The Effect of Capital Controls on Foreign Direct Investment Decisions Under Country Risk with Intangible Assets

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Abstract

This paper examines how capital controls affect FDI decisions and how the impact of these restrictive measures varies with different levels of country risk. We construct a model of firms' FDI decisions, broadly in Dunning's "eclectic theory" framework, using "real options" to emphasize economic uncertainty and country risk. Numerical results of the model take the form of "quality statistics" that uncover the underlying dynamics hidden in the aggregate data that is responsible for the low performance of recent empirical studies. We find that increasing levels of capital controls reduce the life-span of FDI investments at each level of country risk and foreign investors' willingness towards risk sharing increases. We reveal a significant interaction between capital control and country risk, resulting in a nonlinear relationship between these and the volatility and volume statistics. We estimate a standard cross-sectional model that provides strong support for our theoretical findings.

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I. INTRODUCTION

Reversing the trend toward extensive capital market liberalization that dominated economic theory in the 1990's, as an aftermath of the recent Asian crises, a new stream of policy agenda has emerged with an unconcealed protectionist overtone regarding capital movements. The majority of the resulting publications concentrates on how restrictions on capital movements can improve the stability of a country's total capital inflows, by diverting their composition toward long-term capital, particularly foreign direct investments, that is by assumption considered to maintain superior qualities over short-term capital. By doing this they ignore the fact that financial markets for different types of capital flows are interrelated, hence taking actions with the aim to curb short-term capital flows induces an effect on the stability properties of long-term investments as well, altering the overall impact of these measures. Moreover, the effectiveness of capital controls is ambiguous even in the case of short-term capital restrictions as it highly depends on the imposing country's economic characteristics, particularly its overall business climate or country risk properties. Despite their salient economic policy impact the interactions between restrictions on capital flows and FDI received only limited attention in the literature that is dominated by the short-term aspects of capital controls (Rodrik and Velasco, [31], Montiel and Reinhart, [26]), while the relationship between country risk and the effectiveness of capital control is entirely neglected in the theory. The purpose of the paper is ,therefore, to provide a theoretical analysis to address these issues, by investigating how capital controls affect FDI decisions and how the impact of these restrictive measures varies with different levels of country risk. It also contributes to the empirical literature by generating a series of testable hypotheses that improves the performance of the prevalent econometric models.

Capital controls are administrative measures initiated by governments to alter the composition or size of foreign investments, and also to restrict capital outflow of the economy. According to the IMF, by the end of 1996, from a total of 168 countries 144 used some type of controls to promote direct investment (mainly profit repatriation restrictions), 128 countries controlled transactions in capital market securities, and 112 countries regulated trade in money market instruments (Hartwell,[20]). Proponents of these restrictive measures argue that they can help to combat volatility of investments flows and prevent contagion by segregating the economy from the rest of the world. Capital controls are conceived to be particularly effective when financial markets are not well developed, by offering protection against speculators and allowing governments to buy time acting like a temporary last resort. The so-called second-best arguments (Ariyoshi et al.,[5], Cardoso and Laurence, [24]) also suggest that capital account restrictions can be welfare improving by adjusting for financial market imperfections, especially in the case of asymmetric information. Krugman ([23]) and Rogoff ([32]) are the most prominent proponents of capital controls emphasizing the beneficial effects of restrictions as means to at least temporarily avoid major capital flight in the case of a financial crisis and also to divert the composition of capital flows toward long-term investments such as FDI. Not questioning the validity of these statements there are some issues that we have to consider. As Asiedu and Lien (Asiedu and Lien, [6]) note capital controls fall into two categories: administrative or direct controls and indirect controls where the former restrict capital movements through outright prohibitions, while the latter exercise market-based control by introducing multiple exchange rate systems and other indirect regulatory measures. According to the above definition, capital controls, especially market-based measures affect all types of capital by indirectly increasing the costs of capital movements and associated transaction. Therefore, restricting short-term capital might indeed decrease the volume of volatile short term flows but at the same time it can reduce the stability of the long-term investments as well thus its total effect becomes ambiguous. Also capital controls can divert the composition of capital might towards long-term flows, yet the overall amount of capital stock (including long-term flows) might decrease as a reaction to the restrictive measures that drive out both short and a lesser, but significant extent long-term flows. Therefore, neglecting the effect of capital controls on long term flows, especially FDI, can result in policy mismanagement due to the inconsistency of the attempt to attract long term, favorably foreign direct investment flows and to restrict short term flows at the same time. Furthermore as Asiedu and Lien argue that most developing countries receive very little amount of portfolio investments, hence the impact of capital restrictions on private foreign investments is determined predominantly by how controls effect FDI movements.

Therefore to complete the analysis on the nature of capital controls, it is of particular importance to gain insight how these measures alter the behavior of foreign direct investments. The prevalent scarce and predominantly empirical literature, analyzing the effect of capital controls on foreign direct investments is, however, not capable to shed light on these matters. The existing studies are inconclusive even about the sign of the impact of restrictions. Some authors find evidence that capital controls deter FDI (see Desai et al.,[10], Mody and Murshid, [25], Ariyoshi et al.,[5]), while others state that restrictions aiming to decrease short-term flows induce a larger inflow of FDI (Montiel and Reinhart,[26]). In a summary of empirical studies on the effects of capital controls, Eichengreen (Eichengreen, [17]) found no decisive results in favor or against the assumption that lifting capital controls enhances the overall volume of capital flows.

The inconsistency of the empirical analyses of capital control and FDI arises from the complex interactions among microeconomic variables that determine the aggregate capital movements. According to Ariyoshi et al. it is very hard to differentiate between the effects of capital controls and other factors in explaining the changes in the underlying variables altogether as the effects are hard to disentangle from the aggregated data analyses. The paper tackles this problem by approaching it from the microeconomic level, analyzing how single foreign direct investment decisions alter when controls on capital movements are introduced. The analysis tackles this problem by approaching it from the microeconomic level, analyzing how single foreign direct investment decisions alter when controls on capital movements are introduced. I apply a stochastic dynamic decision theoretical model with fixed intervention costs to increase control over the operations. The imposition of fixed intervention costs allows us to incorporate a specific attribute of foreign direct investments, that is, that they are managerial level decisions that are large in volume and costly to reverse, and as such they don't take place permanently but irregularly. By applying the model the hidden dynamics behind the aggregate capital flows are revealed, allowing us to make more adequate statements on how these are affected by specific restrictive measures and also enables us to investigate the interaction between the changes in the economic environment, e.g. changes in the country risk, and the impact of capital controls. This is an addition to the theoretical literature, as there is no attention devoted to the examination of how the country environment alters the effectiveness of capital controls. Based on the prevailing FDI theories the core determinants of foreign direct investment decisions on exit, entry and ongoing investments are determined taking into consideration the risks attached to entering a particular economy. Then restrictions on capital flows are incorporated, by introducing a capital control tax on capital transfers to examine the effect on the volume and duration of FDI flows. By using the model simulations to generate hypothetical foreign direct investment paths, simulated statistics are generated for different stability measures that comprise average life-span, volume, volatility and average ownership acquisition rate. The findings of the micro decision model are then translated into a system of hypotheses and an empirical investigation is performed. It is shown that extending the prevalent analyses with the findings on microeconomic decisions we can create a conclusive model on the sign and impact of capital restrictions on FDI.

The paper proceeds as follows. The next section discusses the stochastic dynamic decision theoretical model with capital controls represented as taxes on international transfers. Section three examines the investment decisions and the theoretical effects of capital controls on the major qualitative characteristics of aggregate FDI flows: duration, volatility and volume. Section four contains an empirical investigation of the stability of FDI flows with respect to country risk and capital control, using the results of the theoretical model, while section five concludes. The Appendix contains the mathematical apparatus for the solution of the model and also describes the numerical solution method used in the paper.

II. THE MODELING FRAMEWORK

A. THEORETICAL BACKGROUND

To setup the modeling framework we can take advantage of the prevailing FDI literature. Dunning's *eclectic theory* (Dunning, [14],[15],[16]) is a natural starting point for this purpose. According to the eclectic paradigm, foreign direct investments are driven by three motivating factors: ownership advantages, location advantages, internalization advantages (OLI). Ownership advantages refer to endogenous, firm-specific characteristics such as unique technology, brand-name, managerial or organizational structure that offset the additional costs of conducting business in a foreign environment that arise from differences in culture, language, customs, legal framework etc. Location advantages are exogenous to the firm comprising differences among prices of the factors of production located in different countries. The diverse spatial distribution of internationally static factors can give rise to the emergence of foreign production. Internalization advantages refer to replacing market transactions by extending internal operation. These imperfections comprise externalities that can take the form of government regulations and controls and information asymmetries. Internalization advantages also arise from the difficulty in contracting firm-specific, knowledge assets. The presence of market imperfections prevent efficient operation internationally through the markets therefore foreign firms ’internalize’ markets into their firm through acquiring ownership in the previously marketed transactions.

This idea is investigated further in the *property rights approach* by Grossman and Hart (Grossman and Hart ,[19]). They stipulate that intangible assets are crucial determinants of the amount of control obtained by foreign investors, since these enable firms to operate efficiently in a foreign environment where domestic firms have various advantages. The more intangible assets are provided by the foreign investors to the operation of the domestic firm, the more reluctant the investor becomes to share information and the more he insists on full control or majority-ownership in order to limit the spillover of the proprietary knowledge. As indicated by the *property rights approach,* ownership matters when a contract is incomplete. The incompleteness of the majority of real life contracts arises from the infinity of contingencies that does not allow to specify all the circumstances of asset usage under different occurrences. Therefore the owner of the asset has the right to decide on its employment in any way not inconsistent with the prior contract, custom or law. If contingent contracts could be established to protect the intangible asset provider (i.e. complete contracting is possible), ownership structure would not matter even if there is information asymmetry between the domestic firm owners and the foreign investor.

