova (2009), however, has found a positive association between financial and trade openness, and the size of government for a larger sample of 87 countries from 1976 to 2003. As a result, the empirical evidence suggests that the relationship between financial openness and government size is far from settled.

Some caution is required when referring to the size of government. Government spending encompasses different forms of expenditures, such as government consumption, productive spending, public transfers, etc. In a pioneering work, Barro (1990) found that when public spending is productive and not subject to congestion, the optimal size of government is equal to the share of government spending on the production function. If government spending is utility enhancing then the ratio of public consumption to private consumption would equal their relative elasticity.[9] Addressing how financial openness affects the size of government seems to suggest that the manner in which financial portfolio choices are made should be analyzed explicitly. However, until this point, a portfolio-choice approach has only rarely been used to study the impact of financial openness on government size.

In a key theoretical contribution, Turnovsky (1999) found that a small open economy is associated with a bigger government if and only if it is a net creditor nation, when government spending is either utility enhancing or productive and volatility enhancing, because a stochastically growing open economy is able to export some of its domestic risk. However, although Turnovsky´s theoretical finding was related to the empirical studies on government size and openness by Rodrik (1998) and Alesina and Wacziarg (1998) it importantly referred to the relationship between the net foreign asset position of a country and the size of its government. Recent work by Erauskin (2011) found that economies with a higher degree of financial openness are associated both theoretically and empirically with a smaller size of productive government in a stochastic small open economy when

[9] See also Turnovsky (1996).

productive spending is also volatility reducing:[10] the lower risk associated with economies that more open (through risk diversification) implies that government is less inclined to increase the scale of its activities. Therefore, it is evident that the definition of public spending leads unsurprisingly to different results for the optimal size of government. More precisely, because the bulk of public spending is on goods that, broadly speaking, contribute to household welfare via the utility function (such as education, health care, defense, and public order),[11] how should the optimal size of government be characterized in the global economy?

In this paper, we depart from the work of Turnovsky (1999) by seeking to address both gaps, i.e., the absence of a convenient theoretical framework to explicitly analyze the impact of financial openness on the size of a utility-enhancing government in a two-country world economy, and the absence of a coherent analysis of the empirical evidence based on the model proposed in the paper.

In this paper, we offer two main contributions. First, we build a full-fledged model that studies the impact of financial openness on the size of utility-enhancing government in a two-country world based on a portfolio approach, and it thus extends the scope of previous studies. In this paper, we also analyze the impact of financial openness on other key related economic variables, such as the consumption-wealth ratio, the growth rate of wealth, and welfare. The framework employed is a general equilibrium model in continuous time with perfect capital mobility, in which public spending enhances utility, based on Turnovsky [1997, Ch. 11; 1999]. Financial openness offers a wider choice of portfolios: thus it offers room for higher productivity. Financial integration also allows an open economy to diversify some of its country-specific risk and achieves less volatility,[12] which implies a reduction in savings and an increase in private consumption. This combined effect suggests that the consumption-wealth ratio should be higher in an

[10] As Andrés, Doménech, and Fatás (2008: 571) recently noted, "There is substantial evidence that countries or regions with large governments display less volatile economies, as shown in Galí (1994) and Fatás and Mihov (2001)."

[11] Of course, public spending can also be productive, but we will not address that matter for purposes of simplicity.

[12] See Doyle and Faust (2005) and Kose et al. (2006).

open economy. The complementarity between public and private consumption[13] indicates that financial openness is associated with a larger public sector. Welfare should also be higher in an open economy. The theoretical results for growth rates depend on differences in productivity and in consumption-wealth ratios among countries. Second, we test the main predictions of the model, and find that they are broadly supported by the empirical evidence based on a sample of 49 countries (22 industrial and 27 developing countries) from 1970 to 2009.

The model employed in this paper contains an additional feature that represents an important difference from previous studies and is related to how financial openness is measured in this paper: it is conveniently characterized by the size of the portfolio share with respect to domestic wealth. We measure financial openness narrowly as the holdings of foreign capital (direct plus portfolio investment) owned by the domestic economy over domestic wealth. To check the robustness of the relationship we also extend how financial openness is measured. The degree of financial integration is also measured more broadly as the holdings of foreign capital (direct plus portfolio investment) owned by the domestic economy plus the holdings of capital (direct plus portfolio investment) by the foreign economy over domestic wealth. In addition, the degree of financial integration is measured in its broadest terms as the share of the holdings of foreign capital (direct plus portfolio investment) and loans owned by the domestic economy plus the holdings of capital (direct plus portfolio investment) and loans by the foreign economy over domestic wealth. Government size is also expressed as a fraction of wealth. Thus the manner in which the degree of financial openness and the size of government are measured differs from the methods typically employed in the literature. Previous studies have typically chosen the sum of all or part of domestic assets and liabilities with respect to other countries over GDP.[14] There are two reasons for our decision. First, measuring financial openness and the size of government in this manner is a direct implication of the model employed in this paper. In addition, the recent availability of data on international investment positions allows for the direct testing of the

[13] The empirical evidence suggests that private consumption responds positively to fiscal shocks (Blanchard and Perotti, 2002), which is explained by the complementarity between public and private consumption: an increase in public consumption raises the marginal utility of private consumption (Ganelli and Tervala, 2009).

[14] See Lane and Milesi-Ferretti (2007), for instance.

variables suggested by the model (the degree of financial openness, the size of government, etc.).[15] Moreover, we have determined that there is a positive and robust relationship between the measures proposed in this paper and the variables commonly used in the literature.

Some limitations of this study deserve discussion. The economy is a real one, i.e., there are no nominal assets such as money, different financial assets, etc. The model abstracts from the analysis of the impact of nominal shocks on the real economy for reasons of tractability.[16] Additionally, this research does not investigate how volatility in international capital flows affects the real economy. The volatility of flows seems to have fallen substantially with the huge increase in international capital flows, presumably because of the increased cross-border integration of financial markets (Evans and Hnatkovska, 2012), although volatility is an important factor associated with long-term growth, as shown by recent evidence (Mody and Murshid, 2011).

This paper proceeds as follows. In Section 2 the macroeconomic equilibrium is characterized. The welfare-maximizing size of the public sector is derived in Section 3, in which we also discuss whether economies that are more open should have a larger public sector. Section 4 reviews different measures of financial openness and offers an overview of the data sources. Section 5 provides the empirical evidence for the model. Finally, Section 6 concludes.

2 The World Economy

2.1 Basic Structure

The world economy consists of two countries, and each produces only one homogeneous good. In each country there is a representative agent and a public sector, and both have an infinite time horizon. This economy is real, i.e., there are no nominal assets such as money, different financial assets, etc. Unstarred variables refer to

[15] The data are mainly provided by the International Monetary Fund and Lane and Milesi-Ferretti (2007), as shown below.

[16] As Obstfeld and Rogoff (1996: 605) have noted, "one of the most difficult tasks in international macroeconomics is building a bridge between the real economy and its monetary side".

the domestic economy, whereas starred variables refer to the foreign economy. This model focuses on the domestic economy because the results for the foreign economy are similar.

The homogeneous good produced by both countries can be either consumed or invested in capital without having to incur any type of adjustment costs. We assume that domestic production can be obtained using only domestic capital, K, through an AK function, and that it can be expressed through a first-order stochastic differential equation, such that production flow dY (the variation of the state variable) is not completely determined, but is instead subject to a stochastic disturbance:

$$dY = \alpha K dt + \alpha K dy, \tag{1}$$

where $\alpha > 0$ is the (constant) marginal physical product of capital, and dy represents a proportional domestic productivity shock. More precisely, dy is the increment of a stochastic process y. Those increments are temporally independent and are normally distributed, and they satisfy $E(dy) = 0$ and $E(dy^2) = \sigma_y^2 dt$. We omit, for convenience, formal references to time, although those variables do depend on time. We must note that dY indicates the flow of production, instead of Y, as in ordinary stochastic calculus.

The foreign economy is structured symmetrically to the domestic economy. Thus, foreign production utilizes capital domiciled abroad, K^*, with a production function similar to that of the domestic economy:

$$dY^* = \alpha^* K^* dt + \alpha^* K^* dy^*, \tag{2}$$

where $\alpha^* > 0$ is the marginal physical product of capital and dy^* represents a proportional foreign productivity shock. We should note that dy^* is the increment of a stochastic process y^*. Those increments are temporally independent and are distributed normally, which satisfies $E(dy^*) = 0$ and $E(dy^{*^2}) = \sigma_{y^*}^2 dt$.

Both domestic capital, K, and foreign capital, K^*, can be owned by the domestic agent or the foreign agent. Subscript d denotes the holdings of assets of the domestic agent and subscript f denotes the holdings of assets of the foreign agent. The following equations must be satisfied:

$$K = K_d + K_f \quad (3)$$
$$K^* = K_d^* + K_f^*. \quad (4)$$

Therefore, given equations (3) and (4), the wealth of the domestic agent, W, and the wealth of the foreign agent, W^*, are given by the following equations:

$$W = K_d + K_d^* \quad (5)$$
$$W^* = K_f + K_f^*. \quad (6)$$

Because both economies are symmetric we focus for the sake of convenience only on the equilibrium solution for the domestic economy. However, the results for the domestic economy are readily extended to the foreign economy.

