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On Corporate International Investment under Incomplete Information

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ABSTRACT

This paper presents a simple model in which real exchange risk, the competition between firms in different markets and diversification gains affect corporate international investment. By accounting for the role of information, the model embodies different existing explanations based on economic and behavioral variables. We show that real exchange risk, diversification motives and information costs are important elements in the determination of corporate international investment decisions. Using optimal control methods, we provide the general solution for the proportion of firm's total capital budget. We apply the method in Bellalah and Zhen (2002) that can be used to solve other financial control problems.

JEL: *G1, G2*

Keywords: *Corporate investment; Information costs; Diversification*

I. INTRODUCTION

Several factors argue for international diversification at the corporate level (Choi (1989), Stulz (1981), Adler and Dumas (1983) and Solnik (1974)). The first explanations are barriers due to the partial segmentation of international capital markets. Segmentation results from regulations, transactions costs, information considerations and unfamiliarity with foreign markets. These costs in segmentation apply to corporate and individual investors. Segmentation may leave room for profitable corporate international investments. The second reason giving rise to the relevance of corporate international investment is agency costs. With these costs, there is some room for corporate activity independent of investor diversification as shown in Choi (1989) and the references therein. The third reason for corporate diversification has some link with the uncertainty of operational cash-flows. The gains from international diversification can be important given the partial segmentation of national economies and markets. The fourth reason for international diversification is due to the effect of exchange risk on corporate international investment. In fact, some authors argue that exchange risk can create a difference in the cost of capital of firms located in different currency zones, affecting hence the flow of international investment. The use of an exchange risk premium (or discount) may be justified by some deviations from purchasing power parity as well as international differences in consumption baskets.

The more recent literature in international investments puts the stress on the role of information in financial markets. Information plays also a central role in explaining the decisions to invest abroad. The strong preference for domestic securities exhibited by investors in international markets, despite the known gains from international diversification, still remains an empirical puzzle in financial economics. The fact that investors appear to only invest in their home country, ignoring in general, foreign opportunities are referred to as the "home bias puzzle". The explanations of this bias are based on barriers to international investment such as governmental restrictions on foreign and domestic capital flows, foreign taxes and high transactions costs. These explanations appear in Black (1974) and Stulz (1981).

Other explanations are associated with the existence of national boundaries and for the geographic proximity (See Bellalah-Zhen (2002). Several explanations and references are advanced in Kang and Stulz (1997) and Stulz (1999) for the home bias. One of these explanations relies on the fact that investors do not invest abroad because they do not know they would benefit or do not want to invest. This explanation supports the main ideas in Merton's (1987) model where an investor who knows little about foreign shares does not invest in them.

This paper studies the effect of information costs, diversification of operational cash flows and exchange risk on corporate international investment decisions in a two-country dynamic optimization model taking these factors as environmental factors. We assume that the corporate environment is characterized by a partial segmentation of international capital markets for investors and or agency costs. The model allows stochastic cash flows and exchange rates. It confirms the fact that real exchange risk and diversification motives are among the determinants of corporate international investment decisions.

The structure of this paper is as follows. In section 2, we present the model and the optimal strategy under incomplete information and taxes. In section 3, we assume that the firm maximizes the present value of the manager's expected utility of net cashflows under a flow balance sheet constraint and derive the optimum proportion of foreign investment in the general case. The solution corresponds to a speculative demand and a hedging demand. It extends some well-known results in the theory of foreign investments.

II. THE MODEL AND OPTIMAL STRATEGY PROBLEM

Consider a standard model for a "two-country" firm whose static cash-flows from its domestic and foreign operations are given by the difference between uncertain input and output prices. This difference is multiplied by a quantity of output, which is assumed to be certain. An example of standard models is the one developed by Choi (1989) where the foreign prices and costs are initially denominated in foreign currency and are translated by uncertain exchange rates. The numeraire is the domestic currency and the only source of segmentation in real exchange risk. The firm has overseas investment and retains its domestic consumption habitat reflecting an implicit assumption according to which all projects are evaluated in domestic currency unit.

In this standard model is that the quantity is set to unity and is independent of the price level. However, in practice, the quantity is a function of the price which is often decreasing. We introduce three variables with respect to the classic models in Choi (1989): taxes, the fact that the quantity is a function of the price and information costs.

