

A Real Options Analysis of Foreign Direct Investment Competition in a News Uncertain Environment

J. Zambujal-Oliveira

Abstract—The relation between taxation states and foreign direct investment has been studied for several perspectives and with states of different levels of development. Usually it's only considered the impact of tax level on the foreign direct investment volume. This paper enhances this view by assuming that multinationals companies (MNC) can use transfer prices systems and have got investment timing flexibility. Thus, it evaluates the impact of the use of international transfer pricing systems on the states' policy and on the investment timing of the multinational companies. In uncertain business environments (with periodical release of news), the investment can increase if MNC detain investment delay options. This paper shows how tax differentials can attract foreign direct investments (FDI) and influence MNC behavior. The equilibrium is set in a global environment where MNC can shift their profits between states depending on the corporate tax rates. Assuming the use of transfer pricing schemes, this paper confirms the relationship between MNC behavior and the release of new business news.

Keywords—Corporate Taxation, International Profit Shifting, Real Options

I. INTRODUCTION

THE aim of this paper is to simulate the way countries define their taxes and how this competition to attract investments influences the companies' behavior. This equilibrium is set in a global environment where international companies can move its profits between countries and where the level of profit depends on the tax rates. Hines (1999) [1] confirms this profit shifts and their relation with transfer pricing schemes.

Generally, tax competition literature studies how taxes are set by non-cooperative governments. These studies contain some underlying assumptions about the role of capital as the full reversibility of the investments and the exogenous flexibility of the investment timing. Although, most FDI decisions can be characterized for having irreversibility (at least partial), uncertainty (originated by the markets and government politics) and dependency of its present value from the investment timing (implicit right to choose the best timing to make the foreign direct investment).

J. Zambujal-Oliveira is with Centre for Management Studies (CEG-IST), Department of Engineering and Management (DEG), Instituto Superior Técnico (IST), Technical University of Lisbon (UTL), Lisbon, Portugal (Corresponding author phone: +351 218 417 981; email: j.zambujal.oliveira@ist.utl.pt).

Several authors have studied the influence of international tax rules on FDI, using data that included several countries [2], [3], [4], [5], [6], [7]]. The determinant factors of the location FDI can change according the country's level of developing [8].

Tax rate differentials between states can be large and remain over time, affecting relevantly the returns of FDI. There is evidence that states with lower tax rates receive more FDI than states with higher tax rates. It is also know, that, for given states, FDI is abundant in periods where tax rates decrease [1].

On tax competition, some interesting works observe that smaller states impose lower tax rates, for unions that include only two states and exclusively differ in the population factor [9], [10]]. The evidence that smaller jurisdictions impose lower tax rates and are more tax competitive is corroborated by on taxes over commodities [11]. Considering the absence of side payments, differences between states can mean that synchronization between tax rates may not be easy, even if the Nash equilibrium result is ineffective.

When states based the taxation on a mobile factor, as foreign direct investments, may exist potential benefits gains from tax policy harmonization. The simplest form of tax policy harmonization might be an accord by between two or more states to define a common tax rate. However, if there are other relevant differences among states, the equilibrium tax rate would be difficult to reach without side payments [9]. An analysis of the equilibrium of a state tax competition game [12] and transfer pricing mechanisms allow firms to place profits where tax rate is lowest, and cut off the operations location and profit link [7]. These practices allow profit shifting to replace, partly the capital mobility [13].

Apart from the introduction, the paper is organized in the following way. In the next section, one assembles a model with two uncertainties for two scenarios (no-news or new-news). The last part of this section compares the investment levels of the two scenarios. In the last section, the paper states its findings.

II. MODEL DESCRIPTION AND SCENARIO COMPARISON

For simulating the investment decisions taken by a MNC, the paper considers a model with two states (S_1 and S_2) in an infinite horizon. Assuming a profit shifting option, MNC should choose the investment level that maximizes the option. The price of the profit shifting option should be equal to the maximum of the difference between global investment and the

onshore investment. Such value corresponds to the opportunity cost associated with the flexibility loss of profit shifting in the other moments.