2.2 Domestic Economy

The Maximization Problem

The preferences of the domestic representative agent are represented by a constant elasticity of substitution (or isoelastic) intertemporal utility function in which she obtains utility from private consumption, C, and from public consumption, G:

$$E_0 \int_0^\infty \frac{1}{\gamma}(CG^\eta)^\gamma e^{-\beta t} dt \quad (7)$$
$$-\infty < \gamma < 1; \eta > 0; \gamma\eta < 1; \gamma(1+\eta) < 1.$$

The welfare of the domestic agent in period 0 is the expected value of the discounted sum of instantaneous utilities, which is conditioned on the set of disposable information in period 0. The parameter β is a positive subjective discount rate (or rate of time preference). For the isoelastic utility function the Arrow-Pratt coefficient of relative risk aversion is given by the expression $1-\gamma$. When $\gamma = 0$ this function corresponds to the logarithmic utility function. The empirical evidence suggests a high degree of relative risk aversion, such that $\gamma < 0$ (Campbell, 1996). The parameter η measures the influence of public consumption on welfare. We assume that both private consumption and public consumption generate a positive marginal utility, such that $\eta > 0$. The other restrictions on the utility function are necessary to ensure concavity with respect to private consumption and public consumption.

The domestic agent consumes at a deterministic rate, $C(t)dt$, in the instant dt and must pay the corresponding taxes; thus, given equations (1), (2), (5) and (6), the dynamic budget restriction can be expressed in the following way:

$$dW = [\alpha K_d + \alpha^* K_d^*]\,dt + [\alpha K_d dy + \alpha^* K_d^* dy^*] - Cdt - dT, \tag{8}$$

where dT denotes the taxes the domestic representative agent must pay to the public sector. The structure of taxes will be detailed below.

In addition to the domestic representative agent, there is also a public sector. Public sector spending, dG, increases with wealth, such that we can achieve a balanced growth path. Public spending evolves according to the following equation:

$$dG = gWdt + Wdz, \tag{9}$$

where $g = G/W$ is the size of the public sector and dz is the increment of a stochastic process z. Those increments are temporally independent and are normally distributed, which satisfy $E(dz) = 0$ and $E(dz^2) = \sigma_z^2 dt$. Public sector spending is financed solely via tax collection: the public sector equilibrates its budget continuously, i.e.,

$$dT = dG. \tag{10}$$

Combining equations (9) and (10), and plugging them into equation (8), we obtain the following restriction for the resources of the domestic economy:

$$dW = [\alpha K_d + \alpha^* K_d^* - C - gW]\,dt + [\alpha K_d dy + \alpha^* K_d^* dy^* - Wdz]\,. \tag{11}$$

Remember that holding assets by the domestic agent is subject to the domestic wealth equation (5). If we define the following variables for the domestic agent:

$$\begin{aligned} n_d &\equiv \frac{K_d}{W} = \text{share of domestic capital} \\ &\quad \text{in the portfolio of domestic agents} \\ n_d^* &\equiv \frac{K_d^*}{W} = \text{ share of foreign capital} \\ &\quad \text{in the portfolio of domestic agents,} \end{aligned}$$

equation (5) can be expressed more conveniently in the following way:

$$1 = n_d + n_d^* \tag{12}$$

and substituting those variables into the budget constraint (11) we obtain the following dynamic restriction for the resources of the domestic economy:

$$\frac{dW}{W} = \left[\alpha n_d + \alpha^* n_d^* - \frac{C}{W} - g\right] dt + \left[\alpha n_d dy + \alpha^* n_d^* dy^* - dz\right]. \tag{13}$$

This equation can be more conveniently expressed as

$$\frac{dW}{W} = \psi dt + dw, \tag{14}$$

where the deterministic and stochastic parts of the rate of accumulation of assets, dW/W, can be expressed in the following way

$$\psi \equiv n_d\left[\alpha - \alpha^*\right] + \alpha^* - g - \frac{C}{W} \equiv \rho - g - \frac{C}{W} \tag{15}$$

$$dw \equiv n_d\left[\alpha dy - \alpha^* dy^*\right] + \alpha^* dy^* - dz, \tag{16}$$

where $\rho \equiv \alpha n_d + \alpha^* n_d^* \equiv n_d\left[\alpha - \alpha^*\right] + \alpha^*$ denotes the gross rate of return of the asset portfolio.

Equilibrium

Next, the case in which the public sector acts as a central planner is analyzed. The objective of the central planner is to choose the path of private consumption and portfolio shares that maximizes the expected value of the intertemporal utility function (7) of the domestic representative agent, subject to $W(0) = W_0$, (14), (15), and (16). This optimization is a stochastic optimum control problem.[17] Initially we assume that the public sector establishes an arbitrarily exogenous size of the public sector, g. We analyze the case in which such a size is chosen optimally in Section 3.

The macroeconomic equilibrium is derived in Appendix A. The equilibrium portfolio shares and the consumption-wealth ratio in the domestic open economy are given by the following equations:

$$n_d = \frac{\alpha - \alpha^*}{[1-\gamma(1+\eta)]\Delta} + \frac{\alpha^{*^2}\sigma_{y^*}^2 - \alpha\alpha^*\sigma_{yy^*} + \alpha\sigma_{yz} - \alpha^*\sigma_{y^*z}}{\Delta} \quad (17)$$

$$n_d^* = 1 - n_d \quad (18)$$

$$\left(\frac{C}{W}\right)_o = \frac{1}{(1-\gamma)(1+\eta)}\left[\beta - \gamma(1+\eta)(\rho - g) + 0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,o}^2\right], \quad (19)$$

where

$$\Delta = \alpha^2\sigma_y^2 - 2\alpha\alpha^*\sigma_{yy^*} + \alpha^{*^2}\sigma_{y^*}^2 \quad (20)$$

$$\sigma_{w,o}^2 = n_d^2\alpha^2\sigma_y^2 + 2n_d n_d^*\alpha\alpha^*\sigma_{yy^*} + n_d^{*^2}\alpha^{*^2}\sigma_{y^*}^2 + \sigma_z^2 - 2n_d\alpha\sigma_{yz} - 2n_d^*\alpha^*\sigma_{y^*z}. \quad (21)$$

Note that neither the expression Δ nor the variance of the rate of accumulation of domestic assets, $\sigma_{w,o}^2$, can be negative and the variables with subscript o refer to

[17] To solve problems of stochastic optimum control, see, for example, Kamien and Schwartz (1991, Section 22), Malliaris and Brock (1982, Ch. 2), Obstfeld (1992), or Turnovsky (1997, Ch. 9; 2000, Ch. 15).

values in an open economy. Appendix B shows that the second-order conditions are satisfied.

The equilibrium rate of wealth accumulation of the open domestic economy follows the stochastic process:

$$\frac{dW}{W} = \psi_o dt + dw_o, \tag{22}$$

where the deterministic and stochastic components are, respectively:

$$\begin{aligned} \psi_o &= \frac{1}{(1-\gamma)(1+\eta)} \{(1+\eta)(\rho - g) - \beta \\ &\quad -0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,o}^2\} \qquad (23) \\ dw_o &= n_d \alpha dy + n_d^* \alpha^* dy^* - dz. \qquad (24) \end{aligned}$$

Although with more general utility functions the optimal portfolio shares and consumption-wealth ratio will be functions of time, those variables are all constant in this model because the utility function exhibits constant relative risk aversion, the production function is linear, and the mean and variances of the underlying stochastic processes are stationary. The equilibrium is characterized by balanced real growth in which all the (real) assets grow at the same rate and by a constant consumption-wealth ratio and portfolio shares. The same is also true for the foreign economy.

2.3 Welfare

Economic welfare is measured by the value function we used to solve the problem of intertemporal optimization, which is given by equation (59) in Appendix B:

$$V(W) = \frac{g^{\eta\gamma}}{\gamma(1+\eta)} \left(\frac{C}{W}\right)^{\gamma-1} W^{\gamma(1+\eta)}. \tag{25}$$

From the total differential of equation (25), we obtain (after some algebra) the following equation:

$$\frac{dV}{V} = (\gamma - 1)\frac{d(C/W)}{C/W} + \gamma\eta\frac{dg}{g}, \tag{26}$$

where we can observe that changes in the optimal consumption-wealth ratio and the (exogenous) size of the public sector have an impact on welfare.

First, a higher optimal consumption-wealth ratio can improve or deteriorate the welfare of the domestic economy because the value function can take either positive or negative values, depending on the sign of the coefficient, γ. Because C/W and g are positive in equation (25), $\gamma V(W) > 0$. When $\gamma < 0$, anything that increases the optimal consumption-wealth ratio raises welfare. Thus, for example, a higher subjective discount rate, increases the optimal consumption-wealth ratio and generates higher welfare, when $\gamma < 0$.

Second, the size of the public sector is an important factor that influences welfare. Note that the optimal consumption-wealth ratio, which is given by equation (19), also depends on the size of the public sector, g. Therefore, the impact of changes in the size of the public sector on welfare is given by the following equation:

$$\frac{dV}{V} = \gamma\left[\eta - \frac{g}{C/W}\right]\frac{dg}{g}.$$

Therefore, a larger size of the public sector can increase or reduce welfare, although it unambiguously reduces the growth rate. The important point lies on whether $g \lesseqqgtr \eta C/W$. If $g < \eta C/W$, an increase in the size of the public sector raises welfare because the marginal utility derived from public consumption is higher than the marginal utility derived from private consumption. If $g = \eta C/W$, an increase in the size of the public sector does not change welfare because the marginal utility derived from public consumption is equal to the marginal utility derived from private consumption: the size of the public sector maximizes welfare, as we show below. Finally, if $g > \eta C/W$, an increase in the size of the public sector reduces welfare because the marginal utility derived from public consumption is lower than the marginal utility derived from private consumption.