As in the case of real life investments inputs and the resulting outputs are most of the time unobservable and well-specified contracting mechanisms are not in place, the lack of control can lead to the loss of the intangible knowledge capital of the firm. This type of connection between intangible investments, incomplete contracting and knowledge outflow is of crucial importance in the FDI literature as the use of technological knowledge plays a vital role in these types of investments. Foreign direct investment flows can provide external benefits to their host economies. These benefits correspond to the fact that foreign firms assets contain non-proprietary parts that spill over to the industry and later to the whole economy in they are operating. As Graham and Krugman (Krugman, [18]) argue technology diffusion plays an important role even in advanced economies such as the United States. Spillovers are desirable for host economies but if these become extensive due to unclear laws governing intellectual property rights that create a nontransparent economic environment, they can discourage foreign investment as investors become reluctant to put strategically important processes or technology in the host economy.

The above discussed models provide static explanations for the emergence of foreign direct investments. FDI decisions, however, similarly to other financial investment decisions, are dynamic in their nature as their returns spread out in time. According to Aharoni (Aharoni, [1]), the investment process takes place under uncertainty, involves different organizational levels, consumes a long period of time and the decision evolves from many intertemporal bargains and commitments within the organization. Investors have the flexibility to adapt to the changes in the economic environment by revising their earlier decisions. Therefore we cannot assume that foreign direct investors are committed to a certain type of operating strategy forever.

To get a full picture we have to incorporate the elements of the theory of finance into the theoretical framework by determining the factors that effect the timing and duration of investment flows. The most important issue is the dynamic uncertainty involved in foreign operation. The above discussed theories emphasize static uncertainties arising from the unfamiliarity of the foreign operating environment, but neglect the issue of uncertainties arising from the dynamic changes in the economic environment. These give rise to questions of optimal strategic decisions on entry, exit and intensity of operations. Dynamic uncertainties comprise two major factors: operational uncertainty characterizing the business risk involved in similar types of businesses, and country risk that comprises the risks involved in choosing a specific location of operations. The major difference between the two types of risks is that business risks are predictable, while country risk is unpredictable to the investors. As business risk can be more or less treated similarly, independently of the location of the firm, it is not responsible for the emergence and continuity of foreign investments. Country risk, however, constitutes a major factor determining FDI decisions. Moosa (Moosa, [27]) defines it as the 'exposure to a loss in cross-country transactions, caused by events in a particular country that are, at least to some extent under the control of the government but definitely not under the control of a private enterprise or individual'. Pool-Robb and Baily (Pool-Robb and Baily,[30]) decompose country risk into political and economic factors. Political factors comprise war, disorder, change in the attitude of domestic consumers, government, changes in the rules and regulations The effects of political risk on the cash flows can vary from outright expropriation to changes in the tax or tariff laws. According to Moosa (ibid.) the economic factors refer to the 'current and potential state of the economy'. These comprise several indicators like interest rate, inflation or exchange rate, economic growth, fiscal balance, unemployment, the extent of export reliance, the balance of payment etc. The effect of country risk may differ for different businesses. Although the overall risk assessment of a country is the same for all actors in the economy there might be special risks attached to a particular industry or firm. Moosa refers to the example of legislations curtailing foreign ownership in strategic sectors, such as mining. This is evidently a country risk for those firms involved in the sector affected by the legislation but not for any other firms. To incorporate these issues into an assessment method he differentiates between macro and micro country risks, where the former covers the overall risk of a country without taking into consideration specific characteristics of the industry, where the investment takes place, while latter refers to the sensitivity of foreign investors' cash flows to changes in the economic environment thus it comprises country characteristics that are specifically related to the business, where the investor indulges.

B. THE MODEL

BASIC FDI PROBLEM, MODEL ASSUMPTIONS

Consider the decision of an investor to start operations in a foreign market. It is assumed that the investor owns a proprietary, *knowledge asset,* K_F, that he is able to take advantage of. In line with the *property rights approach* it is assumed that the knowledge asset is non-contractible thus if less than full ownership is obtained, the domestic managers of the firm are able to exploit K_F by setting up a new firm that is going to be the new competitor of the foreign firm. Domestic firms, operating on the market are similar to the foreign firm. The only difference between them and their foreign counterpart is their inferior knowledge base, K_D that makes their production less efficient. The knowledge advantage of the foreign firm, K_F over the knowledge base in the domestic economy, K_0, is represented by the efficiency factor ξ_0, thus $K_{Ft} = K_0\xi_0$ The intangible asset, ξ_0, is a constant efficiency parameter multiplying the tangible capital asset, K_0, prevalent in both domestic and foreign owned firms. It is assumed that knowledge is a static attribute to the firm thus the investors are not able to change its quantity. It is also assumed that the knowledge advantage of foreigners decreases over time with K_F staying constant, due to the spillovers from the foreign firm to the local competitors. Using this argument, the knowledge base of the domestic firms can be represented as $K_{D_t} = K_0(\xi_0 - \xi_t)$ with ξ_t characterizing the efficiency differential at time t. The speed of the decrement depends on the ability of the local firms to absorb the new technology and also the laws governing property rights that avoid knowledge leakages. In the paper these factors are going to be referred to as transparency/spillover factors, κ, of the economy. In accordance with Grossman and Hart (Grossman and Hart ,[19]) it is assumed that ownership and control are integrated and the more control/ownership is obtained the spillovers can be reduced, thus the transparency factor is decreasing with increased control, b and thus $\frac{d\kappa}{db} < 0$. Assuming exponential decay of the knowledge differentials the actual amount of efficiency gap, ξ, can be represented as follows:

$$\xi_t = \xi_0 \exp(-\kappa(b)t)$$

or

$$d\xi = -\kappa(b)\xi dt$$

It is worth to note that the properties of the spillover function induces $K_{D0} = 0$ and $K_{D\infty} = K_{F_t} = K_0\xi_0$. Investors can enter the domestic market by acquiring some part of a domestic firm's assets or creating a venture with a domestic firm by acquiring b ownership share of the investment. Ownership share in the firm refers to the total amount of liabilities comprising debt instruments as well. This assumption eliminates the problem that equity investments are 'bolted down'. [1]When entering the market foreign investors also have to make a one-time investment, c_I into the knowledge asset, K_F to achieve an efficiency gain of ξ_0 over the domestic firms . The cost of this investment is assumed to depend positively on the knowledge differential, thus: $\frac{dc_I}{d\xi_0} > 0$. It is assumed that firms similar to the domestic firm offer the same gains all over the world. This assumption allows us to depart from questions on the possible entry modes and the methods of selecting the appropriate location that is not a matter of interest for the investigation.

After the entry decisions made, the investors enter the operation faze of their investment. By employing the superior knowledge asset they can extract extra rents compared to the firms in the market conducting similar business, thus they can increase the value of their firm above its purchase prize. The actual amount of value increase is not observable to external actors of the firm thus the investors are not interested in selling the firm immediately after entering the market[2]. The target industry can be characterized by a single production good with a hyperbolic overall demand. As we are not interested in the effect of consumer preferences on corporate decisions at this stage we can simply assume that the demand function has a unit elasticity and takes the following form:

$$P = \frac{\theta}{Q_D} \tag{1}$$

where P is the price of the single good produced, Q_D is the domestic demand and θ is a demand parameter comprising the uncertainties originating from the business. In accordance with the financial literature θ is assumed to evolve according to a geometric Brownian motion. Assuming that the $(\Omega, \mathcal{F}, Q_P)$ tuple is a complete probability space with a filtration $(\mathcal{F}_t)$ satisfying the conditions of right continuity and augmentation by Q_P- negligible sets, θ is the solution of the following stochastic differential equation:

$$d\theta = \mu \cdot \theta dt + \sigma\theta dz \tag{2}$$

where μ is the growth rate of the market demand. The variability of firm specific shocks is denoted by σ and it is assumed to be a constant and z is a standard one-dimensional $\mathcal{F}_t-$measurable Brownian motion. In accordance with the *dynamic theory* it is also assumed that in excess of the inherent business risks there is an external risk called country risk, present beyond the control of the investor also determining the feasibility of an FDI project. For the purposes of the model I will use the definition of microeconomic country risk, defined

[1] Hausmann and Fernandez-Arias[21] argue that foreign investors can decrease their *net* ownership (or their interest) in a firm through acquiring debt by using the firm's assets as collateral. In this case FDI is decreased by the acquired debt amount , which is counted as an outflow in the current account.

[2] This eliminates the agency problems due to the asymmetric information, by assuming that the market pays only the minimum price for the firm.

by Moosa (ibid.), that takes into consideration the particular characteristics of the foreign investor's activities in the host economy. To incorporate the unpredictable changes in the economic environment, country risk is assumed to effect the demand for the goods produced by the firm through a Poisson component that is added to the motion of θ in the following way (Vollert, [35]):

$$d\theta = \mu_0 \theta dt + \sigma \theta dz - \eta \theta dq \tag{3}$$

where, q represents the Poisson process, and η the severity of a negative change in the economic environment[3].

$$dq = \begin{cases} 1 \text{ with probability } pdt \\ 0 \text{ with probability } 1 - pdt \end{cases}$$

where p is the country risk parameter representing the probability of the occurrence of a change in the economic environment over the next infinitesimal time period. The Poisson part is considered to be not diversifyable, so markets attach a risk premium to it. Therefore, the motion of the demand parameter can be written in the following form using the equivalent martingale measure to incorporate the market price of risk:

$$d\theta = (r - \delta + p\eta)\theta dt + \sigma\theta d\widetilde{z} - \eta\theta dq = \mu_0\theta dt + \sigma\theta d\widetilde{z} - \eta\theta dq \tag{4}$$
$$d\widetilde{z} = \frac{\mu_0 - r - p\eta}{\sigma} dt + dz$$

where the first term in the second equation is the market price of risk including a Poisson risk component.