The delay in a profit shifting option is related with receiving incremental information. When a MNC shift profits at a given time, it rejects the delay option and takes the loss of the opportunity cost associated with the firm's flexibility. The investment decision results from selecting the highest present value of the global profit flow $\pi_G(\pi_{S_2}, \pi_{S_1})^1$ that maximizes the option value. Considering this point, the company should take the right decision for each situation. If the expected present value $E[V(\pi_G)] \leq E[V(\pi_{S_1})]$, the MNC should stay still and doesn't invest offshore. In this situation, MNC should suspend the offshore investment and takes the investment decision later. Otherwise, if $E[V(\pi_G)] > E[V(\pi_{S_1})]$, the MNC's decision should be to shift profits immediately.

From now on, one considers two scenarios of uncertainty. The no-news does not include the arrival of new news. The new-news includes the arrival of good and bad with a given probability.

A. No-news Scenario

In an uncertain environment, the offshore investment decision can be a function of new news. Bad news impact negatively the investment. Good news are indifferent to the investment decision [14]. The asymmetrical nature of uncertain causes that only unfavorable situations may substantially alter the propensity to invest. Additionally, the magnitude of the bad news translates itself as higher irreversibility levels. Thus, as present value decreases, higher required returns become the investment projects less viable. Assuming an onshore profit flow in state S_1 (π_{S_1}) that follows the process:

$$d\pi_{S_1} = \alpha_{S_1}\pi_{S_1}dt + \sigma_{S_1}\pi_{S_1}dz_{S_1}. \quad (1)$$

α_{S_1} : Growth rate; σ_{S_1} : Volatility of profit flow;

Considering an offshore profit flow π_{S_2} after MNC has expanded its activities, investing in state S_2 :

$$d\pi_{S_2} = \alpha_{S_2}\pi_{S_2}dt + \sigma_{S_2}\pi_{S_2}dz_{S_2}. \quad (2)$$

α_{S_2} : Growth rate; σ_{S_2} : Volatility of profit flow;

Therefore, the global profit flow π_G captures the net profit flows of states S_1 and S_2 :

$$\pi_G(\pi_{S_2}, \pi_{S_1}) = [(1 - \tau_{S_1}) + \theta(\zeta)]\pi_{S_1} + (1 - \tau_{S_2})\pi_{S_2}, \quad (3)$$

$\pi_G(\pi_{S_2}, \pi_{S_1})$: Global profit flow; π_{S_2}, π_{S_1} : Profit flows in states S_1, S_2 ;
 τ_{S_1}, τ_{S_2} : Tax rates in states S_1, S_2 ;

with a function of costs $\theta(\zeta)$ that contains the shifted profit between states S_1 and S_2 :

$$\theta(\zeta) = (\tau_{S_1} - \tau_{S_2})\zeta - \varphi(\zeta) \quad (4)$$

¹ π_{S_2}, π_{S_1} : Profit flows in states S_1, S_2

ζ : Profit shifted between states; $\theta(\zeta)$: Net profit shifted; $\varphi(\zeta)$: Cost function of profit shifting

Considering the absence of news, the aim is calculating the profit level $\pi_{S_2}^*$ that motivates the investment abroad. Later, one will compare the difference of this profit level with the one necessary to motivate the offshore investment with a bad news environment. The expression (3) considers $(1 - \tau_{S_2})\pi_{S_2}$ as the net offshore profit flow in state S_2 and also, includes the net profit flow in state S_1 , $[(1 - \tau_{S_1}) + \theta(\zeta)]\pi_{S_1}$. The expression $\theta(\zeta) = (\tau_{S_1} - \tau_{S_2})\zeta - \varphi(\zeta)$ represents the tax benefits from profit shifting between states. As a consequence of expanding its activity to state S_2 , MNC will try to maximize its profits, minimizing its taxes by transferring profits from state S_1 to S_2 .

Associated with the profit shifting procedure exists some operational costs (lawyer costs, tax administration costs and other service costs) represented by the function $\varphi(\zeta)$. If there aren't profits transfer, $\zeta = 0$ and $\varphi(\zeta) = \varphi'(\zeta) = 0$. Additionally, the second derivative of cost function $\varphi''(\zeta)$ is bigger than zero. As one assumes that is expensive to transfer all profits because, MNC should not eliminate profits in the high-tax state [15].