3 Government Size, the Consumption-Wealth Ratio, the Growth Rate, and Financial Openness

To obtain the size of the public sector that formally maximizes the welfare of the domestic representative agent—in short, the optimal size of the public sector—the expression on the right hand side of the Bellman equation (52) in Appendix A is partially differentiated with respect to g, where $G = gW$:

$$\frac{\eta}{g} C^{\gamma} (gW)^{\eta\gamma} - V'(W)W = 0,$$

which combining with the first-order condition equation (53) implies that the optimal size of the public sector, $\widehat{g}$, must satisfy the following condition:

$$\hat{g} = \eta \frac{C}{W}, \tag{27}$$

which is identical to Turnovsky (1996: 60; 1999: 888).[18] Equation (27) implies that the marginal utility of public consumption must be equal to the marginal utility of private consumption when both public and private consumption are optimally chosen.

Combining equation (27) with (19), we can calculate the optimal size of the public sector, the consumption-wealth ratio, and the growth rate when public consumption is optimally chosen in an open economy:

[18] We should note that the optimal size of the public sector, $\hat{g}$, is not exactly identical to that shown by Turnovsky (1999). However, it is identical in the sense that in both cases the optimal ratio of public consumption to private consumption is given by $G/C = \eta$.

$$\begin{aligned}\hat{g}_o &= \frac{\eta}{[1-\gamma(1+\eta)](1+\eta)}\{\beta-\gamma(1+\eta)\rho \\ &\quad +0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,o}^2\} && (28)\\ \left(\frac{C}{W}\right)_o &= \frac{1}{[1-\gamma(1+\eta)](1+\eta)}\{\beta-\gamma(1+\eta)\rho \\ &\quad +0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,o}^2\} && (29)\\ \psi_o &= \frac{1}{1-\gamma(1+\eta)}\{\rho-\beta-0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,o}^2\}. && (30)\end{aligned}$$

ever we refer to the optimal size of the public sector in general, we will use the term $\widehat{g}$—and whenever we refer only to the optimal size in an open economy we will use $\widehat{g}_o$.

In addition, we obtain the optimal size of the public sector, the consumption-wealth ratio, and the growth rate when public consumption is optimally chosen in a closed economy. With perfect capital mobility, in which domestic and foreign assets are traded without restrictions, the share of the domestic portfolio materialized in foreign capital, n_d^*, is conveniently characterized to approximate the degree of financial openness of the domestic economy. In a closed economy, that is, $n_d = 1$, or $\rho = \alpha$, the equilibrium solution will be given by the following expressions:

$$\begin{aligned}\hat{g}_c &= \frac{\eta}{[1-\gamma(1+\eta)](1+\eta)}\{\beta-\gamma(1+\eta)\alpha \\ &\quad +0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,c}^2\} && (31)\\ \left(\frac{C}{W}\right)_c &= \frac{1}{[1-\gamma(1+\eta)](1+\eta)}\{\beta-\gamma(1+\eta)\alpha \\ &\quad +0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,c}^2\} && (32)\\ \psi_c &= \frac{1}{1-\gamma(1+\eta)}\{\alpha-\beta-0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,c}^2\} && (33)\end{aligned}$$

Now it is convenient to calculate the difference between the variance of the growth rate in an open economy and in a closed economy. Referring to equation

(21), this variance is equal to:

$$\sigma^2_{w,c} = \alpha^2\sigma^2_y + \sigma^2_z - 2\alpha\sigma_{yz} \tag{34}$$

in a closed economy. Thus, if we subtract equation (34) from equation (21) we obtain (after some algebra):

$$\sigma^2_{w,o} - \sigma^2_{w,c} = \Delta n^*_d \left(n^*_d - 2\widetilde{n}^*_d\right), \tag{35}$$

where

$$\widetilde{n}^*_d = \frac{\alpha^2\sigma^2_y - \alpha\alpha^*\sigma_{yy^*} - \alpha\sigma_{yz} + \alpha^*\sigma_{y^*z}}{\Delta},$$

is the share of the domestic portfolio materialized in foreign capital that minimizes the variance of the growth rate given by equation (21).

Focusing first on the optimal size of the public sector, if we subtract equation (31) from equation (28), we obtain by using equation (35) (after some algebra),

$$\hat{g}_o - \hat{g}_c = -0.5\eta\gamma\Delta n^{*^2}_d. \tag{36}$$

The sign of the result in equation (36) depends only on the parameter γ: the size of the public sector in an open economy will be unambiguously higher than the size of the public sector in a closed economy for $\gamma < 0$, no matter what the values of the portfolio shares are, provided of course that $n^*_d \neq 0$. An easy way to explain that result can be found, without loss of generalization, by focusing on the case $n_d = \widetilde{n}_d$, where

$$\widetilde{n}_d = 1 - \widetilde{n}^*_d = \frac{\alpha^{*^2}\sigma^2_{y^*} - \alpha\alpha^*\sigma_{yy^*} + \alpha\sigma_{yz} - \alpha^*\sigma_{y^*z}}{\Delta}, \tag{37}$$

denotes the share of the domestic portfolio materialized in domestic capital that minimizes the variance of the growth rate of wealth [equation (21)]. When $n_d = \widetilde{n}_d$ we know from equation (35) that the variance of the growth rate in an open economy is lower than in a closed economy, $\sigma^2_{w,o} < \sigma^2_{w,c}$. Totally differentiating equation (28), it can easily be shown that a reduction in the variance of the growth rate is equivalent to an increase in the gross rate of return of the asset portfolio, ρ, of $0.5\,[1-\gamma(1+\eta)]$. A higher gross rate of return of the asset portfolio, ρ, raises (reduces) government size if $\gamma < (>)0$, and this value does not change if $\gamma = 0$ [see equation (28) above]. This result depends on the sum of two opposite standard effects, substitution and income effects. A higher gross rate of return of the asset portfolio always has a negative substitution effect because public consumption becomes less attractive, whereas investment is more attractive. The income effect on government size, which was originated by a higher gross rate of return of the asset portfolio, is equal to unity, which makes it possible to raise both actual and future public consumption. If $\gamma < (>)0$, the income (substitution) effect dominates the substitution (income) effect, and if $\gamma = 0$, the two effects compensate one another. From this point forward, whenever a result depends on the sign of the parameter γ, we will only focus on the case where $\gamma < 0$, which is the most relevant situation empirically (Campbell, 1996). Because a lower variance of the growth rate indicates a stronger positive income effect than the negative substitution effect on government size, the size of government in an open economy will be greater than in a closed economy for $\gamma < 0$. It should be emphasized that our result has been shown for the most relevant case that $\gamma < 0$, no matter the values of the portfolio shares. Additionally, the higher the value of the optimal share of the domestic portfolio materialized in foreign capital, n^*_d, the larger the difference between the results for an open economy and those for a closed economy, all other factors being equal. Turnovsky (1999) reached this same result for a logarithmic utility function that depended on the creditor or debtor position of the country.

Similarly, because the optimal size of the public sector is given by equation (27) and the difference in the size of the public sector by equation (36), the difference between the consumption-wealth ratio in an open economy [equation (29)] and the ratio in a closed economy [equation (32)] is given by the following:

$$\left(\frac{C}{W}\right)_o - \left(\frac{C}{W}\right)_c = -0.5\gamma\Delta n^{*^2}_d. \tag{38}$$

Thus, the consumption-wealth ratio in an open economy is higher than in a closed economy, when $\gamma < 0$. This result follows an analogous reasoning to the case in which the optimal size of government was analyzed above, given that public and private consumption are complementary.

The growth rate in an open economy is compared to the growth rate in a closed economy, which departs from equation (15) that corresponds to an open economy, by subtracting the closed economy growth rate [equation (33)] from the open economy growth rate and then inserting equation (38):

$$\psi_o - \psi_c = n_d^*(\alpha^* - \alpha) + 0.5\gamma(1+\eta)\Delta n_d^{*^2}. \tag{39}$$

The growth rate in an open economy can be higher than, equal to or lower than the growth rate in a closed economy, depending on the signs of the two terms in equation (39). If both economies are completely symmetric, that is, if $\alpha = \alpha^*$, the growth rate in an open economy is lower than in a closed economy when $\gamma < 0$ because the consumption-wealth ratio in an open economy is higher than that in a closed economy. However, the opposite may also be true if the impact of higher foreign productivity is stronger than that produced by a higher consumption-wealth ratio in an open economy.

It is easy to show that welfare is unambiguously higher in an open economy than in a closed economy by simply referring to the value function given by equation (25): the consumption-wealth ratio in an open economy is higher than that in a closed economy for $\gamma < 0$ [see equation (38)]. In fact, this result applies to all values of the parameter γ, regardless of the values of productivity, α and α^*, across countries.