Profits of the firm under domestic and foreign ownership are represented by the following Cobb-Douglas type functions:

$$\begin{aligned} f_F &= PK_{Ft}^{\alpha} L_{DFt}^{1-\alpha} - cL_{DFt} \\ f_D &= PK_{Dt}^{\alpha} L_{DDt}^{1-\alpha} - cL_{DDt} \end{aligned} \tag{5}$$

where P is the price of the good and c is the cost of the flexible asset , α is the coefficient of the Cobb-Douglas function, the knowledge type asset is represented by K_i and a flexible domestic asset, such as labor is denoted by L_{Di}, where $i = F, D$ referring to foreign and domestic ownership respectively. It is assumed that firms are price takers on the global level therefore we can omit the questions of collusive actions. The instantaneous profit

[3] The smaller the level of η the less severe is the effect of a negative change.

maximization problem of the firms are the following:

$$f_{F_t} = \max_{L_{Dt}} P_t K_{Ft}^{\alpha} L_{Dt}^{1-\alpha} - cL_{Dt} \tag{6}$$

Therefore after the maximization the profit function takes the following form (see Appendix for further details):

$$\begin{aligned} f_{Ft} &= \frac{\alpha\theta\xi_0}{2\xi_0 - \xi_t} \\ f_{Dt} &= \frac{\alpha\theta(\xi_0 - \xi_t)}{2\xi_0 - \xi_t} \end{aligned} \tag{7}$$

In line with the *static approaches* of FDI, it is assumed that foreign operation involves some additional costs apart from the normal costs due to the lack of knowledge about the foreign market and on the other hand to the uncertainty of the investment climate. Anderson and Gatignon (Anderson and Gatignon,[3]) claim that increased ownership increases exposure to risk resulting in high-control modes with high returns and risks, and low-control modes (e.g. licences and other contractual agreements) with low risk and returns. Therefore foreign investment can be viewed as a trade-off between control and cost of resource commitment. It is also assumed that the costs of the investment and the growth opportunity are influenced by the country risk factor, imposing additional costs on the investors in the form of decreased liquidity and also increasing the overhead costs through increased uncertainty. Therefore we can write the operating cost function in the following form: $C_M = C_M(b, p, \xi_t)$, $\frac{dC_M}{db} > 0$, $\frac{dC_M}{dp} > 0$.

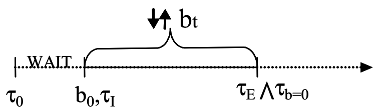
During the operation period foreign investors are able to change their control over the assets acquired, by changing their ownership share in the firm's assets. In accordance with the property rights approach, changing ownership involves transaction costs, that is attributed to incomplete contracts. As actual performance is non-observable, market participants are not equally informed about the true value of the firm. Also due to the asset specificity the circle of potential buyers is very limited. These characteristics will induce costs on investors when buying or selling their assets as they have to find their transaction counterparts. To change the level of ownership, therefore, it is assumed that investors have to pay a transaction cost T that depends on the amount of acquired or sold ownership, the level of country risk, and the actual value of the firm, denoted by V, thus $T = T(t, b, b', p, V_t)$, where b' is the new level of ownership. It is assumed that the higher the absolute value of the change in ownership $|b - b'|$, the higher the level of the transaction cost, $\frac{\Delta T}{\Delta(\Delta b)} > 0$. The transaction cost also depends on the level of country risk. Higher level of country risk makes it the harder to sell the assets of the firm. Empirical studies show that as country risk increases, the liquidity of the firm's assets decreases as uncertainty over the country environment makes potential buyers more reluctant to invest in the market. This induces an extra cost on the investors as it is becomes more time consuming an costly to find an appropriate buyer. This assumption is incorporated in T by assuming that it contains a fixed cost part positively dependent on the country risk parameter, $\frac{dT_{Fixed}}{dp} > 0$. This excess cost corresponds to the general characteristics for the ownership stakes in the firm. The more liquid the assets of the firm are the smaller is the amount of the fixed cost involved in the transaction. Thus we can call the fix cost part of T as the liquidity cost of selling and buying assets hence as country risk increases investors become less willing to change their ownership in the firms assets. The introduction of fixed intervention costs allows us to incorporate a specificity of foreign direct investments that differentiates them from small scale portfolio investments. Unlike small scale portfolio investments, foreign direct investments are managerial level decisions that are large in volume and costly to reverse thus take place irregularly. The application of fixed costs will allow us to approach these decisions in a more realistic way. As Vollert (Vollert, [35]) argues optimal managerial strategy is only to take action when certain significant events occur, therefore they act only at certain time instances rather then continuously and in between they let the system move uncontrolled.[4].

Investors also have the option to exit the market any time without any compensation. According to Boddewyn (Boddewyn,[8]) there are two major causes of disinvestment in a firm 1) mistakes in pre-internationalization decisions and activities, and 2) changes in the host market conditions. The first group of triggers applies usually in the case of these firms that are inexperienced in international markets. Poor decisions may also be the outcome if the firm does not know how to collect sufficient information about the foreign market or it does not have enough resources for acquiring or analyzing the information. Nevertheless, unfavorable changes in the host country's economic environment are the most decisive determinants of divestments and export withdrawals. As Boddewyn claims divestments are in very few cases strategic decisions for they are the responses of environmental stimuli that were not anticipated. Divestment decisions differ from decisions under normal operation as time pressure in the case of divestments is likely to hasten and simplify the decisions. Due to these facts there is hardly any example of firms establishing clear criteria for divestment. Using the results of dynamic optimization we can claim that the exit decision of a firm is determined by whether its continuation value is larger than its selling value. In terms of foreign divestment Boddewyn claims that in the previous discrepancies are harder to detect, distance, psychological detachment and the more negative perception of foreign risk facilitate the persuasions of superiors as well as organizational commitment thus barriers to exit are considered to be lower than in the case of domestic divestment decisions Because of the relative indeterminacy of divestments to investment decisions it is very hard to set a model rule for the exit decision of firms. Nevertheless we can set a boundary condition stating that any time the foreign investor can decide to leave the country if the expected flow of proceeds of the project are less than zero.

Using the previous assumptions we can describe the decision process is a two stage problem that is pictured in Figure 1, where τ_I is the time of the entry, b_0 is the initial ownership, $\tau_E \wedge \tau_{b=0}$ is the first time the investor chooses to exit or to decrease its ownership share

[4] This is somewhat similar to the concept of menu cost of changing prices

FIGURE 1.



to zero.The foreign investor's objective is assumed to be the maximization of the dividend stream, bf_{Ft}, during his investment period less the extra uncertainty costs, C_M he has to bear from operating abroad. The assumption of discrete managerial decisions with a fixed part of the intervention costs, gives us the opportunity to formulate the model as an impulse control problem under uncertainty. In the operation period the investor is able to decrease or increase the level of ownership in the range $\mathcal{Z} = [b_{\min}, b_{\max}] = [0, 1]$ by paying the switching cost T . Then the corresponding impulse control strategy consists of a sequence of finite stopping times $t_i \in [\tau_I, \infty]$ and corresponding impulse controls of ownership, $\zeta_i = b_{t_i} = b_i \in \mathcal{Z}$ when the investor buys the firm at τ_I with an ownership share of b_0. Let $w \in \mathcal{W}$ be an admissible impulse control strategy. Then the problem can be represented as a continuous time stochastic dynamic optimal stopping problem with impulse control in b that takes the following form:

$$
\begin{aligned}
V_t = V(t, \theta_0, \xi_0, b_0) = & \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (8) \\
= \sup_{\substack{(\xi, b_{F0,}, \tau_I, \tau_{Exit}, w) \in \\ \mathcal{W} \times \mathcal{W} \times [0,\infty) \times [0,\infty) \times \mathcal{W}}} & \widetilde{\mathbb{E}} \Big[- e^{-\rho \tau_I} (V_{\tau_I} - T(\tau_I, \theta_{\tau_I}, b_{\tau_I}, 0, V_{\tau_I}, p) + c_I \xi_0) + \\
\int_{\tau_I}^{\tau_{Exit}} & \left[e^{-\rho t} b_t f_F(t, \theta_t, \xi_t, b_t) - C_M \right] dt - \sum_{i: \tau_I \leq t_i \leq \tau_{Exit}} e^{-\rho t_i} T(t_i, \theta_{t_i}, b_{i-1,} b_i, V_{t_i}, p) \Big]
\end{aligned}
$$

$$
\begin{aligned}
V(\infty, \theta_\infty, \xi_\infty, b_\infty) &= b_\infty \frac{\alpha \theta_\infty}{2} - T_c(\infty, \theta_\infty, 0, b_\infty, V_\infty, p) \\
V(0, \theta_0, \xi_0, 0) &= 0
\end{aligned}
$$

where V_t is the value function of the foreign investor. This is a combined stochastic optimal stopping impulse-control problem with stochastic exit and entry times. These types of problems are described by Vollert (ibid.), and Oksendal and Sulem (Oksendal and Sulem,[28]) in great detail. Unfortunately the solution of the problem does not allow for analytical approaches, therefore we have to rely on numerical methods (see Appendix for further details).