Assuming a risk diversified by trading financial assets, the opportunity cost of capital μ will be exogenous. A reasonable assumption consists of not permitting the integral shift in the profits from the high-tax state to the low-tax state. It is costly to shift all profits in the sense that the multinational firm cannot eliminate positive profits in the high-tax country. One obtains the critical level of profit shifting, differentiating the expression (4) with respect to ζ and equaling it to 0:

$$\zeta^* = \arg[\varphi(\zeta) = \tau_{S_1} - \tau_{S_2}]$$

$\varphi(\zeta)$: Cost function of profit shifting; τ_{S_1}, τ_{S_2} : Tax rates in states S_1, S_2

From the previous expression can be concluded that when the tax rate of state S_1 is lower than the tax rate of state S_2 the profit shift level is positive $\zeta(\cdot) > 0$.

$$F(\pi_{S_2}, \pi_{S_1}) = E\left\{\int_t^\infty \pi_G(\pi_{S_2}, \pi_{S_1}) e^{-\mu(s-t)} ds\right\} \quad (5)$$

μ : Risk-adjusted discount rate; t : Time

The firm problem consists in choosing the highest option value between the onshore and offshore investments. The decision to invest offshore will occur when the present value of offshore investment surpass the present value of onshore investment. If the multinational company only infinitely invests onshore, producing a profit flow π_{S_1} the present value will be:

$$V(\pi_{S_1}) = E\left[\int_t^\infty [(1 - \tau_{S_1}) + \theta(\zeta)] \pi_{S_1} e^{-\mu(s-t)} ds\right],$$

$$V(\pi_{S_1}) = \frac{[(1 - \tau_{S_1}) + \theta(\zeta)]\pi_{S_1}}{\mu - \alpha_{S_1}} = \frac{[(1 - \tau_{S_1}) + \theta(\zeta)]\pi_{S_1}}{\delta_{\pi_{S_1}}}, \quad (6)$$

μ : Risk-adjusted discount rate; $\delta_{\pi_{S_1}}$: Convenience yield

Otherwise, MNC infinitely invests onshore and offshore, producing a profit flow π_G , the present value of its payoff will be:

$$V^G(\pi_{S2}, \pi_{S1}) = E \left[\int_t^\infty \frac{\pi_G(\pi_{S2}, \pi_{S1})}{e^{-\mu(s-t)}} ds \right], \quad (7)$$

Making use of (6) and (7), one can calculate the option value:

$$F = E \left[\int_t^\infty \frac{\pi_G(\pi_{S2}, \pi_{S1})}{e^{-\mu(s-t)}} ds \right] - E \left[\int_t^\infty \frac{\pi_{S1}}{e^{-\mu(s-t)}} ds \right],$$

$$F = \frac{[(1-\tau_{S1})+\theta(\zeta)]\pi_{S1}}{\mu-\alpha_{S1}} + \frac{(1-\tau_{S2})\pi_{S2}}{\mu-\alpha_{S2}} - \frac{(1-\tau_{S1})\pi_{S1}}{\mu-\alpha_{S1}}, \quad (8)$$

$$F = \frac{\theta(\zeta)}{\mu-\alpha_{S1}} \pi_{S1} + \frac{(1-\tau_{S2})}{\mu-\alpha_{S2}} \pi_{S2} = \frac{\theta(\zeta)}{\delta_{\pi_{S1}}} \pi_{S1} + \frac{(1-\tau_{S2})}{\delta_{\pi_{S2}}} \pi_{S2}, \quad (9)$$

Considering the absence of news, the aim is calculating the profit level that motivates investments abroad. In the next section, one compares the difference between this profit level and one necessary to motivate the foreign investment in an option existence environment. The value of the option $F(\pi_{S2}, \pi_{S1})$ to shift profits depends on both π_{S1} and π_{S2} . One expects that the profit shifting option will be held if π_{S2} has got low values or π_{S1} is very high. As one assumes an infinite horizon, there isn't a final function for backwarding. Using contingent claims approach, one gets the following expression:

$$\frac{1}{2} \left(\sigma_{\pi_{S2}}^2 \pi_{S2}^2 F_{\pi_{S2}\pi_{S2}} + 2\rho\sigma_{\pi_{S2}}\sigma_{\pi_{S1}}\pi_{S2}\pi_{S1}F_{\pi_{S2}\pi_{S1}} + \frac{1}{2}\sigma_{\pi_{S1}}^2 \pi_{S1}^2 F_{\pi_{S1}\pi_{S1}} \right) + (r - \delta_{\pi_{S2}})\pi_{S2}F_{\pi_{S2}} + (r - \delta_{\pi_{S1}})\pi_{S1}F_{\pi_{S1}} - rF = 0 \quad (10)$$

$$F_{\pi_{S2}} = \frac{\partial F}{\partial \pi_{S2}}; F_{\pi_{S1}} = \frac{\partial F}{\partial \pi_{S1}}; F_{\pi_{S2}\pi_{S2}} = \frac{\partial^2 F}{\partial \pi_{S2}^2}; F_{\pi_{S1}\pi_{S1}} = \frac{\partial^2 F}{\partial \pi_{S1}^2};$$

r : Risk-free rate

Equation (10) is a partial differential equation with two variables (π_{S2}, π_{S1}) . In order to yield a solution for the function $F(\cdot)$ there are a set of conditions that should be satisfied over the region where the shift profit option is immediately exercised [16]. The first one is the value-matching condition:

$$F(\pi_{S2}, \pi_{S1}) = V^G(\pi_{S2}, \pi_{S1}) - V(\pi_{S1}) \quad (11)$$

The second ones are the two smooth-pasting conditions:

$$F_{\pi_{S2}}(\pi_{S2}, \pi_{S1}) = V_{\pi_{S2}}^G(\pi_{S2}, \pi_{S1}) = \frac{(1-\tau_{S2})}{\delta_{S2}} \quad (12)$$

$$F_{\pi_{S1}}(\pi_G(\pi_{S2}, \pi_{S1}), \pi_{S1}) = V_{\pi_{S1}}^G(\pi_{S2}, \pi_{S1}) - V_{\pi_{S1}}(\pi_{S1}) = \frac{\theta(\zeta)}{\delta_{S1}} \pi_{S1} \quad (13)$$

$$F_{\pi_{S2}} = \frac{\partial F}{\partial \pi_{S2}}; F_{\pi_{S1}} = \frac{\partial F}{\partial \pi_{S1}}; F_{\pi_{S2}\pi_{S2}} = \frac{\partial^2 F}{\partial \pi_{S2}^2}; F_{\pi_{S1}\pi_{S1}} = \frac{\partial^2 F}{\partial \pi_{S1}^2}; V_{\pi_{S2}}^G = \frac{\partial V}{\partial \pi_{S2}}; V_{\pi_{S1}}^G = \frac{\partial V}{\partial \pi_{S1}}$$

Equation (10) together with boundary conditions (11) - (13) should yield a solution for function $F(\pi_G, \pi_{S1})$ in the waiting region. Therefore, one should impose the following conditions. First, the net profits in states S_1, S_2 should be bigger than zero:

$$[(1 - \tau_{S1}) + \theta(\zeta)]\pi_{S1} > 0, (1 - \tau_{S2})\pi_{S2} > 0, \quad (14)$$

π_{S2}, π_{S1} : Profit flows in states S_1, S_2 ; τ_{S1}, τ_{S2} : Tax rates in states S_1, S_2 ; ζ : Profit shifted between states; $\theta(\zeta)$: Net profit shifted; $\varphi(\zeta)$: Cost function of profit shifting

The same condition should be satisfied by the global profit flow:

$$\pi_G(\pi_{S2}, \pi_{S1}) > 0 \quad (15)$$

As this is a free boundary problem, hasn't got an analytical solution. Considering the existence of a proportional variation of π_{S2} and π_{S1} , the decision could depend on the ratio $\pi_S = \pi_{S2}/\pi_{S1}$ [16]. Thus, the option value should be homogeneous of first degree in π_S permitting to write [17]:

$$F(\pi_{S2}, \pi_{S1}) = \pi_{S1} f \left(\frac{\pi_{S2}}{\pi_{S1}} \right) = \pi_{S1} f(\pi_S) \quad (16)$$