It should be noted that financial openness has been characterized by the share of the domestic portfolio materialized in foreign capital, n_d^*. In this paper, a higher value for the portfolio share denotes a higher degree of financial openness. Of course, positing that an open economy has a larger public sector than a closed economy (the result we have just obtained) is not equivalent to claiming that there is a positive relationship between the degree of financial openness and the size of government (a more relevant and realistic result for empirical testing). However, both results are closely related, in fact. For simplicity, and without loss of generalization, we focus on the impact of changes in domestic production risk in an open economy and ignore the covariance terms. Differentiating equation (17) with respect to σ_y^2, we obtain the following equation:

$$\frac{\partial n_d}{\partial \sigma_y^2} = -\frac{\alpha^2 n_d}{\Delta} < 0, \tag{40}$$

that is, an increase in the variance of the domestic productivity shock reduces the share of domestic holdings of domestic capital. The effect of an increase in production risk on the rate of return of the domestic portfolio, $\rho \equiv \alpha n_d + \alpha^* n_d^*$, is then given by the following equation:

$$\frac{\partial \rho}{\partial \sigma_y^2} = (\alpha - \alpha^*) \frac{\partial n_d}{\partial \sigma_y^2}, \tag{41}$$

where the sign of the derivative depends on the difference of the marginal products of capital, $\alpha - \alpha^*$. In addition, the impact on the variance of the growth rate, $\sigma_{w,o}^2$ [equation (21)], is given by the following equation (after some algebra):

$$\frac{\partial \sigma_{w,o}^2}{\partial \sigma_y^2} = \alpha^2 n_d (2\widetilde{n}_d - n_d). \tag{42}$$

This result indicated that a higher variance of domestic productivity shocks can increase or reduce the variance of the growth rate. On one hand, a higher variance of domestic productivity shocks increases the variance of the growth rate directly; on the other hand, a higher variance of domestic productivity shocks reduces the variance of the growth rate by shifting investment from domestic capital to foreign capital. Therefore, the impact of a change in domestic risk on the consumption-wealth ratio (29) is equal to the following:

$$\frac{\partial (C/W)}{\partial \sigma_y^2} = -\frac{\gamma}{1-\gamma} \left(\frac{\partial \rho}{\partial \sigma_y^2} - 0.5(1-\gamma) \frac{\partial \sigma_{w,o}^2}{\partial \sigma_y^2} \right). \tag{43}$$

Substituting equations (40), (41), and (42) into equation (43), equation (43) is reduced to this equation:

$$\frac{\partial (C/W)}{\partial \sigma_y^2} = 0.5\gamma\alpha^2 n_d^2. \tag{44}$$

We see in equation (44) that the consumption-wealth ratio falls with the variance for $\gamma < 0$, and increases otherwise. This result implies, based on equation (27), a similar result for government size:

$$\frac{\partial(G/W)}{\partial\sigma_y^2} = 0.5\gamma\alpha^2 n_d^2.$$

Government size decreases as the variance increases for $\gamma < 0$, and increases otherwise. In short, if production risk diminishes, portfolio share increases, and this raises the consumption-wealth ratio, and increases government size. Thus, greater openness is positively related to the consumption-wealth ratio and government size, as discussed above.[19]

4 The Degree of Financial Openness and Data Sources

Different measures for the degree of financial openness have recently been suggested by the literature.[20] Thus some discussion is required about the choice of how to measure the degree of financial openness. Lane and Milesi-Ferretti (2007) employed two *de facto* measures to capture the scale of cross-border financial integration. The first measure refers to the stock of external assets and liabilities with respect to GDP. The second measure is based on portfolio equity and foreign direct investment stocks (both assets and liabilities) with respect to GDP. Chinn and Ito (2008) propose a *de jure* index to capture the extent and intensity of capital controls, mainly based on the IMF´s *Annual Report on Exchange Arrangements and Exchange Restrictions*. We are inclined to use the measures proposed by Lane and Milesi-Ferretti (2007) for two reasons. First, these measures better capture the significant and growing change in the degree of financial integration. Conversely, the index suggested by Chinn and Ito (2008: 311) changes slowly, as it captures "the extent and intensity of capital controls" from a *de jure* perspective. Second, the model developed in this paper suggests that the relevant variable should be

[19] Alternatively, one could introduce some type of friction, e.g. a tax on financial transactions, that could be varied to reflect changing barriers to international equity investment to relate positively to financial openness, and the consumption-wealth ratio, and government size.
[20] See Chinn and Ito (2008) for a recent discussion of this issue.

expressed in terms of domestic wealth, W, which is defined in equation (5). Therefore, the Lane and Milesi-Ferretti (2007) approach is more convenient for our purposes.

Therefore, three measures for the degree of financial openness are proposed in this paper, which are broadly inspired Lane and Milesi-Ferretti (2007).[21] These three measures also help us check the robustness of the analyzed relationships. However, please note that the ratios of Lane and Milesi-Ferretti (2007) are expressed with respect to GDP, whereas in this paper, they are expressed with respect to domestic wealth, W, to be internally consistent with the results of our model. We show the relationship between both measures below.

- Measure 1 (narrow), $FO1$: Share of foreign capital (the stock of direct investment and portfolio equity assets) in the portfolio of domestic agents (over domestic wealth). This measure is directly suggested by the theoretical model.

- Measure 2 (broader), $FO2$: The ratio of the stock of direct investment and portfolio equity assets and liabilities for the domestic economy over domestic wealth.

- Measure 3 (broadest), $FO3$: The ratio of the stock of all external assets and liabilities of the domestic economy over domestic wealth. These assets and liabilities include the stock of direct investment plus portfolio equity, portfolio debt investment, other investment assets (general government, banks, etc.), reserve assets (minus gold) and financial derivatives.

Thus, higher values for the measure indicate a higher degree of financial openness. Using three different measures could yield results that vary from one another. However, as we show below, the method is much simpler than it seems.

[21] See also Lane and Milesi-Ferretti (2003). Although they suggest two measures, we employ three.

The data set employed to test the main results of the model covers 49 industrial and developing countries[22] from 1970 to 2009.[23] The industrial countries include Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, The Netherlands, Norway, New Zealand, Spain, Portugal, Sweden, Switzerland, the United Kingdom, and the United States. The developing countries include Argentina, Brazil, the Czech Republic, Chile, China, Colombia, Costa Rica, Guatemala, Honduras, Hungary, India, Indonesia, Israel, Jamaica, Korea, Malaysia, Mexico, Pakistan, the Philippines, Poland, the Slovak Republic, South Africa, Thailand, Tunisia, Turkey, Uruguay, and Venezuela. The data on private consumption, public consumption, and GDP for those countries are provided directly by the World Bank's World Development Indicators (WBWDI). The data on international investment positions and exports and imports are obtained from the International Monetary Fund´s International Financial Statistics (IMFIFS). In addition, because data on international investment positions are incomplete or missing for many countries (particularly for those years before 1986), Lane and Milesi-Ferretti (2001, 2007)[24] provided an excellent source of data for those years.[25] Domestic holdings of foreign capital, K_d^*, is measured as the stock of direct investment plus portfolio equity investment by domestic agents abroad, whereas foreign holdings of domestic capital, K_f, refer to the stock of direct investment plus portfolio equity investment by foreign agents in the domestic economy. Total external assets and liabilities include the stock of direct investment plus portfolio equity, portfolio debt investment, other investment assets (general government, banks, etc.), reserve assets (minus gold) and financial derivatives. The gross domestic capital stock, K, which is measured in current US dollars for the countries in the sample, is constructed using the procedure suggested by

[22] This distinction is acknowledged to be somewhat arbitrary. See, for instance, Lane and Milesi-Ferretti (2001, 2007) and Kraay, Loayza, Servén, and Ventura (2005).

[23] In the discussion paper version, the initial sample included Singapore as well. However, although it does not change the broader picture, the inclusion of Singapore completely drives some of the results and distorts the estimates. Thus, we are inclined not to take Singapore into account.

[24] From this point forward, we refer only to Lane and Milesi-Ferretti (2007) as the relevant data source for this paper.

[25] Please note that most of the data from IMFIFS and from Lane and Milesi-Ferretti (2007) coincide for recent years.

Kraay and Ventura (2000) in their Appendix 2,[26] by cumulating gross domestic investment in current US dollars (from WBWDI), by assuming a depreciation rate of 4% per year and by adjusting the value of the previous year's stock using the US gross domestic investment deflator. The initial capital stock in 1970 is estimated using the average capital-output ratio over the period from 1965–1970[27] [based on Nehru and Dareshwar (1993)] multiplied by GDP in current US dollars (WBWDI). Domestic wealth, W, is equal to $W = K_d + K_d^*$ [see equation (5)] in our simplified model. However, we also include the net foreign asset position of the country when we estimate domestic wealth; therefore, we are able to test the empirical model more realistically.

First, we check the relationship between the different measures of financial openness. We show the relationship between the magnitudes $FO1$ and $FO2$, then between $FO1$ and $FO3$, and finally between $FO2$ and $FO3$. We test the following regressions:

$$\begin{aligned} FO2_{ct} &= a_0 + a_1 FO1_{ct} + u_{ct}, \\ FO3_{ct} &= a_0 + a_1 FO1_{ct} + u_{ct}, \text{ and} \\ FO3_{ct} &= a_0 + a_1 FO2_{ct} + u_{ct}, \end{aligned}$$

where FOi_{ct} denotes the degree of financial openness using measure i for country c in period t, and u_{ct} is the error term for country c in period t. Under the null hypothesis that there is a positive relationship between both measures of financial openness the coefficient a_1 should be positive. Table 1 shows the results: all of the regressions exhibit a positive and significant relationship. Moreover, the goodness of fit is very high in all cases.

However, an additional important issue is how those measures are related to those typically suggested in the literature, such as those by Lane and Milesi-Ferretti (2007), for instance. In our model, variables that capture the degree of financial openness are expressed in terms of wealth, whereas the literature on financial openness has usually been referred to in terms of *GDP*. To examine the

[26] See also Erauskin (2009) for more details.

[27] The initial value for the capital-output ratio for the world is the weighted mean of the capital-output ratios in the sample from 1965 to 1970.

Table 1: Relationship between different measures of financial openness. Pooled estimation.