INTRODUCING CAPITAL CONTROLS

Capital controls are imposed to limit the volatility and increase the maturity- thus increase the overall stability- of capital flows. Germane to this idea, by restricting capital movements policy makers attempt to change their country's foreign capital composition to FDI that is argued to be less prone to detrimental changes in the economy. Although these measures might be successful in tilting foreign capital inflows towards foreign direct investments they can also alter their qualitative properties. Using the theoretical model developed in the previous section we are able to create measures for stability of FDI flows. Capital controls are assumed to penalize capital transfers from the restricted market to another. As they restrict the flexibility to all capital owners to withdraw or invest their funds into the economy they create excess cost for the foreign investors who would like to circumvent them. Foreign direct investors are affected by capital controls through two channels. First, capital controls increase the cost of borrowing in the restrictive economy that increases the cost of capital for affiliates of multinational firms that fund themselves from the local market (see Desai et al., [11], Dooley and Isard, [13]). Second, capital controls also entail profit repatriation restrictions that reduces the effective returns of foreign direct investors. Multinational corporations can avoid these by tailored transfer pricing policies, yet this is cumbersome and costly to organize. By capturing the cost characteristics of capital controls we are able to model them as either direct or indirect taxes on capital transfers. This is similar to the idea used by Black, [7], Stulz,[33] and Campion et al.,[9], who model restrictions to international capital movements as taxes that obstruct net investment or make it costly to hold risky foreign securities. The basic model can be extended by introducing a tax, γ, on the profits realized by the firm. Profits in the model are generated by two sources: 1. operating profits, f, 2. through selling parts of the firm's assets. Assuming that both types of profits are affected by the restrictive measures the same way we can adjust the model in the following way:

$$
\begin{aligned}
f_{ci} &= (1-\gamma) f_i, i = F, D \\
T_c &= (1 - T_{variable}(t, \theta, b, b', V, p))(1-\gamma)
\end{aligned}
\tag{9}
$$

where f_c is the tax adjusted profit and T_c is the adjusted variable part of the transaction cost after the ownership changes from b to b'. We can formulate this problem similarly to the base line case by substituting the dividend and cost functions with their modified counterpart. The following example characterizes a numerical solution using specific functional forms and parameter values.

Example 1 *Let the spillover function be given by $\kappa(b) = k + \Lambda(1-b)$, which satisfies the assumptions that it be decreasing in b, where $0 \leq b \leq 1$. Consider a strictly convex cost function of foreign operation $C_M = c(b,p) = c_1 b^2 + c_2 p$, where the first part indicates that higher amount of ownership increases the cost of uncertainty due to the unfamiliarity of the foreign environment and the second part indicates that increasing country risk increases the foreign of operation as it makes the business environment unsafe. The initial investment into the intangible asset is assumed to take the following form: $c_I = c_5 \xi_0$.The transaction cost function is the following without capital controls:$T(b_t, p, V_t) = |b_i - b_{i-1}|\, c_2 V(i, \theta_{i-1}, \xi_{i-1}, b_{i-1}) + c_3 p$. The parameters of the model are arbitrary chosen to be equal to: $\Lambda = 1$, $k = 1$, $\eta = 0.3$;*

$c_1 = 3$, $c_2 = 1$, $c_3 = 0.2$, $c_4 = 1, c_5 = 1, \sigma = 0.3$, $r = 0.04$, $\delta = 0.02, \alpha = 0.4$. *The choice of* r *is the standard real interest rate value in the US. Parameter* α *coincides with the estimates for the US economy and also with several developing economies (see Albuquerque,* [2]*).The grid for the numerical analysis is created by taking according to parameters:* $\Delta\xi = 0.08$, $\xi_0 = 10$, $\theta_{\max} = e^{15}, \theta_0 = e^3, \Delta\theta = \sigma\sqrt{3\Delta\xi}$[5], $\Delta b = 0.1$.

III. Theoretical analysis of capital controls

To analyze the problem we have to create measures that describe the quality of FDI flows. The natural candidates are measures describing volatility,duration and volume of the projects. As the solution of the model provide exit and entry times we can create a duration measure (DUR) from their difference: $(\tau_E \wedge \tau_{b=0}) - \tau_I$. The measure for the foreign direct investment is derived from the numerical solution of the value function in the following manner: $\Delta FDI_t = \iota \frac{\Delta V_t}{\theta_t}$, $\iota = \begin{cases} 1, \ b' \neq b \\ 0, \ b' = b \end{cases}$. The change in the investment level is given in terms of the overall output parameter, θ_t As volatility measure we can use the coefficient of variation of the FDI path.

Before analyzing the effects of capital controls on the qualitative properties of FDI, it is worth to investigate how the various parameters impact the model's results. A change in the discount rate r decreases the future value of the profit stream the foreign investor realizes, that makes them less willing to stay longer and also increases the value of the investments. The increase in the level of transparency(decrease in Λ, k) decreases the willingness to increase the ownership stake in the economy as there is now need to ensure the safety of intangible asset property rights through ownership. This will induce the overall amount of ownership stakes to decrease. This finding is in accord with the empirical research done by Hausmann and Fernandez-Arias (Hausmann and Fernandez-Arias,[21]) who have found that the more market inefficiencies one can find in an economy the more incentives are present for FDI. The various cost parameters reduce the available cash flow for foreign investors thus decreasing the attractiveness of staying in the local economy. This in turn leads to a shorter longevity of foreign investment projects and a smaller overall volume. The increase in the fixed cost of ownership changes leads to a more sluggish change in the ownership structure. The increase in the variance σ leads to a larger FDI volume and longer duration of investments. Higher volatility, namely, increases the chances of hitting very positive demand values, while the opportunity of loss is limited from below by zero[6]. Increased volatility causes higher trigger values of changes in ownership because the risk represented in the Wiener process is assumed to be market priced. Higher overall growth in the industry μ leads to higher trend-growth of future cash inflows that in turn will lead to an increase in FDI. The parameter α has an effect

[5] Chosing this spacing allows for the most robust numerical solution; see Hull and White for further detail[22]

[6] This is in line with standard option theory. See for example Hull[22] for further detail.

on the profit stream of the firm. The more knowledge asset specific is the production the more extra benefits can be created through the intangible foreign investment, which will lead to a greater volume of FDI with a longer duration.

I have simulated the sample path of θ in the underlying model, $N = 5000$ times over a 10 year period, assuming that the initial knowledge differential ξ_0 disappears at the end of the tenth year. Based on the sample paths I created the optimal threshold levels for exit entry and ownership changes for different levels of country risk ,p,and capital control,γ and simulated the actual amount of foreign direct investments flows. The overall levels of the quality measures were calculated as averages of the statistics in the single simulation paths. The next part of this chapter summarizes the results of the model simulations.

A. Model statistics

Figure 2 reports the average life-span values of the FDI projects with varying country risk and capital controls.

FIGURE 2. AVERAGE DURATION OF FDI PROJECTS

γ \ p	0.00	0.05	0.10	0.15	0.20	0.25	0.30
0.00	9.680	7.807	4.784	3.161	2.357	1.817	1.547
0.04	9.680	7.701	4.707	3.083	2.330	1.810	1.489
0.06	9.680	7.670	4.604	3.011	2.302	1.784	1.564
0.08	9.680	7.635	4.510	3.094	2.217	1.759	1.468
0.12	9.664	7.535	4.492	2.954	2.191	1.695	1.407

The duration of FDI investments decreases at each level of country risk with increasing barriers to capital movements reflecting that strict capital control measures decrease the flexibility of the managers in deciding on the allocation of their investment proceeds, therefore they choose to reduce their operation in the market. The marginal effect of country risk on duration is also negative for every level of capital control. Comparing the effects of capital controls at different levels of country risk, shows that countries with higher risk experience a larger decrement in the average project life-span of their net FDIs. The negative impact rises from 0.002 percent to a significant 10 percent level when p reaches 0.3. Therefore introducing capital controls in riskier economies induces a sharper loss in terms of the duration of the FDI projects.

FIGURE 3. NO ENTRY PERCENTAGE N=5000

γ \ p	0.00	0.05	0.10	0.15	0.20	0.25	0.30
0.00	0.02%	4.02%	12.28%	17.84%	26.46%	31.46%	47.66%
0.04	0.02%	5.18%	12.28%	19.46%	39.24%	44.02%	47.66%
0.06	0.02%	5.18%	13.82%	19.46%	39.24%	44.02%	78.54%
0.08	0.02%	6.28%	13.82%	32.86%	39.24%	44.02%	47.66%
0.12	0.26%	6.28%	13.82%	19.46%	26.46%	31.46%	47.66%

Another useful qualitative measure, derived from the model simulations is the percentage rate of cases when investors choose not to enter the market at all. Consistently with the analysis on the effects of country risk, we can see that the actual entry rate decreases both in p and γ As we assumed that market risk is not diversifiable, thus there is a risk premium added to the required rates of returns on the investments, the inactive project's value increases in p creating an incentive for investors to wait. As the fixed cost of entry also increases in the levels of country risk, this will have a negative effect on the entry times as well. An interesting outcome of the model is that more restrictive capital movement measures can induce investors to enter the market. As we can see, for higher levels of country risk and very high levels of capital control, investors decide to enter the markets more often than with lower levels of γ. The rationale behind this finding is that higher capital controls diminish the value of the option to invest in the market that offsets the value of waiting by increasing its opportunity cost and inducing lower trigger values for entry.