We consider a two-country firm whose static cash flows from its home and foreign operations are:

$$R_t=(P_t-C_t)Q_t-\tau\,(P_t-C_t)Q_t,\quad Q_t=P_t^{\beta} \tag{1}$$

$$R_t^*=e_t\,(P_t^*-C_t^*)Q_t^*-\tau^* e_t\,(P_t^*-C_t^*)Q_t^*,\quad Q_t^*=P_t^{*\alpha} \tag{2}$$

where P_t, C_t (refer to home country) and P_t^*, C_t^* (refer to foreign country) are output and input prices of production. The terms Q_t and Q_t^* are quantity of output. The terms α and β are negative constants, τ and τ^* are tax rates in home and foreign country, e_t is uncertain exchange rate.

While the introduction of taxes in the model is straight forward, the use of information costs merits some developments. The information costs refer to Merton's (1987) model and are proposed in the recent literature to explain the home bias. The main distinction between Merton's model and the standard CAPM is that investors invest only in the securities about which they are "aware". This assumption is referred to as incomplete information. However, the more general implication is that securities markets are segmented. Using this assumption, Merton (1987) shows that the expected return depend on other factors in addition to market risk. We can apply Merton's model for the dynamics of assets and options. Under the risk-neutral probability, as shown in Bellalah (1990), Bellalah and Jacquillat (1995) and Bellalah (1999), the cash-flows of an asset must be discounted to the present under the riskless rate plus the information cost rate.

We assume the following dynamics for the different variables in equations (3) to (7) regarding the output prices, the input prices and the exchange rate:

$$d P_t = (\alpha_p + \lambda_p) P_t dt + S P_t dB_t \quad (3)$$

$$dC_t = (\alpha_c + \lambda_c) C_t dt + S C_t dB_t \quad (4)$$

$$dP^*_t = (\alpha_{p*} + \lambda_{p*}) P^*_t dt + S^* P^*_t dB'_t \quad (5)$$

$$dC^*_t = (\alpha_{c*} + \lambda_{c*}) C^*_t dt + S^* C^*_t dB'_t \quad (6)$$

$$de_t = (\alpha_e + \lambda_e) e_t dt + S_e e_t d\overline{B}_t \quad (7)$$

where α_p, α_c, α_{p*}, α_{c*} and α_e represent the instantaneous expected rates respectively. The terms λ_p, λ_c, λ_{p*}, λ_{c*} and λ_e are information costs rates relative to the different variables. The terms S, S^* and S_e are the instantaneous volatilities of the different variables. The terms B_t, B_t' and $\overline{B}_t$ are three one-dimensional mutually independent Brownian motions. They represent the external independent sources of uncertainty in the markets. These dynamics are also used in Bellalah (2002), Bellalah and Bellalah (2002) and Bellalah and Zhen (2002). Using equations (3) and (4), the output and input prices are:

$$P_t = P_0 e^{(\alpha_p + \lambda_p - (1/2)S2)t} e^{SB_t}$$

$$C_t = C_0 e^{(\alpha_c + \lambda_c - (1/2)S2)t} e^{SB_t}$$

The static cashflows for time t from the firm's home operations are given by:

$$\begin{aligned} R_t &= (1-\tau) P_t^{\beta} (P_t - C_t) \\ &= (1-\tau) P_0^{\beta} e^{\beta(\alpha_p + \lambda_p - (1/2)S2t} e^{(\beta+1)SBt} (P_0 e^{(\alpha_p + \lambda_p - (1/2)S2)t} - C_0 e^{(\alpha_c + \lambda_c - (1/2)S2)t}) \\ &= K e^{(\beta+1)SBt} F(t) \end{aligned}$$

with $F(t) = e^{\beta(\alpha_p + \lambda_p - (1/2)S2)t} (P_0 e^{(\alpha_p + \lambda_p - (1/2)S@)t} - C_0 e^{(\alpha_c + \lambda_c - (1/2)S2)t})$ and $K=(1-\tau)P_0^{\beta}$.

In this context, the changes in the cashflows per unit of time from the firm's home operations are given by:

$$\begin{aligned} dR_t &= K(\beta+1)Se^{(\beta+1)SBt}F(t)dB_t + (1/2)(\beta+1)^2 S^2 K e^{(\beta+1)SBt}F(t)dt + Ke^{(\beta+1)SBt}F'(t)dt \\ &= R_t (\beta+1)SdB_t + R_t ((1/2)(\beta+1)^2 S^2 + F'(t)/F(t))dt \\ &= R_t (\beta+1)SdB_t + R_t f(t)dt \end{aligned} \quad (8)$$

with $f(t) = (1/2)(\beta+1)^2 S^2 + F'(t)/F(t)$ and $F(t) \neq 0$.