$f(\cdot)$: Function to be determined; (π_{S2}, π_{S1}) : Option function

After successive differentiations, one obtains (see how to determine function $f(\cdot)$ in Appendix):

$$\frac{1}{2} (\sigma_{\pi_{S2}}^2 - 2\rho\sigma_{\pi_{S2}}\sigma_{\pi_{S1}} + \sigma_{\pi_{S1}}^2) \pi_S^2 f''(\pi_S) + (\delta_{\pi_{S1}} - \delta_{\pi_{S2}}) \pi_S f'(\pi_S) - \delta_{\pi_{S1}} f(\pi_S) = 0 \quad (17)$$

$\pi_S = \frac{\pi_{S2}}{\pi_{S1}}$, $\delta_{\pi_{S1}}, \delta_{\pi_{S2}}$: Convenient yields; $\sigma_{\pi_{S2}}^2, \sigma_{\pi_{S1}}^2$: Volatilities; ρ : Correlation between profit flows.

The previous expression is an ODE for the function $f(\pi_S)$ of the independent variable π_S . As expression (17) is a second order homogeneous linear equation, the solution is linear combination of two linearly independent solutions given by:

$$f(\pi_S) = K_1 \pi_S^{\omega_1} + K_2 \pi_S^{\omega_2} \quad (18)$$

K_1, K_2 : Constants to be determined

Its boundary conditions include the value-matching and the smooth pasting conditions. The value-matching condition turns into:

$$f(\pi_S^*) = \frac{\theta(\zeta)}{\delta_{\pi_{S1}}} + \frac{(1 - \tau_{S2})}{\delta_{\pi_{S2}}} \pi_S^*$$

The smooth-pasting conditions turn into:

$$f'(\pi_S^*) = \frac{(1 - \tau_{S2})}{\delta_{\pi_{S2}}}$$

$$f(\pi_S^*) - \pi_S^* f'(\pi_S^*) = \frac{\theta(\zeta)}{\delta_{\pi_{S1}}}$$

From equation (17), one composes the fundamental quadratic expression:

$$Q = \frac{1}{2}(\sigma_{\pi_{S2}}^2 - 2\rho\sigma_{\pi_{S2}}\sigma_{\pi_{S1}} + \sigma_{\pi_{S1}}^2)\omega(\omega - 1) + (\delta_{\pi_{S1}} - \delta_{\pi_{S2}})\omega - \delta_{\pi_{S1}} = 0 \quad (19)$$

Solving $Q = 0$, assuming $\delta_{\pi_{S1}}$ and $\delta_{\pi_{S2}}$ positive, and being ω_1 the higher root of equation (19), the optimal level of profit shifting π_S^* will be:

$$\pi_S^* = \frac{\pi_{S2}^*}{\pi_{S1}^*} = \frac{\omega_1}{\omega_1 - 1} * \frac{\delta_{\pi_{S2}}}{(1 - \tau_{S2})} * \frac{\theta(\zeta)}{\delta_{\pi_{S1}}} \quad (20)$$

From expression (20), the condition to proceed with the offshore investment is that $(\pi_{S2}/\pi_{S1}) > (\pi_{S2}^*/\pi_{S1}^*)$. The same expression can be used as a rule to analyze the effects in the investment from taxes [5]. The value of π_S^* will be different for diverse state tax rates. Different levels of π_S^* correspond to different timings of exercise the profit shifting option. Equation (20) also shows that profit shifting increase profits and lower the level that activates the investment. This means the increase on the profit shifting contributes to decrease company's effective tax rate, increasing investments attractiveness. The rationale behind is the following: an increase in the profit shifting reduces the investment needs and triggers the level that induces the offshore investment.