FIGURE 4. COEFFICIENT OF VARIATION N=5000

γ \ p	0.00	0.05	0.10	0.15	0.20	0.25	0.30
0.00	0.289	0.509	0.619	0.536	0.430	0.355	0.274
0.04	0.282	0.319	0.493	0.449	0.356	0.251	0.200
0.06	0.219	0.271	0.387	0.371	0.361	0.210	0.118
0.08	0.222	0.239	0.288	0.448	0.212	0.167	0.155
0.12	0.157	0.226	0.271	0.248	0.222	0.203	0.154

As we can see from Figure 4, the coefficients of variations take a variable pattern for different levels of capital control. The marginal effect of country risk, p, is nonlinear. As we can see, for every level of capital control, the coefficient of variations take a peak for mid-level risk economies and decreasing for both low and high risk economies. The hump-shaped curve can be explained by the complex liquidity-volume effect of country risk. On one hand, the probability of a large demand-drop rises reducing the overall value of the FDI investment. The diminishing value of the investment increases the trigger value of θ for exit, as investors are not able to hedge themselves against the unpredictable, negative Poisson occurrences [7]. On the other hand higher probability of detrimental effects induces a higher market risk premium with a larger θ trigger value that causes a deferred entry time (Dixit and Pindyck, [12]). Moreover, the fixed cost of ownership acquisition also increases in p, by the assumption that increasing country risk induces less frequent trade in the real asset markets. This will induce a later entry as the reward for investing is lower, and harder to find a matching selling party. The second effect of the increase in the fixed cost of changing ownership leads to a lower overall investment value and an earlier exit time, as decreased market liquidity reduces the flexibility of the decision maker to withdraw his funds. The resultant of the different effects will determine the actual characteristics of the FDI investment in terms of variable country risk. This suggests that aggregate measures of volatility in themselves cannot tell much about the actual characteristics of foreign investments. Both good and bad quality economies can have invariable direct investments, the cause of the low volatilities, however differ. Whereas in the former case the need for changing control over the assets is very low due to the low probability of negative changes in the demand, in the latter case, low volatility comes from the

[7] Poisson jumps were assumed to be nondiversifiable therefore their effect on the trigger values of θ is going to be negative. See Dixit and Pindyck, [12])

fact that the actual volume of investments is too low to induce changes in the desired levels of control, as the cost of imposing this changes outweigh their benefits.

The peculiar effect of country risk on the volatility of FDI also influences its cross-effect with capital controls, creating nonlinearity in that variable's marginal effect as well. For every level of country risk the variability of the inward FDI stream decreases for economies with more restrictive capital control measures. Comparing capital controls for countries with different country risk characteristics, however, reveals that restrictive measures induce the most significant decrease on the volatility of FDI in countries in the mid ranges for country risk, whereas their effect decreases for high risk economies. If we adjust the volatility measures by the average life-span of the projects we actually find that the overall volatility of the investments increases with more capital restrictiveness. Decrease in variability can only achieved with very strict measures that in turn will lead to a very low level of FDI. This will induce that countries with higher level of capital control and higher level of country risk attract on average more volatile foreign direct investments than countries with more liberal capital policy but lower levels of country risk. This result is of particular importance for empirical analysis by shedding light on hidden microeconomic dynamics and revealing the major factors that are responsible for shaping patterns of the macro FDI data.

FIGURE 5. AVERAGE VOLUME OF FDI N=5000

γ \ p	0.00	0.05	0.10	0.15	0.20	0.25	0.30
0.00	3.682	2.776	2.744	2.623	2.826	2.812	3.039
0.04	2.728	2.676	2.481	2.757	2.774	2.981	3.003
0.06	2.905	2.585	2.832	2.731	2.681	2.988	2.359
0.08	2.789	2.847	2.778	2.599	2.946	2.943	2.884
0.12	2.835	2.596	2.541	2.497	2.445	2.402	2.619

The values in Figure 5 indicate that country risk decreases the total amount of FDI investments (AVR) in the economy by increasing the total, fixed cost of capital movements. As expected the average volume of FDI is diminishing in both country risk and capital restrictiveness, thus countries attempting to decrease the volatility of capital flows by restrictions might experience that the desired foreign direct investment floes dry out as well. The nonlinearity in the effects of the capital control arise from the impacts of country risk discussed above.

FIGURE 6. AVERAGE OWNERSHIP SHARE N=5000

γ \ p	0.00	0.05	0.10	0.15	0.20	0.25	0.30
0.00	57.48%	34.69%	30.67%	30.01%	29.15%	29.61%	29.96%
0.04	47.32%	32.76%	30.09%	29.87%	34.53%	30.49%	31.36%
0.06	46.84%	33.13%	30.95%	30.52%	35.89%	31.17%	37.11%
0.08	46.43%	33.20%	31.48%	34.68%	31.27%	31.95%	32.23%
0.12	50.93%	32.40%	31.37%	31.42%	31.66%	31.97%	32.35%

Figure 6 shows the average level of required control over the investment period. Both increasing levels of country risk and capital control lead to lower amount of average ownership share in the FDI project. With increasing levels of country risk and capital controls foreign investors become ready to share the risks of unfavorable occurrences with the local firms even risking the loss of their proprietary knowledge through the amplified spillover effects.

B. EMPIRICAL ANALYSIS

After the theoretical analysis it is worth to take a look at some empirical facts on the stability measures of foreign direct investments to see how they compare with the theoretical findings of the analysis. I have used data on net FDI stock measured in terms of GDP for 84 countries taken from UNCTAD *Foreign Direct Investment Statistics* for the 1980-2001 period. Figure 10 in the Appendix lists the countries included in the sample. The measures for capital control were taken from the IMF *Annual Report on Exchange Rate Arrangements and Exchange Restrictions* publications for the same period. The index equals to one if capital control was present in the given year and takes the value of zero in the case of liberal capital policy. The country risk ratings were taken from the World Bank Database on *Foreign Direct Investment,* representing the institutional investor country ratings over the period. The index ranges from zero to 100, the higher values indicating a safer investment environment. As an additional country risk index I have chosen to include Moody's sovereign credit ratings, N, that measure the ability of countries to access international capital markets and is correlated to the general macroeconomic environment and can be used as a crude measure for country risk. I have created six groups based on the Moody's classification ranging from 1-6, denoting the groups $[Aaa, Aa, A, Baa, Ba, B, C]$. I have derived the coefficient of variations series, CV, for each country by calculating the mean corrected standard deviation of the logarithmic difference of net FDI stock series for the sample period. The volume measure, FDI/GDP , is the average net FDI stock in terms of GDP over the sample period. The IIR measure is the average institutional investment rating index for each country over the sample period. The capital control measure, CC was created by averaging the index values for the sample period for the individual countries.

FIGURE 7.

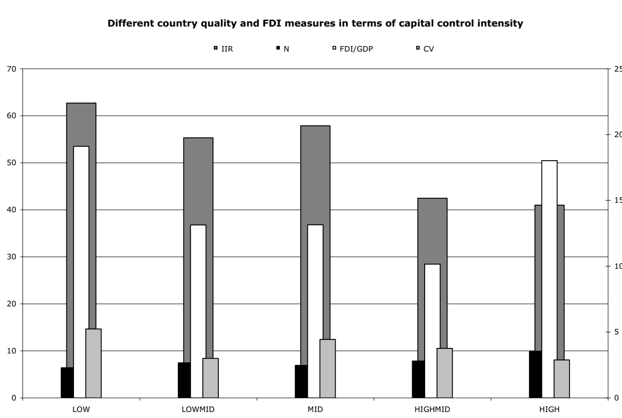


Figure 7 illustrates the stability measures for five levels of capital controls, ranging from low control to high control economies[8]. As we can see neither the volatility measure,CV, nor the volume measure, FDI/GDP, does show any particular pattern when grouped into categories, representing increasing restrictiveness. Figure 7 shows that country risk is increasing in economies with higher capital control as the IIR index decreases and also N the average Moody's index is increasing, indicating that riskier economies tend to impose more severe capital restrictions.

To analyze the effects of country risk and capital control on the volume and volatility of FDI, I performed a simple cross-country regression analysis for the 1980-2001 period. The dependent variables were FDI/GDP and CV. The theoretical findings of the previous section indicated that the relationship between both CV and country risk and capital control is nonlinear. To allow for different patterns in the volatility in terms of IIR and CC I have introduced a group of dummy variables $N_i, .i = Aaa, Aa, A, Baa, Ba, B, C$ that represent the groups of countries under similar sovereign risk based on the Moody's index. I have also created two larger groups $DD11$ and $DD12$ with the first containing the countries from N_1, N_2 and N_3 and $DD12$ the rest. Using these dummies we can obtain a fairly good fit in the predicted values. I have also included an additional variable, the average gross national income per capita, GNI, for each economy in the period to control for differences in their development levels. To avoid the estimation bias coming from the outliers in the data I applied DDD dummy for Hong Kong and Singapore. As the volatility and country risk measure IIR are dependent on each other I have used two stage least squares estimation ($TSLS$). I have applied N_i and GNI as instrument for IIR. Albuquerque (ibid.) suggests that the Moody's sovereign risk index is not driven by investment risk that drives the volatility of FDI thus it is exogenous to the dependent variable and can be applied as an instrument. Using N ,AVR, and $LNGNI$ as instruments we obtain an unbiased estimation of the volatility measure.