Regressand:	$FO2$	$FO3$	$FO3$	$FO2$	$FO3$
Regressor:	$FO1$	$FO1$	$FO2$	$GEQY$	$IFIGDP$
Estimate of a_1	2.2008***	6.0676***	2.6920***	.4417***	.4764***
	(.1186)	(.4820)	(.1386)	(.0393)	(.0441)
R^2	0.8719	0.8212	0.8980	0.7684	0.7915
No. of observations	1.713	1.713	1.713	1.713	1.713

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: International Monetary Fund´s International Financial Statistics (IMFIFS), World Bank´s World Development Indicatos (WBWDI), Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

relationship between both methods of measuring financial openness, we compare the most similar measures. First, we test the relationship between $FO2$ (the stock of direct investment and portfolio equity assets and liabilities, in terms of wealth), and $GEQY$ in Lane and Milesi-Ferretti´s paper (the stock of direct investment and portfolio equity assets and liabilities, in terms of GDP). Next, we test the relationship between $FO3$ (the stock of all external assets and liabilities, in terms of wealth) and $IFIGDP$ from Lane and Milesi-Ferretti (2007) (the stock of all external assets and liabilities, in terms of GDP):

$$FO2_{ct} = a_0 + a_1 GEQY_{ct} + u_{ct}, \text{ and}$$
$$FO3_{ct} = a_0 + a_1 IFIGDP_{ct} + u_{ct},$$

where FOi_{ct} denotes the degree of financial openness using measure i for country c in period t, $GEQY_{ct}$ refers to the stock of portfolio equity and direct investment assets and liabilities with respect to the GDP for country c in period t, $IFIGDP_{ct}$ is defined as the stock of external assets and liabilities with respect to the GDP for country c in period t, and u_{ct} is the error term for country c in period t. Under the null hypothesis that there is a positive relationship between both measures of financial openness, the coefficient a_1 should be positive. Positive and significant results are again found in Table 1. The goodness of fit is again very high for both measures.

Finally, we relate our measures of financial openness with the degree of trade openness, TO, which is typically understood as the sum of exports and imports in

Table 2: Relationship between financial openness and trade openness. Regressor: Trade openness. Pooled estimation.

Regressand:	$FO1$	$FO2$	$FO3$
Estimate of a_1	.1787***	.4952***	1.2517***
	(.0236)	(.0618)	(.1810)
R^2	0.1260	0.1745	0.1378
No. of observations	1.607	1.617	1.617

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

terms of *GDP*. We regress:

$$\begin{aligned} TO_{ct} &= a_0 + a_1 FO1_{ct} + u_{ct}, \\ TO_{ct} &= a_0 + a_1 FO2_{ct} + u_{ct}, \text{ and} \\ TO_{ct} &= a_0 + a_1 FO3_{ct} + u_{ct}, \end{aligned}$$

where FOi_{ct} is the degree of financial openness using measure i for country c in period t, TO_{ct} is trade openness, defined as the ratio of exports and imports over *GDP*, for country c in period t, and u_{ct} is the error term for country c in period t. Under the null hypothesis of a positive relationship between financial openness and trade openness, the coefficient a_1 should be positive. We again find a positive and robust relationship in all cases, as shown in Table 2. However, the goodness of fit falls substantially in comparison with the previous results.

In conclusion, the different measures chosen in this paper to capture the degree of financial openness seem to be positively related to the usual measures of financial openness found in the literature.

5 Empirical Evidence

There are four main results suggested by the model in Section 3:

1. Financial openness is unambiguously positively related to government size.
2. Financial openness shows an unambiguously positive relationship with the private consumption-wealth ratio.
3. The relationship between financial openness and the growth rate shows no clear-cut results. The result depends on the difference between productivity and the consumption-wealth ratios among countries: for similar levels of productivity, the growth rate is lower in an open economy.
4. Public and private consumption are complementary to one another.

First, the model postulates a positive relationship between the size of the public sector (with respect to wealth) and financial openness. The positive association can be tested with the following regression equation:

$$\left(\frac{G}{W}\right)_{ct} = a_0 + a_1 FO_{ct} + u_{ct}, \tag{45}$$

where $(G/W)_{ct}$ denotes the size of the public sector-wealth ratio for country c in period t, FO_{ct} denotes the portfolio share of foreign capital in domestic wealth for country c in period t, and u_{ct} is the error term for country c in period t. The null hypothesis that a more open economy has a larger public sector is true if the coefficient a_1 is positive. We estimate the regression equation (45) for the entire sample of 49 countries by employing the ordinary least squares (OLS) method. To check the robustness of the results, we estimate the value of the coefficient a_1 for the three different measures of financial openness: $FO1$, $FO2$, and $FO3$. As shown in Table 3, we find that all of the point estimates for the parameter a_1 are positive in the pooled estimation. The null hypothesis that the value of the parameter a_1 is equal to zero can be comfortably rejected in all cases. Other variables may also influence the relationship. Thus, certain typical control variables are incorporated

Table 3: Financial openness (different measures) and the size of the public sector (with and without control variables) for the pooled estimation.

	$FO1$		$FO2$		$FO3$	
Estimate of a_1	.0448***	.0340***	.0223***	.0201***	.0079***	.0068***
	(.0056)	(.0071)	(.0043)	(.0050)	(.0016)	(.0016)
Time trend		-.0001		-.00004		.00009
		(.0036)		(.00008)		(.00008)
Trade openness		-.0033		-.0065**		-.0056**
		(.0026)		(.0027)		(.0025)
Population		-3.02e-11***		-2.94e-11***		-2.91e-11***
		(2.37e-12)		(2.34e-12)		(2.33e-12)
Population growth		-.0030**		-.0032**		-.0031**
		(.0014)		(.0015)		(.0014)
GDP per capita		1.52e-07		1.87e-07		1.87e-07
		(1.24e-07)		(1.38e-07)		(1.31e-07)
GDP per capita growth		.0004		.0004		.0004
		(.0003)		(.0002)		(.0002)
R^2	0.0623	0.1137	0.0854	0.1393	0.0903	0.2172
No. of observations	1.698	1.596	1.698	1.596	1.698	1.628

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

into the regression equation, including population and output per capita (both in levels and growth rates) such that the size of the economy and possible pressures on government spending are considered. Please note that the sum of exports and imports of goods and services (as a percentage of GDP) is also incorporated as a control variable to capture the influence of trade openness on the size of the public sector. Because of data availability, the period analyzed is restricted to 1975-2009 for the same set of countries. We find that the inclusion of these variables slightly influences the different estimates of the coefficient a_1, as shown in Table 3, but a strong positive relationship remains. The positive relationship also remains intact even if we estimate the equation for industrial countries only (22 countries), on the one hand, and for developing countries only (27 countries), on the other. Table 4 captures the results for the first measure and for the pooled estimation. The results offered by the empirical evidence are somewhat different for industrial countries in contrast to developing countries but in both cases the null cannot be rejected. Moreover, although the pooled estimation uses all of the available variation in

Table 4: Financial openness (FO1) and the size of the public sector: Industrial and developing countries (pooled), between-group estimates, and within-group estimates.

	Pooled regression			Between regression	Within regression
	All countries	Industrial countries	Developing countries	All countries	All countries
Estimate of a_1	.0448***	.0346***	.0815***	.0737**	.0326**
	(.0056)	(.0059)	(.0313)	(.0365)	(.0147)
R^2	0.0623	0.0878	0.0259	0.0799	0.0494
No. of observations	1.698	877	821	1.698	1.698

Standard errors are in parentheses.

*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.

Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

financial openness and public sector size by OLS, the between-group estimates (i.e., based on the mean values of the variables of the group) and the within-group estimates (also called fixed-effects estimators, i.e., in terms of deviations from the mean values of the variables of the group) offer more information about whether the pooling estimate is driven by persistent (the former case) or transitory (the latter case) differences in the degree of financial openness and the size of the public sector. Table 4 shows the results for the between-group and within-group estimates, in addition to for the pooled estimates. The between-group and within-group estimates for the coefficient capturing the impact of financial openness ($FO1$) on the size of the public sector are again positive, but the within-group estimate is not significant.[28] Second, the result that the consumption-wealth ratio is higher

[28] Similar results are found for other measures of financial openness, such as $FO2$ and $FO3$ (not shown).

in an open economy than in a closed economy can be tested with the regression equation:

$$\left(\frac{C}{W}\right)_{ct} = a_0 + a_1 FO_{ct} + u_{ct}, \tag{46}$$

where $(C/W)_{ct}$ denotes the consumption-wealth ratio for country c in period t. Again, if the null hypothesis that economies that are more open should have higher consumption-wealth ratios is true then the parameter a_1 should be positive. We show the results of fitting the regression equation (46) by OLS for the three different measures of financial openness for the pooled estimation in Table 5. Most of the results remain positive, but we also find a puzzling result because the coefficient for $FO1$ turns negative. However, if we add control variables to the regression, as exhibited in Table 5, the results again change substantially, and there is a positive

Table 5: Financial openness (different measures) and consumption-wealth ratio (with control variables) in the pooled estimation.

	$FO1$		$FO2$		$FO3$	
Estimate of a_1	-.0273	.1335***	.0382**	.1003***	.0135***	.0324***
	(.0245)	(.0218)	(.0176)	(.0261)	(.0050)	(.0079)
Time trend		.0028***		.0023***		.0025***
		(.0003)		(.0003)		(.0003)
Trade openness		-.1073***		-.1279***		-.1215***
		(.0085)		(.0095)		(.0082)
Population		-1.74e-10***		-1.72e-10***		-1.70e-10***
		(1.05e-11)		(1.06e-11)		(1.05e-11)
Population growth		.0053		.0032		.0036
		(.0039)		(.0047)		(.0044)
GDP per capita		-5.58e-06***		-5.71e-06***		-5.65e-06***
		(4.24e-07)		(5.97e-07)		(5.46e-07)
GDP per capita growth		.0036***		.0037***		.0038***
		(.0010)		(.0009)		(.0009)
R^2	0.0015	0.2631	0.0161	0.3185	0.0169	0.3144
No. of observations	1.699	1.597	1.699	1.597	1.699	1.597

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

and robust relationship between financial openness and the consumption-wealth ratio in all cases. When we consider the relationship for industrial countries and developing countries, we obtain different results, particularly for developing countries, as shown in Table 6. Table 6 also shows between-group and within-group estimates; although the between-group estimate notably increases, the within-group estimate becomes negative (but not significant).