B. New- news Scenario

The release of new information implies a new level of gross profits, with a different expected payoff. This principle implies that new news can influence the investment decision. In result of receiving bad news, the company can delay its offshore investment (meaning that the present value of global profit flows is lower than the present value of onshore profit flow), [14]. Modifying our basic model, one assumes that π_{S2} follows the mixed Brownian motion and jump process [16]:

$$d\pi_{S2} = \alpha_{S2}\pi_{S2}dt + \sigma_{S2}\pi_{S2}dz - \pi_{S2}dq, \quad (21)$$

where

$$dq = \begin{cases} 0 & \text{with probability } (1 - \lambda dt) - \text{good news} \\ u & \text{with probability } (\lambda dt) - \text{bad news} \end{cases}$$

The offshore profits depend on the timing and its associated probability and payoff. The probability of occurrence of bad news $(\lambda dt, 1 - \lambda dt)$ determines the value of $dq(0, u)$. The existence of a delay option implies the occurrence of a tax deferral, increasing tax savings and discouraging the investment. [[18], [19] [20], [15]]. Over the region where the

option is exercised the option value is given by the previous defined formula (11) with different present values.

$$V^G(\pi_{S2}, \pi_{S1}) = \frac{(1 - \tau_{S2})\pi_{S2}}{\lambda + \delta_{S2}}; V(\pi_{S1}) = \frac{\pi_{S1}}{\delta_{S1}}$$

$$F(\pi_{S2}, \pi_{S1}) = \frac{(1 - \tau_{S2})}{\lambda + \delta_{S2}}\pi_{S2} + \frac{\theta(\zeta)}{\delta_{S1}}\pi_{S1}. \quad (22)$$

Differentiating the previous expression, one gets:

$$F_{\pi_{S2}}(\pi_{S2}, \pi_{S1}) = \frac{(1 - \tau_{S2})}{\lambda + \delta_{S2}}, F_{\pi_{S1}}(\pi_{S2}, \pi_{S1}) = \frac{\theta(\zeta)}{\delta_{S1}}$$

Repeating the differentiation

$$F_{\pi_{S2}\pi_{S2}}(\pi_{S2}, \pi_{S1}) = F_{\pi_{S1}\pi_{S1}}(\pi_G, \pi_{S1}) = 0$$

Using contingent claims, one obtains the following equation:

$$\frac{1}{2}(\sigma_{\pi_{S2}}^2\pi_S^2 F_{\pi_{S2}\pi_{S2}} + 2\rho\sigma_{\pi_{S2}}\sigma_{\pi_{S1}}\pi_{S2}\pi_{S1} + \frac{1}{2}\sigma_{\pi_{S1}}^2\pi_{S1}^2 F_{\pi_{S1}\pi_{S1}}) + (r - \lambda - \delta_{\pi_{S2}})\pi_{S2}F_{\pi_{S2}} + (r - \delta_{\pi_{S1}})\pi_{S1}F_{\pi_{S1}} - rF = 0 \quad (23)$$

The previous expression (23) has got two uncertainties (π_{S2}, π_{S1}) . Maintaining the assumption that $F(\pi_{S2}, \pi_{S1})$ is homogeneous of first degree, the profit shift decision will depend on the ratio $\pi_S = \pi_{S2}/\pi_{S1}$. This assumption permits to substitute the function $F(\pi_{S2}, \pi_{S1})$ by the function $f(\pi_S)$ as it was done in (16). Successive differentiation of value-matching and smooth pasting conditions of function $F(\pi_{S2}, \pi_{S1})$ permits to obtain the following ODE (Appendix):

$$\frac{1}{2}(\sigma_{\pi_{S2}}^2 - 2\rho\sigma_{\pi_{S2}}\sigma_{\pi_{S1}} + \sigma_{\pi_{S1}}^2)\pi_S^2 f''(\pi_S) + (\delta_{\pi_{S1}} - \lambda - \delta_{\pi_{S2}})\pi_S f'(\pi_S) - \delta_{\pi_{S1}} f(\pi_S) = 0 \quad (24)$$

The unknown function $f(\pi_S)$ should have a solution equal to (18). As one has got three unknown variables, one will need three conditions to fill the solution. When π_S is small, near of 1, the possibility of it increasing to the critical π_S^* is quite low. In this case, the option value should be almost zero. One can ensure that when π_S goes to 1, $f(\pi_S)$ will go to zero, setting the constant $K_1 = 0$. As one needs two additional conditions, one can consider the value matching and smooth pasting conditions at critical level π_S^* .