The expression of *dR* shows that in addition to the output and input price risk, the cash flows are affected by exchange rate changes, the degree of competition in the markets as reflected by the parameter β and the information costs on the different markets. Note that F (t) is different from zero. When F (t) is equal to zero, the return is also zero. The expression of the changes in the cashflows per unit of time from foreign operations is obtained as follows. Let $\overline{R}_t = (1-\tau^*)P^*\alpha_t (P^*_t - C^*_t)$. Using the same method, we obtain:

$$d\overline{R}_t = \overline{R}_t (\alpha+1)S^* dB'_t + \overline{R}_t \overline{f}(t)\, dt \tag{9}$$

We assume also in this case that $\overline{F}(t)$ is different from zero. When $\overline{F}(t)$ is equal to zero, the return is also zero. Here $\overline{f}(t) = (1/2)\,(\alpha+1)^2 S^{*2} + \frac{\overline{F}'(t)}{\overline{F}(t)}$ and $\overline{F}(t) \neq 0$, $\overline{K} = (1-\tau^*)P_0^*\alpha$.

$$\overline{F}(t) = e^{\alpha(\alpha_{p*}+\lambda_{p*}-(1/2)S^{*}2)t}\{P_0^* e^{(\alpha_{p*}+\lambda_{p*}-(1/2)S^{*}2)t} - C_0^* e^{(\alpha_{c*}+\lambda_{c*}-(1/2)S^{*}2)t}]$$

From $R^*_t = e_t \overline{R}_t$ and equations (7) and (9), we have:

$$\begin{aligned} dR_t^* &= e_t d\overline{R}_t + \overline{R}_t de_t \\ &= e_t(\alpha+1)S^*\overline{R}_t dB'_t + e_t \overline{f}(t)\overline{R}_t dt + \overline{R}_t(\alpha_e+\lambda_e)e_t dt + \overline{R}_t S_e e_t d\overline{B}_t \\ &= (\overline{f}(t) + \alpha_e + \lambda_e) R_t^* dt + (\alpha+1)S^* R_t^* dB'_t + S_e R_t^* d\overline{B}_t, \end{aligned}$$

i.e.

$$dR_t^* = g(t) R_t^* dt + (\alpha+1)S^* R_t^* dB'_t + S_e R_t^* d\overline{B}_t \tag{10}$$

where $g(t) = \overline{f}(t) + \alpha_e + \lambda_e$.

The expression of dR_t^* shows that in addition to the output and input price risk, the cash flows are affected by the variations in the exchange rate, the degree of competition in the markets as reflected by the parameters α and the information costs. The manager may choose to invest the wealth in home or foreign markets. Let V_t represents the wealth and *x* be the proportion of foreign investment in the firm's total capital budget i.e. xV_t is the return in foreign market. So *(1-x)* is the proportion of home market investment and $(1-x)V_t$ is the return in home market. Using (2.8) and (2.10), we obtain:

$$\begin{aligned} dV_t &= xV_t g(t)dt + xV_t(\alpha+1)S^* dB'_t + xV_t S_e d\overline{B}_t + (1-x)V_t(\beta+1)SdB_t + (1-x)V_t f(t)dt \\ &= V_t(xg(t)+(1-x)f(t))dt + V_t(1-x)(\beta+1)SdB_t + V_t x(\alpha+1)S^* dB'_t + V_t xS_e d\overline{B}_t \end{aligned} \tag{11}$$

The optimization problem assumes that the firm maximizes the present value of the manager's utility of net cash flows, which is subject to a flow balance sheet constraint as in the standard case in Choi (1989).

III. THE OPTIMAL SOLUTION IN THE GENERAL CASE

Assume the manager wants to maximize the following expected utility of the wealth by choosing an investment strategy x:

$$J = \max_{x} E\left[\int_0^T U(V_t,t)dt + B(V_t,T)\right] \quad (12)$$

The stochastic optimal control problem can be solved using the dynamic programming method. We first use this method to obtain the optimal decision and Hamilton-Jacobi-Bellman equation. We define:

$$J(V_t,t) = \max_{x} E_t\left[\int_t^T U(V_t,t)dt + B(V_T,T)\right]$$

Then from classical dynamic programming principle, we get

$$\frac{\partial J}{\partial t} + \max_{x}\{\frac{\partial J}{\partial V}V[xg(t)+(1-x)f(t)] + (1/2)\frac{\partial^2 J}{\partial V^2}\ \frac{\partial^2 J}{\partial V^2}V^2(1-x)^2(\beta+1)^2S^2$$
$$+(1/2)\frac{\partial^2 J}{\partial V^2}V^2x^2(\alpha+1)^2S^{*2} + (1/2)\frac{\partial^2 J}{\partial V^2}V^2x^2S_e^{\ 2} + U(V,t)\} = 0$$
$$J(V,T) = B(V,T) \quad (13)$$