Third, the model offers no clear-cut results for the theoretical relationship between financial openness and the growth rate of wealth, as shown in equation (39). The relationship between the degree of financial openness and the growth rate of wealth can be tested with the regression equation:

$$\left(\frac{dW}{W}\right)_{ct} = a_0 + a_1 FO_{ct} + u_{ct}. \tag{47}$$

where $(dW/W)_{ct}$ denotes the growth rate of wealth for country c in period t. If the null hypothesis that economies that are more open should have higher growth rates of wealth is true, the parameter of a_1 should be positive. In fact, we find that the estimate a_1 is positive and significant in regression (47) for the three different measures, as shown in Table 7. The positive relationship is also found when control variables are included for the pooled data. Table 8 also shows that the result is robust for both industrial and developing countries. This result also confirms the positive relationship for the between-group and within-group estimates.

However, it seems paradoxical that both the growth rate of wealth and the consumption-wealth ratio are higher in open economies than in closed economies because higher consumption-wealth ratios seem likely to be associated with lower growth rates. In fact, that would be the case if domestic productivity and foreign productivity are equal, as shown in equation (39). But how can growth rates be higher in open economies? To answer, we must examine the term $n_d^*(\alpha^* - \alpha)$, which reflects the difference between foreign and domestic productivity weighted by the degree of financial openness. This term should be positive. We use the growth rate of world GDP per capita and domestic GDP per capita as proxies for foreign productivity, α^*, and domestic productivity, α, respectively. The proper weights are calculated using measure 1 of financial openness, $FO1$. We can then

Table 6: Financial openness (FO1) and the consumption-wealth ratio: Industrial and developing countries (pooled), between-group estimates and within-group estimates.

	Pooled regression			Between regression	Within regression
	All countries	Industrial countries	Developing countries	All countries	All countries
Estimate of a_1	.1335***	.1026***	.3012**	.1965	.1265***
	(.0218)	(.0170)	(.1253)	(.1366)	(.0376)
Time trend	.0028***	.0021***	.0035***		.0044**
	(.0003)	(.0003)	(.0005)		(.0021)
Trade openness	-.1073***	-.0606***	-.1207***	-.0888**	-.1605***
	(.0085)	(.0115)	(.0123)	(.0338)	(.0504)
Population	-1.74e-10***	1.44e-10***	-1.92e-10***	-1.51e-10**	-3.42e-10**
	(1.05e-11)	(4.38e-11)	(1.18e-11)	(6.29e-11)	(1.90e-10)
Population growth	.0053	.0206***	.0054	-.0003	.0193**
	(.0039)	(.0046)	(.0059)	(.0138)	(.0083)
GDP per capita	-5.58e-06***	-5.53e-06***	-7.12e-06***	-6.80e-06***	-9.62e-06*
	(4.24e-07)	(3.72e-07)	(9.61e-07)	(1.34-06)	(4.81e-06)
GDP per capita growth	.0036***	.0043***	.0035***	-.0025	.0043***
	(.0010)	(.0009)	(.0013)	(.0086)	(.0007)
R^2	0.2631	0.3500	0.1652	0.5170	0.1021
No. of observations	1.597	807	790	49	1.597

Standard errors are in parentheses.

*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.

Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

Table 7: Financial openness and growth rate (with control variables) for the pooled estimation.

	$FO1$		$FO2$		$FO3$	
Estimate of a_1	.0332***	.0591***	.0210***	.0292***	.0060***	.0078***
	(.0075)	(.0075)	(.0032)	(.0037)	(.0010)	(.0010)
Time trend		-.00002		-.0001		.00002
		(.0001)		(.0001)		(.0001)
Trade openness		.0074**		.0041		.0076**
		(.0033)		(.0032)		(.0032)
Population		5.43e-12		7.02e-12		7.65e-12*
		(4.41e-12)		(4.38e-12)		(4.32e-12)
Population growth		-.0004		-.0003		.0001
		(.0013)		(.0013)		(.0013)
GDP per capita		-7.38e-07***		-6.04e-07***		-5.26e-07***
		(1.07e-07)		(1.18e-07)		(1.09e-07)
GDP per capita growth		.0035***		.0035***		.0035***
		(.0003)		(.0003)		(.0003)
R^2	0.0214	0.1854	0.0475	0.2085	0.0318	0.1848
No. of observations	1.711	1.598	1.711	1.598	1.711	1.598

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

test the impact of financial openness on the term $n_d^*(\alpha^* - \alpha)$ through the following regression equation:

$$[n_d^*(\alpha^* - \alpha)]_{ct} = a_0 + a_1 FO1_{ct} + u_{ct}. \tag{48}$$

Under the null hypothesis that financial openness is positively related to the term $n_d^*(\alpha^* - \alpha)$ the coefficient a_1 should be positive. We show the results for the regression (48) in Table 9. The term is positive with or without control variables, but the results are not significant. Therefore, the evidence suggests that apparently contradictory results, i.e., enjoying higher consumption-wealth ratios and higher growth rates, can be reconciled. Economies that are more financially, in spite of their higher consumption-wealth ratios, are associated with higher productivity. This higher productivity, in turn, is positively related to the growth rate of wealth.

Table 8: Financial openness (FO1) and the growth rate: Pooled, between-group, and within-group estimates.

	Pooled regression			Between regression	Within regression
	All countries	Industrial countries	Developing countries	All countries	All countries
Estimate of a_1	.0332***	.0431***	.0851***	-.0015	.0447***
	(.0075)	(.0072)	(.0182)	(.0548)	(.0117)
R^2	0.0214	0.0959	0.0158	0.0000	0.0557
No. of observations	1.711	877	834	49	1.711

Standard errors are in parentheses.

*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.

Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

Fourth, both private and public consumption are complementary to one another in this model. This result can be tested with the regression equation:

$$\left(\frac{G}{W}\right)_{ct} = a_0 + a_1 \left(\frac{C}{W}\right)_{ct} + u_{ct}, \tag{49}$$

where $(G/W)_{ct}$ denotes the size of the public sector-wealth ratio for country c in period t. Under the null hypothesis that both private and public consumption are complements, the coefficient a_1 should be positive. Table 10 shows the results, and estimates for a_1 in the regression (49) are clearly and robustly positive in all cases, except for the between-group estimate when control variables are not used (not significant). These results support a positive relationship between private and public consumption—as found by Blanchard and Perotti (2002)—based on the complementarity between private and public consumption (Ganelli and Tervala, 2009).

In conclusion, the empirical evidence for 49 countries for the recent period from 1970 to 2009 broadly supports the four main theoretical results of the model. However, two additional issues to check the robustness of the obtained results must be discussed.

Table 9: The impact of financial openness on productivity (with or without control variables).

	Without controls	With controls
Estimate of a_1	.6709	1.0640
	(.7093)	(.900)
Time trend		-.0033
		(.0034)
Trade openness		-.1656**
		(.0687)
Population		1.10e-10***
		(3.64e-11)
Population growth		-.0648**
		(.0283
GDP per capita		-.00001*
		(6.28e-06)
GDP per capita growth		-.0458***
		(.0071)
R^2	.0479	0.1598
No. of observations	1680	1590

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

Table 10: The complementarity between private and public consumption (with and without control variables).

	Pooled regression		Between regression		Within regression	
Estimate of a_1	.0963***	.1623***	-.0174	.0962***	.1847***	.1881***
	(.0087)	(.0086)	(.0416)	(.0321)	(.0167)	(.0182)
Time trend		-.0004***				.0005**
		(.0001)				(.0002)
Trade openness		.0160***		.0145*		-.0176***
		(.0020)		(.008)		(.0062)
Population		-1.55e-12		-2.02e-11		3.50e-11*
		(2.47e-12)		(2.07e-11)		(1.77e-11)
Population growth		-.0029**		-.0029		.0005
		(.0012)		(.0046)		(.0015)
GDP per capita		1.22e-06***		1.03e-06		-3.33e-07
		(1.04e-07)		(3.89e-07)		(5.10e-07)
GDP per capita growth		-.0001		.0031		-.0004***
		(.0002)		(.0028)		(.0001)
R^2	0.1225	0.3362	0.0037	0.5216	0.5588	0.6251
No. of observations	1.604	1.502	49	49	1.604	1.502

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

5.1 Robustness Checks

First, the degree of financial openness is expressed only in terms of stock variables. As noted by Obstfeld and Taylor (2004: 48), "ceteris paribus, a greater degree of capital mobility should lead to larger flows and, with the accumulation over time, larger stocks of foreign investment". Thus, the measures of financial openness used in this paper can conceal a high degree of volatility in terms of capital flows. Recent research has shown that changes in cross-border holdings and capital flows move together (Evans and Hnatkovska, 2012). This result can also be checked in our sample by comparing the domestic portfolio materialized in foreign capital as a share of domestic wealth, $FO1$, with the corresponding underlying flow for domestic capital. For instance, we plot the case for the United States in Figure 1 and the case for Germany is shown in Figure 2. Both trends follow somewhat similar patterns most of the time, but they tend to diverge more in the most recent period. Are both stock-flow measures closely related? Looking at Figures 1 and 2, it seems to be the case. However, the most recent years, 2008 and 2009, may distort the broader picture because the variables capture the strong impact of the economic and financial crisis. To check, we propose testing the following regression:

$$FOi_{ct} = a_0 + a_1 Flowi_{ct} + u_{ct}, \text{ for } i = 1,2,3, \tag{50}$$

where $Flowi_{ct}$ is the capital flow concerned with the degree of financial openness using measure i for country c in period t and u_{ct} is the error term for country c in period t. Under the null hypothesis of a positive relationship between capital flows and stocks, the coefficient a_1 should be positive in regression (50). We again find a positive and robust relationship in all cases, as shown in Table 11. However, the goodness of fit is low. We now test the same relationship, restricting the sample to the period from 1970 to 2007. The results change dramatically, particularly for the goodness of fit. This evidence shows that, despite flows and stocks generally moving together, the recent economic and financial crisis yields an important departure from the trends exhibited in previous years. Table 12 shows that the results provided in this paper remain robust until 2007 when only flows are considered, but the results are somewhat weaker if we prolong the period of analysis until 2009.