$$f(\pi_S^{**}) = \frac{(1 - \tau_{S2})\pi_S^{**}}{\lambda + \delta_{\pi_{S2}}} + \frac{\theta(\zeta)}{\delta_{\pi_{S1}}}$$

$$f'(\pi_S^{**}) = \frac{(1 - \tau_{S2})}{\lambda + \delta_{\pi_{S2}}}; f(\pi_S^{**}) - \pi_S^{**} f'(\pi_S^{**}) = \frac{\theta(\zeta)}{\delta_{\pi_{S1}}}$$

The resulting quadratic is:

$$Q = \frac{1}{2}(\sigma_{\pi_{S2}}^2 - 2\rho\sigma_{\pi_{S2}}\sigma_{\pi_{S1}} + \sigma_{\pi_{S1}}^2)\omega'(\omega' - 1) + (\delta_{\pi_{S1}} - \lambda - \delta_{\pi_{S2}})\omega' - \delta_{\pi_{S1}} = 0 \quad (25)$$

Assuming that $\delta_{\pi_{S2}}$ and $\delta_{\pi_{S1}}$ are both higher than zero, the challenge is to calculate the ratio level $\pi_S^{**} = \pi_{S2}/\pi_{S1}$ knowing that there is a probability λdt of occurring bad news and from which the offshore investment become profitable.

$$\pi_S^{**} = \frac{\pi_{S2}^{**}}{\pi_{S1}^{**}} = \frac{\omega'_1}{\omega'_1 - 1} * \frac{\delta_{\pi_{S2}} + \lambda}{(1 - \tau_{S2})} * \frac{\theta(\zeta)}{\delta_{\pi_{S1}}} \quad (26)$$

ω'_1 : Higher root of equation; λ : Frequency rate for the news arrival

Making use of equations (20) and (26), one relates the trigger values of π_S of both scenarios:

$$\pi_S^{**} = \left(\frac{\omega'_1}{\omega'_1 - 1} * \frac{\omega_1 - 1}{\omega_1} \right) * \frac{(\delta_{\pi_{S2}} + \lambda)}{(1 - \tau_{S2})} * \frac{(1 - \tau_{S2})}{\delta_{\pi_{S2}}} \pi_S^* \quad (27)$$

By the equation (27), the profit flow π_{S2} can be influenced by all the new news (good or bad). As $\pi_S^{**} > \pi_S^*$, the expected payout level associated with the no-news scenario will be higher than the new-news scenario because in the second scenario there is an asymmetric effect on company profits. Thus, the investment decision results from the magnitude of the descending shift u and its associated probability λdt but is indifferent to the increasing shift level.

This behavior is in line with literature because when a company doesn't receive bad news and has a delay option, the investment has got to be profitable [14]. Otherwise, if a MNC receives bad news, the investment profitability won't be ensured, it would be dependent from timing. For example, if MNC accepts the delay option, waits and receive news, the decision of not investing seems to be adequate. The other possibility would be having invested before the reception of news. In that case, the decision could be inadequate.

III. CONCLUSIONS

This paper used the principle of Baranke to investigate how the possibility to defer investments (FDI) influences companies' behavior. This principle says that the investment decision doesn't change by the appearance of good news. According to this principle, are the bad news (their probability and magnitude) that influence in a relevant way the investment decisions.

Relatively to the goals defined in the introduction, this paper can conclude that under [14] Bernanke's (1983) assumptions, tax influences FDI level. However, this effect is not homogenous because the investment boundaries behave differently in the no-news option and in the new-news option. In what concern to the assessment of tax competition between countries in a profitable environment, these can elevate tax rate level and consequently a rise in the value of the option to delay the FDI. The results taken from this paper demonstrate that the impact of profit transferring depends from company's ability to defer investment. Facing a possibility of profit transferring and investing abroad, the company requires a

higher payoff in the new-news scenario than in the no-news scenario.

This paper confirms that for evaluating the influence of profit transfer on the threshold value, it's necessary to analyze the value of $\theta(\zeta)$. There is an inverse relation between tax savings and the investment value. More tax savings means lower investment [15]. Thus, profit shifting impacts in a heterogeneous way the investment trigger levels. The arrival of bad news has a relevant impact on the investment level of the new-news scenario but the appearance of good news is indifferent.