We look for the optimal solution x^*, from

$$\frac{\partial^2 J}{\partial V^2}V^2(\beta+1)^2S^2x^* + \frac{\partial^2 J}{\partial V^2}V^2(\alpha+1)^2S^{*2}x^* + \frac{\partial^2 J}{\partial V^2}V^2S_e^{\ 2}x^* + \frac{\partial J}{\partial V}V[g(t)-f(t)]$$
$$-\frac{\partial^2 J}{\partial V^2}V^2(\beta+1)^2S^2 = 0$$

$$x^*\frac{\partial^2 J}{\partial V^2}V^2[(\beta+1)^2S^2+(\alpha+1)^2S^{*2}+S_e^{\ 2}] = \frac{\partial^2 J}{\partial V^2}V^2(\beta+1)^2S^2 + \frac{\partial J}{\partial V}Vf(t) - \frac{\partial J}{\partial V}Vg(t)$$

The optimal value of x corresponding to the optimum proportion of foreign investment in the firm's total capital budget is given by:

$$x^* = [\frac{\partial^2 J}{\partial V^2}V(\beta+1)^2S^2 + \frac{\partial J}{\partial V}f(t) - \frac{\partial J}{\partial V}g(t)] / [\frac{\partial^2 J}{\partial V^2}V[(\beta+1)^2S^2+(\alpha+1)^2S^{*2}+S_e^{\ 2}] \quad (14)$$

This is optimal decision, when we take place equations (14) to (13) we get

$$\frac{\partial J}{\partial t}+\frac{\partial J}{\partial V}V[x^{*}g(t)+(1-x^{*})f(t)]+(1/2)\frac{\partial^{2}J}{\partial V^{2}}V^{2}(1-x^{*})^{2}(\beta+1)^{2}S^{2}$$

$$+(1/2)\frac{\partial^{2}J}{\partial V^{2}}V^{2}x^{*2}(\alpha+1)^{2}S^{*2}+(1/2)\frac{\partial^{2}J}{\partial V^{2}}V^{2}x^{*2}S_{e}^{2}+U(V,t)=0$$

$$J(V,T)=B(V,T) \tag{15}$$

We can solve the partial differential equation (15) to obtain the value function $J(V_t,t)$, then get optimal decision x^* by (14). An analogy can be established between our model and the model in Choi (1989). In fact, equation (8) can be written as:

$$d R_t = R_t S_R dB_t + R_t \alpha_R dt \tag{16}$$

with $S_R = (\beta+1) S$ and $\alpha_R = f(t)$.

In the same way, equation (2.10) can be written as:

$$dR_t^{*}=\alpha_{R*}R_t^{*}dt+(\alpha+1)S^{*}R_t^{*}dB'_t+S_e R_t^{*}d\overline{B}_t \tag{17}$$

with: $\alpha_{R*}= g(t)$ and $S^2_{R*}= (\alpha+1)^2 S^{*2}+S^2_e$.

Now, let $S2g = S^2_R + S2_{R*}$. So in the general case, from equation (14), we have the optimal value corresponding to the optimum proportion of foreign investment in the firm's total capital budget as:

$$x^{*} = (1/S^2_g)(((\alpha_{R*} - \alpha_R)/A) + S^2_R) = H_1 + H_2$$

with:

$$H_1 = (1/(AS^2_g))(\alpha_{R*} - \alpha_R)\ H2 = (1/S^2_g)\ S2_R = \frac{(\beta+1)^2S^2}{S_g^2}$$

where $S^2_g = S^2_R + S^2_{R*}$ and $A=-\frac{J_{VV}V}{J_V}$. In this equation, the term A refers to the Arrow-Pratt measure of risk aversion. The term S^2_g refers to the variability of the portfolio. The first term in x^*, i.e. $\frac{1}{S_g^2}(\frac{\alpha_{R*}-\alpha_R)}{A}$ is referred to as the "speculative demand" or the aggressive demand because it depends on the value of A. The second term in x^*, i.e. $\frac{1}{S_g^2}$ S^2_R is called the hedging demand or the passive demand. This term describes the demand for foreign investments on a risk-hedged basis. It is independent of the firm's attitude toward risk.