Figure 1: Stocks and flows over domestic wealth in the United States, 1970-2009

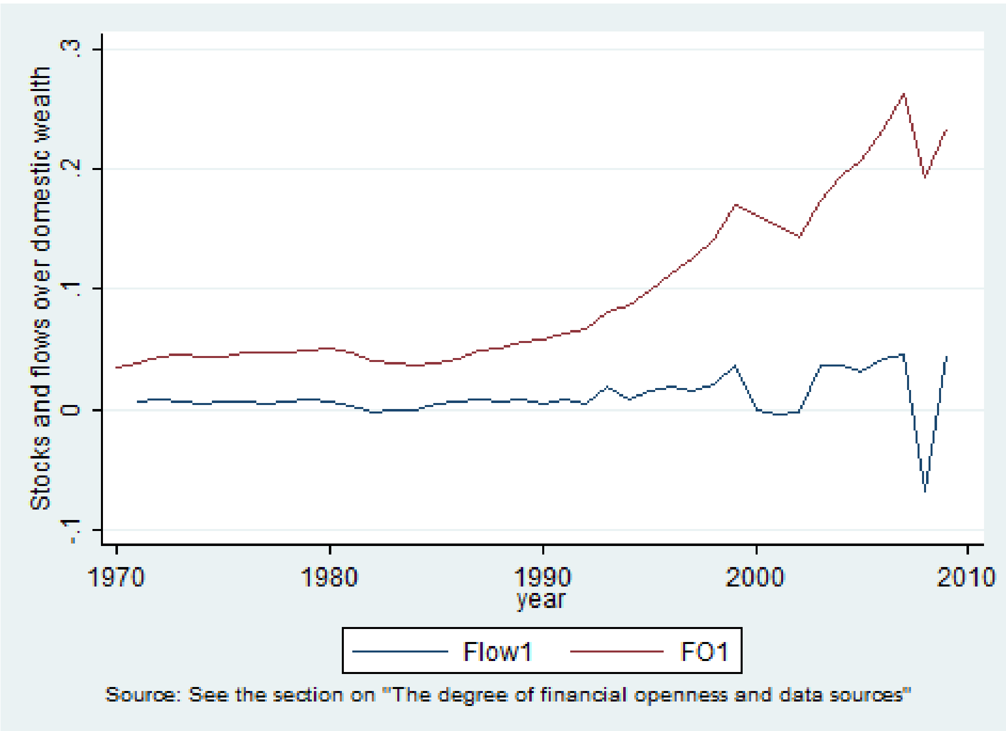

Figure 2: Stocks and flows over domestic wealth in Germany, 1970-2009

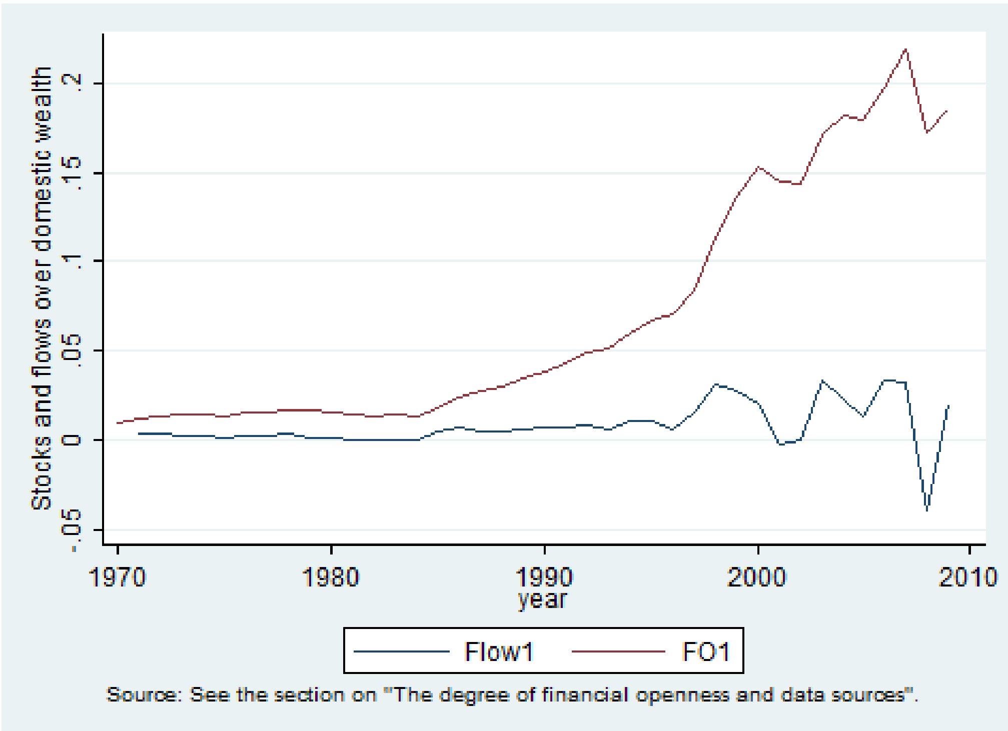

Table 11: The relationship between stocks and flows.

Regressand:	$FO1$		$FO2$		$FO3$	
Regressor:	$Flow1$		$Flow2$		$Flow3$	
	1970 – 2007	1970 – 2009	1970 – 2007	1970 – 2009	1970 – 2007	1970 – 2009
Estimate of a_1	3.1000***	2.1834***	3.2959***	2.3338***	3.1442***	2.9548***
	(.3225)	(.5462)	(.3332)	(.7416)	(.1777)	(.4208)
R^2	0.6687	0.3662	0.6640	0.3468	0.8117	0.4468
No. of observations	1.588	1.684	1.588	1.684	1.588	1.684

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

Table 12: The impact of capital flows on the size of government.

	$Flow1$	
	1970 – 2007	1970 – 2009
Estimate of a_1	.1890***	.0693
	(.0255)	(.0575)
R^2	0.0661	0.0120
No. of observations	1.575	1.669

Standard errors are in parentheses.
*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.
Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

Second, we use the dynamic Generalized Method of Moments (GMM), developed by Arellano and Bond (1991), to consider possible endogeneity in the explanatory variables. We also include two lagged values of the dependent variable to prevent simultaneity or reverse causation. Only one lag of the dependent variable is used as an instrument. Please also note that, although the empirical growth literature has usually averaged out the data over horizons spanning five or ten years, we continue using annual data in this paper to maximize the sample size and to identify the parameters more precisely[29]. We test the relationship between financial openness and government size with and without control variables. GMM estimation is accompanied by the usual diagnostic testing. The first diagnostic test investigates first-order and second-order serial correlation in the disturbances.

[29] See Baltagi, Demetriades and Law (2009), for instance.

The absence of first-order serial correlation should be rejected, but the absence of second-order serial correlation should not. Second, a Sargan test is performed for the null hypothesis that the overidentifying assumptions are rejected. For convenience we focus only on the first measure of financial openness, $FO1$. All of the results are shown in Table 13. The results again confirm the positive relationship between the degree of financial openness and government size. Analogous results are found for the consumption-wealth ratio and for the growth rate of wealth. All of the diagnostics performed are satisfactory. Therefore, the empirical results obtained appear to be robust across many different specifications.

6 Conclusions

In this paper, we use a portfolio approach based on a two-country world to analyze the impact of financial openness on the size of government and other key economic variables, including the consumption-wealth ratio, the growth rate of wealth, and welfare (assuming that public spending is utility enhancing). The theoretical model suggests that both the size of government and the consumption-wealth ratio should be greater in an open economy than in a closed economy. Financial openness allows for a wider choice of portfolios; it may lead to higher productivity and/or less volatility through a greater diversification of the country-specific risk. This result implies a reduction in savings and an increase in private consumption: the consumption-wealth ratio is higher in an open economy than in a closed economy. Because public and private consumption are complements, the size of the public sector is also larger in an open economy than in a closed economy. This result is also true for welfare. The theoretical results for the growth rate are more ambiguous because they depend on differences in productivity, and differences in consumption-wealth ratios among countries.

The empirical evidence confirms that a financially more open economy is associated with bigger government and a higher consumption-wealth ratio. This result is robust across different specifications. When we turn to the growth rate, the empirical evidence suggests that economies that are more open are associated with higher growth rates. This result is somewhat paradoxical because we would expect the opposite for similar levels of productivity. However, economies that are more

Table 13: The impact of financial openness on the government size, consumption-wealth ratio, and the rate of growth. Dynamic GMM estimator (Arellano-Bond, 1991).

	G/W		C/W		dW/W	
First lag dependent variable	1.0806***	.9512***	1.1526***	.8276***	1.2196***	.9508***
	(0.0628)	(.0550)	(.1270)	(.0586)	(.1393)	(.0599)
Second lag dependent variable	-.5758***	-.3950***	-.7713***	-.2891***	-.7302***	-.4038***
	(.0789)	(.0751)	(.2406)	(.0696)	(.1304)	(0.0664)
Estimate of a_1 $(FO1)$	.0655***	.0702***	.2822***	.2481***	.1714***	.1661***
	(.0124)	(.0115)	(.0785)	(.0204)	(.0601)	(.0102)
Trade openness		-.0295**		-.0783***		-.0638***
		(.0118)		(.0199)		(.0086)
Population		4.74e-11**		2.04-10**		1.51e-10***
		(1.90e-11)		(7.94e-11)		(3.71e-11)
Population growth		.0037**		.0113*		.0006
		(.0015)		(.0058)		(.0027)
GDP per capita		3.21e-07		-8.39e-08		2.14e-07
		(4.94e-07)		(1.27e-06)		(5.47e-07)
GDP per capita growth		.0007***		.0049***		.0024***
		(.0001)		(.0004)		(.0002)
No. of observations	1.545	1.486	1.549	1.490	1.564	1.494
Sargan test	207.86	197.65	231.73	408.35	148.56	101.95
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
First-order correlation	-3.95	-3.73	-2.55	-2.40	-2.79	-2.83
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Second-order correlation	.22	-.60	.10	-1.46	.69	–.71
	(0.82)	(0.55)	(0.92)	(0.14)	(0.49)	(0.47)

Standard errors are in parentheses.