FIGURE 8. LNCV

Two Stage Least-squares Regression Estimates

Dependent Variable: LNCV

Variable	Coefficient	t-statistic	t-probability
IIR	0.009023	1.666082	0.099708
IIR*DD11	-0.014056	-3.219971	0.001870
CONST	1.575288	5.836109	0.000000
DD11.*CC	-0.416011	-1.834736	0.070358
DD12.*CC	0.014586	0.055057	0.956234

Adjusted R^2 = 0.2713
Durbin-Watson = 1.8068

Figure 8 reports the estimated coefficients of the most parsimonious model for the log

[8] The data is based on averaging 95 countries grouped by the country restrictiveness index provided by UNCTAD and UBS[4]. The FDI/GDP data is taken from the IMF online dataset.

volatility measure, CV. I have used the logarithmic transformation of the dependent variable and GNI to avoid heteroscedasticity. As we can see the variables account for a significant portion of the total variation in the volatility: 27 percent. The observed effects reflect the theoretical findings of the previous chapter. Confirming the nonlinearity in the country risk component, the slope associated with IIR in Figure 8 has a changing pattern for different levels of country risk. The coefficients of IIR and $IIR * DD11$ imply that increases in country risk for low risk economies induces a negative change in the volatility, while this pattern reverses for high risk economies. The change in sign in the marginal effect of IIR ,therefore,creates a hump shaped curve that is similar to the patterns arising from the model simulations. The explanation of the nonlinearity hinges on the complex effect of country risk on foreign direct investment decisions. Increasing risk diminishes the volatility of FDI as decreased market liquidity induces a higher cost of changing ownership to the investors making them reluctant to reduce their ownership in the firm, even in cases of detrimental changes. In low country risk economies, the flexibility in changing ownership is much higher, yet it does not trigger higher volatilities as the possibility of a crisis situation is very low. As the probability of a crash increases the need for changing ownership increases as well overweighing the increment in the liquidity cost premium resulting in an increasing volatility first. As the liquidity premium increases further firms reduce their operations rather then sell their assets, creating a much lower average FDI with a low volatility. Also the average life-span of the projects decreases exponentially, as investors are more reluctant to enter high risk economies. This is a telling result, showing that the use of the volatility as a measure of quality is generally misleading.

Capital control has a more straightforward effect on the volatility. The overall effect of increasing CC is negative, implying that more restrictive capital control measures decrease the volatility of FDI as changing the levels of ownership becomes more expensive. The slope of the effect, however, changes radically with changes in the country risk. As we can see the effect of capital control in low risk economies (countries with Moody's ratings above Ba) is significantly negative, while in high risk economies, the effect is negligible, even if we use separate dummies to create a finer distinction between the groups. This creates a Laffer curve type pattern for optimal amount of capital control in terms of country risk.

Figure 9 reports the regression results on the net FDI stock in terms of GDP. Corresponding to the findings of the theoretical model the capital control measure, CC, has a significant negative effect on FDI/GDP. Jumping from a liberal regime ($CC = 0$) to a fully restrictive policy ($CC = 1$) results in a 29 percent drop in the average net FDI stock approximately. The effect of the country risk index is more complex. The impact of IIR is significantly negative for low country risk economies, indicating that increasing country risk increase the overall net volume of the net FDI stock, whereas the effect is not significant for high risk economies. The level effect of country risk shows that low risk economies on average have a higher volume of foreign direct investments. The overall impact of the country risk produces, therefore a hump shaped pattern in the average values similarly to the volatility case. A crucial point to the analysis is to investigate the cross- effect of country risk and capital

FIGURE 9. FDI/GDP

White Heteroscedasticity Consistent Estimates

Dependent Variable: FDI/GDP

Variable	Coefficient	t-statistic	t-probability
COEF	20.267064	1.909224	0.060008
IIR*DD11	-0.119898	-2.111514	0.038015
IIR*DD12	-0.319678	-1.640084	0.105121
DD11	18.278652	2.129887	0.036418
DDD	91.151660	2.143603	0.035263
CC	-28.838606	-1.939214	0.056187
CC*IIR	0.133852	1.941733	0.055876

Adjusted R^2 = 0.4508
Durbin-Watson = 1.8694

control. The coefficient of $CC * IIR$ is significantly positive, implying that imposing capital controls in lower risk economies reduces the average volume of FDI in a lesser extent than in high risk economies. Together with the empirical findings on the behavior of the volatility of foreign direct investments, we can argue that capital controls reduce the quality of foreign direct investments. Their impact in high risk economies is negligible in terms decreasing the volatility of these flows but have a significantly negative impact on their average volume. Therefore countries considering the applications of these measures should be aware of their policy implications on their desired resources of capital as well. Countries with very high levels of risk attempting to introduce restrictive measures in order to limit the volatility of their capital flows have to take into consideration that their efforts to decrease volatility and thus the overall riskiness of their economies solely by the means of capital control might be in vain.

IV. SUMMARY

Recent financial crises have put capital controls in the focus of renewed investigation, attempting to quantify the impact of restrictive measures on the stability of capital flows in terms of their volume, composition and volatility. This paper investigated the effects of capital control on the qualitative properties of foreign direct investments. A stochastic dynamic decision theoretical model with fixed intervention costs and gradually decreasing foreign competitive knowledge advantage was introduced to examine how foreign investment decisions change when restrictive barriers on capital movements are implemented. The simulations of the theoretical model allowed us to generate different quality measures to assess the impact of capital control on foreign direct investments. By constructing the average life-span (duration), volatility, volume, ownership share and entry rate statistics we could uncover the underlying dynamics hidden in the macroeconomic data that is responsible for the low performance of the empirical studies of the matter in the prevailing literature. We found that capital controls induce a significant impact on the characteristics of long term foreign direct investment flows, therefore those studies evaluating the effects of capital controls by concentrating solely on short-term flows may lead to false conclusions on the desirability of such measures.

The results of the theoretical analysis showed that increasing capital controls reduce the duration of FDI investments at each level of country risk, reflecting that strict capital control measures decrease the flexibility of the managers in deciding on the allocation of their investment proceeds, therefore they choose to reduce their operation in the market. Also the willingness towards risk sharing increases that was demonstrated by the diminishing average ownership shares in terms of capital controls and country risk. The simulations of foreign direct investment decisions uncovered a significant interaction between capital control and country risk, that resulted in a nonlinear relationship between these and the volatility and volume measures of FDI. We could show that introducing capital controls in riskier economies induces a sharper loss in terms of the stability of the FDI projects. This is a very important outcome of the model as the countries with high risk are more willing to impose constraints on capital flows, to attract more stable long-term capital, such as FDI. Knowing that the effect of these measures actually decreases the stability of FDI flows makes these means less attractive in these economies. On the short term, therefore, countries might experience a structural change towards FDI, following capital restrictions, but the overall quality of these flows also reduces.

By conducting a simple empirical analysis we could validate the findings of the theoretical model. Analyzing the effects of capital controls on FDI confirmed the theoretical finding of a nonlinear relationship between capital control, country risk and the volatility of foreign direct investments. We could show that capital controls reduce the quality of foreign direct investments both in terms of volatility and volume. The efficiency of restrictive measures on capital in high risk economies was found to be negligible on the volatility of these flows and having a significantly negative impact on their average volume. Countries considering the applications of these measures on short-term capital flows aiming to improve the quality structure of their financial resources should therefore be aware of the counterproductive effect of their policy on foreign direct investments. Just as restrictions on the flow of goods and services causes global welfare losses, as we can see capital controls limit the amount of long term investments that deteriorates the governments attempts to provide stable financial backing for their excess investments. The stability of capital flows is of particular concern in economies with high country risk as the probability of occurrences of sudden capital outflows are the highest in these. Therefore it is of overriding importance to understand how the impact of these regulations on the quality of foreign direct investments alters when country risk changes. As the effects of capital controls depend heavily on the imposing country's economic environment, particularly its country risk characteristics, singling out positive examples from the past might not be sufficient validation for implementing such measures.

I. APPENDIX

A. PROFIT FUNCTION

The following provides the derivation of the profit function used in the model. The instantaneous profit maximization problem of the firm takes the following form, assuming a Cobb-Douglas production function.

$$\Pi_F = \max_{L_D} PK_F^{\alpha} L_D^{1-\alpha} - cL_D \tag{i}$$

The first order conditions for the domestic and foreign owned firm take the following form, after substituting in for $K_i = F, D$

$$L_{DF} = \left(\frac{(1-\alpha)P}{c}\right)^{\frac{1}{\alpha}} \xi_0 K_0$$

$$L_{DD} = \left(\frac{(1-\alpha)P}{c}\right)^{\frac{1}{\alpha}} (\xi_0 - \xi) K_0$$

The output by each firm can be derived as the following:

$$Q_{FS} = (\xi_0 K_0)^{\alpha} L_{DF}^{1-\alpha} = \xi_0 b_0 K_0 \left(\frac{(1-\alpha)P}{c}\right)^{\frac{1-\alpha}{\alpha}}$$

$$Q_{DS} = (K_0(\xi_0 - \xi))^{\alpha} L_{DD}^{1-\alpha} = K_0(\xi_0 - \xi) \left(\frac{(1-\alpha)P}{c}\right)^{\frac{1-\alpha}{\alpha}}$$

$$Q_S = Q_{FS} + Q_{DS} = Q_D = \frac{\theta}{P} = (2\xi_0 - \xi) K_0 \left(\frac{(1-\alpha)P}{c}\right)^{\frac{1-\alpha}{\alpha}}$$

$$P^{\frac{1}{\alpha}} = (2\xi_0 - \xi)^{-1} \theta K_0^{-1} \left(\frac{(1-\alpha)}{c}\right)^{-\frac{1-\alpha}{\alpha}}$$

$$\Pi_F = P(K_0\xi_0)^{\alpha} \left(\frac{(1-\alpha)P}{c}\right)^{\frac{1-\alpha}{\alpha}} (\xi_0 K_0)^{1-\alpha} - c\left(\frac{(1-\alpha)P}{c}\right)^{\frac{1}{\alpha}} \xi_0 K_0$$

$$= \xi_0 K_0 \left(\frac{(1-\alpha)P}{c}\right)^{\frac{1}{\alpha}} \frac{\alpha c}{1-\alpha} = \xi_0 K_0 \left(\frac{(1-\alpha)}{c}\right)^{\frac{1}{\alpha}} \frac{\alpha c}{1-\alpha} (2\xi_0 - \xi)^{-1} \theta K_0^{-1} \left(\frac{(1-\alpha)}{c}\right)^{-\frac{1-\alpha}{\alpha}} = \frac{\alpha c}{1-\alpha} \frac{\theta \xi_0}{2\xi_0 - \xi} \frac{(1-\alpha)}{c}$$

B. SOLUTION OF THE STOCHASTIC IMPULSE-CONTROL PROBLEM

The impulse-control problem defined in the paper can be decomposed to two separate problems: the operation period with exit, also referred to as an intensity option with exit, and an entry decision problem or timing option that are solved in the following. Proof of existence and uniqueness are not provided. The interested reader should refer to Oksendal and Sulem (Oksendal and Sulem,[29]) and Vollert (Vollert,[35]).