We can provide a detailed expression of the aggressive demand H_1 denoted by:

$$EP_t = P_0 e^{(\alpha_p + \lambda_p)t}, \qquad EP_t^* = P_0^* e^{(\alpha_{p*} + \lambda_{p*})t},$$
$$EC_t = C_0 e^{(\alpha_c + \lambda_c)t}, \qquad EC_t^* = C_0^* e^{(\alpha_{c*} + \lambda_{c*})t}.$$

The aggressive demand H_1 is:

$$H_1 = \frac{1}{AS_g^2}(\alpha_{R*} - \alpha_R)$$
$$= \frac{1}{AS_g^2}[(\alpha_e + \lambda_e) + (1/2)\alpha(\alpha+1)S^{*2} - (1/2)\beta(\beta+1)S^2$$
$$+(\alpha_C + \lambda_C)\frac{EC_t}{EP_t - EC_t} - (\alpha_{C*} + \lambda_{C*})\frac{EC_t^*}{EP_t^* - EC_t^*}$$
$$+(\alpha_{P*} + \lambda_{P*})(\alpha + \frac{EP_t^*}{EP_t^* - EC_t^*}) - (\alpha_P + \lambda_P)(\beta + \frac{EP_t}{EP_t - EC_t})] \qquad (18)$$

This expression of the speculative demand embraces some theories on foreign direct investment.

Some theories emphasized the cost advantage of host countries. This is reflected in the term $(\alpha_C + \lambda_C)\frac{EC_t}{EP_t - EC_t} - (\alpha_{C*} + \lambda_{C*})\frac{EC_t^*}{EP_t^* - EC_t^*}$.

Note that information costs regarding the costs in both countries are taken into account in this expression.

Other theories of foreign direct investment incorporate the demand side effect. In this case, foreign investments are affected by the expectation of whether output prices are higher abroad than in the domestic market. This idea is reflected in the term $(\alpha_{P*} + \lambda_{P*})(\alpha + \frac{EP_t^*}{EP_t^* - EC_t^*}) - (\alpha_P + \lambda_P)(\beta + \frac{EP_t}{EP_t - EC_t})$.

Note that information costs regarding the output prices in both countries are taken into account in this expression. The other terms $(\alpha_e+\lambda_e) + (1/2)\alpha(\alpha+1)S^{*2} - (1/2)\beta(\beta+1)S^2$ are linked to exchange rates.

They indicate how the flow of investment is affected by the exchange rate by accounting for the degree of competitiveness in the economy of the foreign country. They reflect how the investments flow from domestic to the foreign country depends on the stochastic changes.

The second term in x^*, H_2 can be written as $H_2 = \frac{(\beta+1)^2 S^2}{S_g^2}$.

The hedging demand shows that foreign investment will increase the greater the variability of domestic returns. This demand can also be traced to uncertainties in prices and costs and the degree of competitiveness in the markets. The greater variability in domestic price and cost can stimulate foreign investments.

We can write the equation for the optimal x^* as:

$$\alpha_{R*} - \alpha_R = A\,(x^* S^2{}_g - S^2{}_R) \tag{19}$$

Following Choi (1989), define q as the ratio of supply of foreign assets to the total wealth of the domestic economy. By aggregating over all firms and defining q as the time integral of current account balances, the equilibrium relationship is:

$$\alpha_{R*} - \alpha_R = A_m\,(qS^2{}_m - S^2{}_R) \tag{20}$$

The equation is equivalent to equation (18) in Choi (1989). The term A_m refers to a weighted average of the firm's measure of relative risk aversion. The term $S^2{}_m$ is the variance of return on the world portfolio of investment projects. The equation can be seen as a description of the "capital market line". It is nearly similar to the international asset pricing models in Solnik (1974) and Stulz (1981).

IV. SUMMARY

We present a simple model of international corporate investment by specifying the properties of the firm's domestic and foreign output and input prices and the effects of the exchange risk and competition among firms. The model extends the theory in Choi (1989) for international corporate investment in an environment where a partial segmentation and the presence of some costs provide some independence to corporate decisions.

Following Choi (1989) and Bellalah and Zhen (2002), we assume that the firm maximizes the present value of the manager's expected utility of net cashflows under a flow balance sheet constraint. The manager may choose to invest wealth in home or foreign markets. By accounting for the effects of exchange rates, taxes and information costs, we derive the optimal value corresponding to the optimum proportion of foreign investment in the firm's total capital budget in the general case. The solution has two parts: an expression of the speculative demand and an expression for the hedging demand. The speculative demand incorporates the demand side effect where foreign investments are affected by the expectation of whether output prices are higher abroad than in the domestic or home market in the presence of information costs. It reflects also the way the investments flow from domestic to the foreign country depend on the stochastic changes. Our technique for solving optimal control problems can be applied in several problems in financial economics.

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