*: Significant at 10% level; **: Significant at 5% level; ***: Significant at 1% level.

Sources: IMFIFS, WBWDI, Lane and Milesi-Ferretti (2007), Nehru and Dareshwar (1993), and own elaboration.

open are found to achieve higher rates of portfolio return, which explains why the growth rate is higher in an open economy than in a closed economy. Moreover, government consumption and private consumption are shown to be complementary. Therefore, the empirical evidence based on a sample of 49 countries for the period from 1970 to 2009 broadly supports the main results of the model.

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A Optimization

The first step to solve the optimization problem in the domestic economy is to introduce a value function, $V(W)$, which is defined by the following equation:

$$V(W) = \underset{\{C,n_d\}}{Max}\ E_0 \int_0^\infty \frac{1}{\gamma}(CG^\eta)^\gamma e^{-\beta t} dt, \tag{51}$$

subject to restrictions (14), (15), and (16) and given initial wealth. The value function in period 0 is the expected value of the discounted sum of instantaneous utilities, evaluated along the optimal path, starting in period 0 in the state $W(0) = W_0$.

Second, starting from equation (51) the value function must satisfy the following equation, known as the Hamilton-Jacobi-Bellman equation of stochastic control theory or, for short, the Bellman equation:

$$\beta V(W) = \underset{\{C,n_d\}}{Max} \left[\frac{1}{\gamma}(CG^\eta)^\gamma + V'(W)W\psi + 0.5V''(W)W^2\sigma_w^2\right]. \tag{52}$$

Third, equation (52) is partially differentiated with respect to C and n_d to obtain the first-order optimality conditions of the problem:

$$C^{\gamma-1}G^{\eta\gamma} - V'(W) = 0 \tag{53}$$

$$V'(W)W(\alpha - \alpha^*) + V''(W)W^2 cov[dw, \alpha dy - \alpha^* dy^*] = 0. \tag{54}$$

The solution to this maximization problem is obtained through trial and error. We seek to find a value function $V(W)$ that satisfies, on one hand, the first-order optimality conditions and, on the other hand, the Bellman equation. In the case of isoelastic utility functions the value function has the same form of the utility function [Merton (1969), generalized in Merton (1971)]. Thus, we guess that the value function is of the form:

$$V(W) = AW^{\gamma(1+\eta)}, \tag{55}$$

where the coefficient A is determined below. That guess implies the following equations:

$$\begin{aligned} V'(W) &= A\gamma(1+\eta)W^{\gamma(1+\eta)-1} \\ V''(W) &= A\gamma(1+\eta)\left[\gamma(1+\eta)-1\right]W^{\gamma(1+\eta)-2}. \end{aligned}$$

Inserting these expressions into the first-order optimality conditions (53) and (54), the result is given by the following equations:

$$C^{\gamma-1}G^{\eta\gamma} = A\gamma(1+\eta)W^{\gamma(1+\eta)-1} \tag{56}$$

$$(\alpha-\alpha^*)\,dt = \left[1-\gamma(1+\eta)\right]cov\left[dw, \alpha dy - \alpha^* dy^*\right]. \tag{57}$$

Both of these equations are typical in stochastic models over continuous time. Equation (56) indicates that, at the optimum, the marginal utility derived from private consumption must be equal to the marginal change in the value function or the marginal utility of wealth. Equation (57) shows that the optimal choice of portfolio shares must be such that the risk-adjusted rates of return for both domestic and foreign capital are equalized.

Combining equations (56) and (57) and substituting them into equation (52), we are able to calculate (after some algebra), the equilibrium portfolio shares and the consumption-wealth ratio in the domestic open economy, shown in equations (17), (18), and (19):

$$\begin{aligned} n_d &= \frac{\alpha-\alpha^*}{\left[1-\gamma(1+\eta)\right]\Delta} + \frac{\alpha^{*^2}\sigma_{y^*}^2 - \alpha\alpha^*\sigma_{yy^*} + \alpha\sigma_{yz} - \alpha^*\sigma_{y^*z}}{\Delta} \\ n_d^* &= 1-n_d \\ \left(\frac{C}{W}\right)_o &= \frac{1}{(1-\gamma)(1+\eta)}\left[\beta - \gamma(1+\eta)(\rho-g)\right. \\ &\quad \left. +0.5\gamma(1+\eta)\left[1-\gamma(1+\eta)\right]\sigma_{w,o}^2\right], \end{aligned}$$

where

$$\begin{aligned} \Delta &= \alpha^2\sigma_y^2 - 2\alpha\alpha^*\sigma_{yy^*} + {\alpha^*}^2\sigma_{y^*}^2 \\ \sigma_{w,o}^2 &= n_d^2\alpha^2\sigma_y^2 + 2n_d n_d^*\alpha\alpha^*\sigma_{yy^*} + {n_d^*}^2{\alpha^*}^2\sigma_{y^*}^2 + \sigma_z^2 \\ &\quad -2n_d\alpha\sigma_{yz} - 2n_d^*\alpha^*\sigma_{y^*z}, \end{aligned}$$

as they are shown in equations (20) and (21).

B Second-Order Conditions

To guarantee that consumption is positive in the domestic open economy we impose the feasibility condition that the marginal propensity to consume out of wealth [see equation (19)] must be positive because wealth does not become negative:

$$\frac{1}{(1-\gamma)(1+\eta)}\{\beta-\gamma(1+\eta)(\rho-g)$$
$$+0.5\gamma(1+\eta)[1-\gamma(1+\eta)]\sigma_{w,o}^2\}>0.$$

For the first-order optimality conditions to characterize a maximum, the corresponding second-order condition must be satisfied; that is, the Hessian matrix associated with the maximization problem and evaluated at the optimal values of the choice variables:

$$\begin{bmatrix} (\gamma-1)\left(V'(W)\right)^{\frac{\gamma-2}{\gamma-1}} & 0 \\ 0 & V''(W)W^2\Delta \end{bmatrix}$$

must be negative definite,[30] which implies the following:

$$\begin{aligned} (\gamma-1)\left(V'(W)\right)^{\frac{\gamma-2}{\gamma-1}} &< 0 \\ V''(W)W^2\Delta &< 0, \end{aligned}$$

[30] See Chiang (1984: 320-323), for example.

where $\Delta > 0$ (in a risky economy) was previously defined in equation (20). To evaluate those conditions, first we obtain the value of the coefficient A in equation (56):

$$A = \frac{g^{\eta\gamma}}{\gamma(1+\eta)} \left(\frac{C}{W}\right)^{\gamma-1}, \tag{58}$$

where C/W is the optimal value given by equation (19). Next, we insert equation (58) into the value function (55). Noting that $g = G/W$, the value function is given, after some algebra, by this equation:

$$V(W) = \frac{g^{\eta\gamma}}{\gamma(1+\eta)} \left(\frac{C}{W}\right)^{\gamma-1} W^{\gamma(1+\eta)}, \tag{59}$$

where we can observe that, given the restrictions on the utility function, $V'(W) > 0$ and $V''(W) < 0$, provided that $C/W > 0$.

In addition, we impose that the macroeconomic equilibrium must satisfy the transversality condition to guarantee the convergence of the value function:

$$\lim_{t\to\infty} E\left[V(W)e^{-\beta t}\right] = 0. \tag{60}$$

Let us now show that satisfying the feasibility condition is equivalent to satisfying the transversality condition.[31] To evaluate equation (60), we begin by expressing the dynamics of the accumulation of wealth:

$$dW = \psi W dt + W dw. \tag{61}$$

The solution to equation (61), starting from the initial wealth $W(0)$, is given by the following equation:[32]

$$W(t) = W(0)e^{(\psi - 0.5\sigma_w^2)t + w(t) - w(0)}.$$

[31] See Merton (1969) and Turnovsky (2000).

[32] See Malliaris and Brock (1982: 135-136), for example.

Because the increments of w are temporally independent and are normally distributed, then we have the following equations:[33]

$$\begin{aligned} E[AW^{\gamma(1+\eta)}e^{-\beta t}] &= E[AW(0)^{\gamma(1+\eta)}e^{\gamma(1+\eta)(\psi-0.5\sigma_w^2)t+\gamma(1+\eta)[w(t)-w(0)]-\beta t}] \\ &= AW(0)^{\gamma(1+\eta)}e^{\left[\gamma(1+\eta)(\psi-0.5\sigma_w^2)+0.5\gamma^2(1+\eta)^2\sigma_w^2-\beta\right]t}. \end{aligned}$$

The transversality condition (60) will be satisfied if and only if

$$\gamma(1+\eta)\left\{\psi-0.5\gamma(1+\eta)\left[1-\gamma(1+\eta)\right]\sigma_w^2\right\}-\beta<0.$$

Now substituting equations (15) and (19), this condition is equivalent to:

$$\frac{C}{W}>0,$$

and, therefore, feasibility also guarantees convergence.

Finally, it should be noted that because the public sector equilibrates its budget continuously, the intertemporal budget constraint of the public sector is satisfied trivially.

[33] See Malliaris and Brock (1982: 137-138), for example.

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