THE OPERATION FAZE

The value of the investment into the firm in the operation faze will take the following form using the second part of Equation (8) :

$$V_t = V(t,\theta_t,\xi_t,b_t) = \sup_{\substack{(\tau_{Exit},w)\in \\ [0,\infty)\times\mathcal{W}}} \widetilde{\mathbb{E}}\left[\int_{\tau_I}^{\tau_{Exit}} e^{-\rho t}\left[b_t f(t,\theta_t,\xi_t,b_t) - C_M\right]dt \right.$$
$$\left. - \sum_{i:\tau_I\le t_i\le \tau_{Exit}} e^{-\rho t_i} T_c(t_i,\theta_{t_i},b_{i-1,}b_i,V_{t_i})\right]$$

The maximum operator of the problem looks like the following:

$$\begin{aligned}\mathcal{M}V(t,\theta_t,\xi_t,b) &= \max\left\{\max_{b_F^*\in\mathcal{M}\setminus\{b_F\}}\{V(t,\theta_t,\xi_t,b^*) - T_c(t_i,\theta_{t_i},b_,b^*,V_{t_i})\},0\right\} \quad \text{(ii)}\\ &= \max\left\{\max_{b_F^*\in\mathcal{M},b_F^*>b_F}\{V(t,\theta_t,b^*) - T_c(t_i,\theta_{t_i},b_,b^*,V_{t_i})\},\right.\\ &\left.\max_{b_F^*\in\mathcal{M},b_F^*<b_F}\{V(t,\theta_t,\xi_t,b^*) - T_c(t_i,\theta_{t_i},b_,b^*,V_{t_i})\},0\right\}\end{aligned}$$

Expanding the value function we get the following set of quasi-variational inequalities for the operation regime, $X_t = (t,\theta_{t,},\xi_t,b_t)$, $X_t \in [0,\tau_{Exit}) \times \mathcal{R}^+ \times \mathcal{R}^+ \times [0,1]$.

$$\begin{aligned}\frac{1}{2}\sigma^2\theta^2\frac{d^2V^A}{d\theta^2} + \mu\theta\frac{dV^A}{d\theta} - \kappa(b_{F0})\xi\frac{dV^A}{d\xi} - (r+p)V^A + pV^A((1-\eta)\theta,\xi) + b_t f(X_t) - C_M &\le 0 \quad \text{(iii)}\\ V^A &\ge \mathcal{M}V^A\end{aligned}$$

where one of the inequalities is an equality. According to Vollert (ibid.) if the above set of quasi variational equations has a solution, it can be shown that it satisfies the original impulse control problem in a unique way. The firm value is increasing in θ_t with b_t and ξ being constant. For low levels of demand the cash flow function is decreasing in b_t as $\frac{d\Pi_F}{db} > 0$ [9]. We conjecture that for a sufficiently small level of θ ceteris paribus, a downward adjustment of the ownership level is optimal. If demand is high, than a higher amount of ownership is acquired as the higher level of demand justifies for the switching cost occurred by increasing b .The profit function increases in ξ. If ξ is very small the cash flows are decreasing in b_t thus a disinvestment occurs. For large values of ξ the acquired level of ownership increases as the increase in the profit can overweigh the cost of switching. If θ is large but ξ is small the Cash flow is decreasing in b_t, thus there is going to be an ownership reduction. If θ is small but ξ is large than the cash flow will decrease in b_t and an ownership reduction will occur. For very low levels of ξ and θ it is beneficial to leave the country as it is very hard to sell the assets of the firm. The regions of adjustment will look like the following:

In the continuation region we have then:

.

$$\mathcal{C} := X_t \in [0, \tau_{Exit}) \times \mathcal{R}^+ \times \mathcal{R}^+ \times \mathcal{M}; \theta^{**}(t, b_t, \xi_t) < \theta_t < \theta^*(t, b, \xi_t) \tag{iv}$$

with corresponding upper and lower b levels b^* and b^{**}. In the continuation region the first inequality in Equation iii is an equality and the system evolves freely without any adjustments. Once the demand or spillover parameters reach the boundaries of the operation region, the second inequality in (iii) becomes an equality and according to the definition of the maximum operator this yields the value matching conditions for the three free boundaries, θ^{**}, θ^*, .θ^E.The corresponding conditions are the following:

$$\begin{aligned} V^A(t, b_t, \xi_t, \theta^{**}) &= V^A(t, b^{**}, \xi_t, \theta^{**}) - T_c(t, b, b^{**}, \theta^{**}), \\ V^A(t, b_t, \xi_t, \theta^{*}) &= V^A(t, b^{*}, \xi_t, \theta^{*}) - T_c(t, b_t, b^{*}, \theta^{*}), \\ V^A(t, b_t, \xi_t, \theta_E) &= V^A(t, 0, \xi_t, \theta_E) \end{aligned} \tag{v}$$

We have to add a terminal condition as well:

$$V^A(t, b_t, \theta_t, 0) = (1 - T_c(1+\gamma))\frac{\alpha\theta}{2r} - c_3 p \tag{vi}$$

9

$$\begin{aligned} \Pi_F &= \frac{\alpha\theta\xi_0}{2\xi_0 - \xi} \\ \frac{d\Pi_F}{db} &= \frac{\alpha\theta\xi_0}{(2\xi_0 - \xi)^2}\frac{d\xi}{db} > 0 \text{ as } \frac{d\xi}{db} > 0 \\ \xi &= \xi_0 e^{-(k+\Lambda(1-b))t} \\ \frac{d\xi}{db} &= \xi_0 e^{-(k+\Lambda(1-b))t}\Lambda t > 0 \end{aligned}$$

This means that after all the comparative advantages of the foreign investors disappear they simply sell the firm at the then prevailing price.

As we can see all the values of contraction and expansion depend on the current levels of ownership.

TIMING OPTION, ENTRY DECISION

The timing of the entry to the market can be described by the following optimization problem:

$$V^E(t, b_0, \xi_0, \theta_0) = \sup_{(\tau_I, b_I) \in [0,\infty] \times \mathcal{M}} \widetilde{\mathbb{E}} e^{-\rho \tau_I} \left[V^A(\tau_I, \theta_{\tau_I}, \xi_0, b_{\tau_I}) \right.$$
$$\left. - T_c(\tau_I, 0, b_{\tau_I}, \xi_0, \theta_{\tau_I}) - c_I \xi_0 \right]$$

$$d\xi = 0$$

To determine the optimal level of initial ownership the following maximum operator is introduced:

$$\mathcal{M}V^E(t, \theta_t, \xi_t, b) = \max_{b_I \in \mathcal{M}} \left\{ V^A(t, \theta_t, \xi_t, b_t) - T_c(t, 0, b_I, \theta_t) - c_I \xi_0 \right\} \qquad \text{(vii)}$$

Just as in the case of the exit option we can determine the continuation region during which no action is taken. This will look like the following:

$$\mathcal{C} := X_t \in [0, \tau_I) \times \mathcal{R}^+ \times \mathcal{R}^+ \times \mathcal{M}; \theta_t > \theta^I(t, b, \xi_t)$$

The corresponding quasi variational equalities are the following:

$$\frac{1}{2}\sigma^2\theta^2 \frac{d^2V^E}{d\theta^2} + \mu\theta \frac{dV^E}{d\theta} - (r+p)V^E + pV^E((1-\eta)\theta, \xi) \leq 0 \qquad \text{(viii)}$$
$$V^E \geq \mathcal{M}V^E$$

where one of the inequalities is an equality. Here we have to note that before entry there is no spillover effect.