APPENDIX

Successive differentiation of $F(\cdot)$ results in the following expressions:

$$F_{\pi_{S2}}(\pi_{S1}, \pi_{S2}) = f'(\pi_S),$$

$$F_{\pi_{S1}}(\pi_{S1}, \pi_{S2}) = f(\pi_S) - \pi_S f'(\pi_S),$$

and

$$F_{\pi_{S2}\pi_{S2}}(\pi_{S1}, \pi_{S2}) = \frac{1}{\pi_{S1}} f''(\pi_S),$$

$$F_{\pi_{S2}\pi_{S1}}(\pi_{S1}, \pi_{S2}) = -\pi_S \frac{1}{\pi_{S1}} f''(\pi_S),$$

$$F_{\pi_{S1}\pi_{S1}}(\pi_{S1}, \pi_{S2}) = \pi_S^2 \frac{1}{\pi_{S1}} f''(\pi_S)$$

REFERENCES

- [1] J. Hines, "Lessons from Behavioral Responses to International Taxation," *National Tax Journal*, vol. 52, pp. 304-322, (1999).
- [2] A. Auerbach and K. Hassett, "Recent U.S. Investment Behavior and the Tax Reform Act of 1986: A Disaggregate View," NBER Working Papers, 1992.
- [3] A. Desai, C. Foley, and J. Hines, "Do Tax Havens Divert Economic Activity?," *Economic Letters*, vol. 90, pp. 219-224, 2001.
- [4] R. de Mooij and S. Ederveen, "Taxation and Foreign Direct Investment: A Synthesis of Empirical Research," 2001.
- [5] M. Devereux and R. Griffith, "Taxes and the location of production: evidence from a panel of US multinationals," *Journal of Public Economics*, vol. 68, no. 3, pp. 335-367, 1998.
- [6] H. Grubert and J. Mutti, "Taxes, Tariffs and Transfer Pricing in Multinational Corporation Decision Making," *Review of Economics and Statistics*, vol. 73, pp. 285-293, 1991.
- [7] J. Hines and E. Rice, *Fiscal Paradise: Foreign Tax Havens and American Business*.: NBER Working Paper Series, 1994.
- [8] A. Blonigen and M. Wang, "Inappropriate Pooling of Wealthy and Poor Countries in Empirical FDI Studies," NBER Working Papers, 2004.
- [9] S. Bucovetsky, "Asymmetric tax competition," *Journal of Urban Economics*, vol. 30, no. 2, pp. 167-181, 1991.
- [10] Wilson, "Tax Competition with Interregional Differences in Factor Endowments," *Regional Science and Urban Economics*, vol. 21, pp. 423-451, 1991.
- [11] R. Kanbur and M. Keen, "Tax competition and tax coordination : when countries differ in size," *Policy Research Working Paper Series*, 1993.
- [12] S. Peralta, X. Wauthy, and V. Ypersele, "Should Countries Control International Profit Shifting ?," *CORE Discussion Papers* 2003072, 2003.
- [13] R. Davies and T. Gresik, "Tax Competition and Foreign Capital," *University of Oregon Economics Department Working Papers*, 2001.
- [14] B. Bernanke, "Irreversibility, Uncertainty, and Cyclical Investment," *Quarterly Journal of Economics*, vol. 98, no. 1, pp. 85-106, 1983.

- [15] P. Panteghini and G. Schjelderup, "Competing for Foreign Direct Investments: A Real Options Approach," CESIFO Working Paper, 929, 2003.
- [16] A Dixit and R Pindyck, Investment under uncertainty.: Princeton University Press, 1994.
- [17] J. Zambujal-Oliveira, "Validity of the homogeneity property in real assets replacement procedures," International Review of Applied Financial Issues and Economics, forthcoming.
- [18] D. Mauer and S. Ott, "Investment under Uncertainty: The Case of Replacement Investment Decisions," Journal of Financial and Quantitative Analysis, pp. 581-605, 1995.
- [19] J. Zambujal-Oliveira and J. Duque, "Operational Asset Replacement Strategy: A Real Options Approach," European Journal of Operational Research, vol. 210, no. 2, pp. 318-325, 2011.
- [20] J. Hines and E. Rice, "Fiscal Paradise: Foreign Tax Havens and American Business," NBER Working Paper Series, 1994.