In the entry situation we only have a one variable system as spillovers at that time are not present. The first stage problem then reduces to an ODE that has a solution of the following general form:

$$V^E(t, b_t, \xi_0, \theta_0) = A\theta_0^{\delta_1} + B\theta_0^{\delta_2} \tag{ix}$$

A,B are some constants and $\delta_1 > 0$ and $\delta_2 < 0$ are the roots of the following non-linear polynomial (Dixit and Pindyck,[12]):

$$\frac{1}{2}\sigma^2\delta(\delta - 1) + \mu\delta + p\,(1 - \eta)^\delta - p - \rho = 0 \tag{x}$$

To rule out bubble solutions we have to assume that the B the constant corresponding to the negative root δ_2 is zero. Therefore we have that:

$$V^E(t, 0, \xi_0, \theta_0) = A\theta_0^{\delta_1} \tag{xi}$$

The optimal entry value of demand parameter, θ_I, can be determined by using the same concept as in the exit case. The corresponding conditions are the following:

$$V^E(t, b_I, \xi_0, \theta_I) = V^A(t, \theta_I, \xi_0, b_I) - T_c(t, 0, b_I, \theta_I) - c_I\xi_0, \tag{xii}$$

where

$$b_I = \arg\max V^E(t, b, \xi_0, \theta_I) \tag{xiii}$$

The two equations have to be solved simultaneously to obtain the optimal initial ownership, b_I, and trigger value of entry, θ_I.

NUMERICAL SOLUTION OF THE MODEL-FINITE DIFFERENCE METHOD

Due to the complexity of the introduced model we are not able to obtain an analytic solution. Therefore we have to employ a numerical technique to solve the model. Vollert (ibid.) shows that the solution of the original impulse control problem can be transformed into the solution of the above stated quasi variational inequalities. Using these equations we can employ some numerical solution technique that satisfies the conditions for constructing an optimal solution that is unique[10]. For this purpose it is convenient to use the finite difference approach to approximate the HJB equations. To solve the two stage problem we have to start first with the operation's faze. To ensure convergence let us rewrite the HJB equation by substituting θ with x where $\ln\theta = x$. and $V(t, \theta, \xi, b) = F(t, x, \xi, b)$ The corresponding equation takes then the following form:

[10] The conditions to ensure the existence and uniqueness are summarized in the so-called impulse-control verification theorem with optimal stopping.See Vollert (ibid. p. 80)

$$\frac{1}{2}\sigma^2 F_{xx} + (\mu - \frac{1}{2}\sigma^2)F_x - \kappa(b_{F0})\xi F_\xi - (r+p)F + pF(\ln(1-\eta)+x,\xi) + b_t f - C_M \le 0 \quad \text{(xiv)}$$

The procedure starts by creating a rectangular discretization of the state space with regard to ξ and x together with the action space.

$$\begin{aligned} & x_{\min}, \Delta x, 2\Delta x, ..., x_{\max} \\ x_t &= j\Delta x, -J/2 \le j \le J/2 \\ & \xi_0, -\Delta\xi, -2\Delta\xi, ..., 0 \\ \xi_t &= \xi_0 - i\Delta\xi, 0 \le i \le I \\ & 0, \Delta b, 2\Delta b, ..., 1 \end{aligned} \quad \text{(xv)}$$

$\theta_{\max}$ has to be chosen far enough from the current θ so that it could almost never be reached.

The resulting grid consists of $(N_x+1)(N_\xi+1)(N_{b_F}+1)$ points. The (i,j,k) point on the is grid the point that corresponds to x $j\Delta x$, the spillover parameter $i\Delta\xi$ and ownership level $k\Delta b_F$. The variable $F_{i,j,k}$ denotes the value of the investment with flexible ownership level and optional total exit at the point (i,j,k). The derivatives are approximated by the following differences (Dixit and Pindyck (ibid.)):

$$\begin{aligned} F_{xx} &= \frac{F_{i,j+1,k} - 2F_{i,j,k} + F_{i,j-1,k}}{(\Delta x)^2} \\ F_x &= \frac{F_{i,j+1,k} - F_{i,j-1,k}}{2\Delta x} \\ F_\xi &= \frac{F_{i+1,j,k} - F_{i,j,k}}{\Delta\xi} \end{aligned} \quad \text{(xvi)}$$

Substituting these values into the HJB equation we get the following difference equation:

$$\begin{aligned} F_{i,j,k} = p^+ F_{i-1,j,k} + p^0 F_{i-1,j,k} + p^- F_{i-1,j,k} + p\frac{\Delta\xi}{\kappa\xi}(F_{i-1,j,k}(\ln(1-\eta)+x,\xi) - F_{i-1,j,k}) \\ + \frac{\Delta\xi}{\kappa\xi} b f_{i,j,k} - \frac{\Delta\xi}{\kappa\xi} C_{Mi,j,k} \end{aligned}$$

where

$$
\begin{aligned}
p^{+} &= \frac{1}{\kappa i}\frac{\sigma^2+(\mu-\frac{1}{2}\sigma^2)\Delta x}{2(\Delta x)^2} \\
p^{0} &= 1-\frac{1}{\kappa i}\frac{\sigma^2}{(\Delta x)^2}-\frac{r}{\kappa i} \\
p^{-} &= \frac{1}{\kappa i}\frac{\sigma^2-(\mu-\frac{1}{2}\sigma^2)\Delta x}{2(\Delta x)^2}
\end{aligned}
\tag{xvii}
$$

The terminal condition represents the assumption, that after the comparative advantage of the firm disappears it cannot extract more profit from the host economy on average than operating in his country of origin. Therefore it is assumed that at $\xi = 0$ the investor sells the firm at the then prevailing value.

$$
V_{N_\xi,j,k} = \frac{\alpha\theta}{2r} - T_C(0, k\Delta b_F, V_{N_\xi+1,,j,k}) \tag{xviii}
$$

To ensure stability the following must hold:

$$
\begin{aligned}
\Delta\xi &\leq \frac{\sigma^2}{(\mu-\frac{1}{2}\sigma^2)^2} \\
\Delta x &\leq \frac{\sigma^2}{\left|\mu-\frac{1}{2}\sigma^2\right|}
\end{aligned}
\tag{xix}
$$

The switching condition is the following:

$$
V_{i,j,k} < \max\left[\max_{k\neq k'}\left\{V_{i,j,k'} - T_c(i,j,k,k')\right\}, 0\right] \tag{xx}
$$

if switching is optimal the above inequality becomes an equality. By simple backward solution methods (see Wilmott, [36] for further reference) the problem can easily be solved. The only complication that arises is that the underlying process is a jump-diffusion implying that the defined grid for the backward solution may not match the after jump values of the underlying asset. Therefore we have to use some approximation around these values. According to Tavella (Tavella,[34]) this can be done by a simple extrapolation technique. In the numerical model presented above I have used a simple two-point intrapolation between the gridpoints to obtain the after jump values of the option and a four point extrapolation beyond the gridpoints in the case of positive jumps. The accuracy of the underlying method is of the order $O(\delta\theta^2, \delta t, \delta\xi)$. The solution to the timing problem is similar to the exit case. As we have a closed form solution for the value of waiting we do not need to discretize the HJB equation of entry. To determine θ_I we have to write up the discretized version of the value matching and smooth pasting conditions.

$$\begin{aligned} A\theta^{\delta_1} &= V^A(t,\theta_t,\xi_t,b_t) - T_I(t,0,b_I,\theta_I) - c_I\xi_0 \\ \delta_1 A\theta^{\delta_1} &= \frac{\partial V^A(t,\theta_t,\xi_t,b_t)}{\partial\theta}\theta - \frac{\partial T_I(t,0,b_I,\theta_I)}{\partial\theta} \end{aligned} \tag{xxi}$$

$$\begin{aligned} \left(\frac{\partial V^A(t,\theta_t,\xi_t,b_t)}{\partial\theta}\theta - \frac{\partial T_I(t,0,b_I,\xi_0,\theta_I)}{\partial\theta}\theta\right)/\delta_1 &= V^A(t,\theta_t,\xi_t,b_t) \\ &\quad -T_I(t,0,b_I,\theta_I) - c_I\xi_0 \end{aligned} \tag{xxii}$$

Using the discretization rules described above, we get the following equation that determines the switching rule for entry:

$$\begin{aligned} V_{i,j,k} < \max_{k\neq 0}\Bigg\{ & \left(\frac{V_{i,j+1,k} - V_{i,j-1,k}}{2\Delta x} j\Delta x - \frac{T_{i,j+1,k} - T_{i,j-1,k}}{2\Delta x} j\Delta x\right)/\delta_1 \\ & + Ti,j,k + c_I i\Delta\xi \} \end{aligned}$$

Capital control

The solution to the problem with capital control is similar to the basic model with substituting the different profit and impulse cost functions.

II. Appendix

Figure 10. Sample Countries (N=84)

COUNTRY-NET FDI STOCK

- Argentina
- Australia
- Austria
- Bahamas
- Bahrain
- Barbados
- Belgium and Luxembourg
- Botswana
- Brazil
- Bulgaria
- Canada
- Chile
- China
- Colombia
- Costa Rica
- Croatia
- Cyprus
- Czech Republic
- Denmark
- Dominican Republic
- Ecuador
- Egypt
- El Salvador
- Estonia
- Finland
- France
- Germany
- Greece
- Guatemala
- Honduras
- Hong Kong, China
- Hungary
- Iceland
- India
- Indonesia
- Iran
- Ireland
- Italy
- Jamaica
- Japan
- Jordan
- Kazakhstan
- Korea, Republic of
- Kuwait
- Latvia
- Lebanon
- Lithuania
- Malaysia
- Malta
- Mauritius
- Mexico
- Morocco
- Netherlands
- New Zealand
- Nicaragua
- Norway
- Oman
- Panama
- Paraguay
- Peru
- Poland
- Portugal
- Romania
- Saudi Arabia
- Singapore
- Slovakia
- Slovenia
- South Africa
- Spain
- Sweden
- Switzerland
- Taiwan Province
- Thailand
- Trinidad and Tob
- Tunisia
- Turkey
- Ukraine
- United Arab Emi
- United Kingdom
- United States
- Uruguay
- Venezuela
- Viet Nam

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