IPO Underpricing Across the World: Does the Country Risk Matter?

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Abstract

The underpricing of initial public offerings (IPOs) has been widely examined across different stock markets around the world. Although some differences exist in IPO procedures, underpricing is present on every studied market. However, little attention has been paid to the degree of underpricing across these different markets. In this paper, we examine at what extent the Country Risk is involved in underpricing. A theoretical model is developed to integrate the Country Risk as a non-financial risk. The addition of Country Risk allows us to explain the difference in underpricing across stock markets around the world.

JEL classification: G32, G34.

Key words: Initial Public Offerings, IPOs, Underpricing, Country Risk, Non-financial Risk.

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Introduction

Empirical research has widely documented the presence of initial public offering (IPO) underpricing, measured as persistent positive initial day returns, on almost every financial market in the world (Loughran, Ritter and Rydqvist [1994]). An abundance of theoretical explanations which are not mutually exclusive has been advanced to explain this perplexing anomaly (Ritter and Welch [2002]).

However, less attention has been given to the international differences in underpricing. As Loughran et al. [1994] pointed out, countries with the lowest underpricing tend to be those in which most of the firms going public are relatively large firms with long operating histories and where the contractual mechanism used has auction-like features. This explanation for cross-difference in underpricing ignores many others important features as the various financial system across country. For instance, LaPorta, Lopez-De-Silanes, Shleifer and Vishny [2002] report that differences in the effectiveness of international financial systems can be attributed to differences in investor protection against expropriation as contained in the structure of a nation's civil laws. They further argue that the legal rules protecting investors and the quality of law enforcement varies greatly across nations. In a recent survey, Ritter [2003] emphasizes the differences between the American and European IPO markets. Although there are many differences in terms of IPO practices, none significant difference in terms of underpricing seems to be observed between both continents. One explanation for this uniform underpricing could be that these countries don't exhibit significant different country risk. We offer a model that highlight the role of country risk in determination of the IPO timing and underpricing.

Although there are many works arguing a consistent positive relation between value uncertainty (risk) and the first-day return (underpricing) (see, e.g., Carter and Manaster [1990], Carter, Dark and Singh [1998], Chen and Mohan [2002] and Chung, Li and Yu [2005]), none of them, to our knowledge, refers to the country risk to explain the cross-market differences in underpricing. The study contributes to the literature by modeling an IPO company's optimal response to the presence of investors which are aware of two kinds of risks: financial risk and non-financial risk. This latter is characterized by the country risk. We show that countries exhibiting the strongest country risk have their financial markets more subject to IPO underpricing. It is typically the case when the issuer is more risk averse than the investors. Then, a part of underpricing allows to compensate for the country risk.

We also contribute to the literature on market timing by equity issuers. Some empirical regularities suggest that firms time their decisions to go public. Ibbotson [1975], and Ritter [1984] among others document waves in IPOs, a phenomenon called "hot issue markets". One possible reason for the hot markets in IPOs is that firms face better market condition and better investors sentiment during some periods than in other times. This is a result we derive in the context of our model: we show that in presence of a non-financial risk as a country risk, the underpricing is stronger when the market conditions are favorable and firm is more risk averse than investors.

The remainder of the paper is organized as follows. Section 1 introduces a brief empirical test showing an *a priori* involvement of the country risk in the underpricing explanation. The general framework of the model is introduced in section 2. In section 3, the presence of non-financial risk (as risk country) is added and its implication for IPO pricing is studied. Concluding remarks are finally formulated in the last section.

1 Underpricing and country risk: a preliminary evidence

In a recent paper, Ritter [2003] presents an updating table of the article of Loughran et al. [1994]. This table shows the presence of underpricing in 38 countries.

Here, we purpose a very simple test to assess the link between underpricing and country risk as described in the table 1.

Table 1: Regressions of underpricing to country risks.
The sample includes 33 countries for which underpricing of IPO and both measures of country risk are available. Ind S&P designates the index associated to the S&P sovereign debt rating. CCR is the measure of country credit ratings as downloaded from the Campbell Harvey site. The coefficient significance is indicated in parentheses.

	Underpricing	
Variable	1	2
Intercept	0.13	0.37
	(3.28)	(4.66)
Ind S&P	0.44	
	(2.69)	
CCR		-0.35
		(-2.06)
Observations	33	33
Adjusted R^2	0.16	0.09

We use two measures of country risk. The first measure comes from the study of Campbell, Erb and Viskanta [1996]: the country risk is estimated by the country credit ratings. The source of this data is Institutional Investor's semi-annual survey of bankers. It is available on Campbell Harvey homepage [1] for the time period of 1985 to 1995. Most of the time, this period overlaps the examination period of papers measuring the IPO underpricing reported in Ritter [2003]. The second measure comes from the credit ratings provided by Standard and Poor's agency. These credit ratings apply to the sovereign debt in local currency. They are available free of charge on the web site of Standard and Poor's.[2] The pitfall of this last measure is that only updated data are available. It means that the estimation period of underpricing and the one of credit ratings are not synchronous. The table 2 in Appendix presents data for 33 countries. Regressions between underpricing and our both measures of country risk are significant at 5% level of confidence as shown in table 1.

[1] $http://www.duke.edu/\ charvey/Country_risk/ccr/ccrtab5.htm$

[2] $http://www.standardandpoors.com/ratings/$

This result suggests that country risk participate in the underpricing puzzle as a non-financial risk.

2 The model

In this section, we successively present the players (Firm and Investors) and the general maximization program before emphasizing the IPO pricing situations.

2.1 The IPO Firm

We designate the entrepreneur (or existing shareholders) by the generic term: firm. We assume that this firm is implanted in an emerging country. The firm plans to carry out an IPO on the local financial market. The total number shares of firm is q and it plans to sell a number n of them at $t = 0$. The remaining of shares $(q-n)$ will be sold at $t = 1$. The shares sold are from existing shareholders and no new equity issue is planed. The price p_1 at which these shares could be sold at $t = 1$ is a random variable laying over $[0, 1]$ according to a density function of $f(p_1) > 0$. This price is the unique source of risk for the firm. At $t = 0$, the realized value of firm is p_0 which is common knowledge. We could analyze the price p_0 as the current price of an asset at date $t = 0$, this asset could be deliverable at date $t = 1$ as it is the case on a future market. If the firm chooses to not issue at $t = 0$ ($n = 0$), it means that it differs its IPO at $t = 1$. The intermediary case $(q > n > 0)$ means that firm has chosen a multi-stage sell of its shares.

The firm is endowed with an initial certainty wealth w_0. At $t = 1$, its wealth will be:

$$\tilde{w}_1 = w_0 + q\tilde{p}_1 + n(p_0 - \tilde{p}_1) \tag{1}$$

In the expression 1, $q\tilde{p}_1$ designates the random value of the firm in the future whereas $n(p_0 - \tilde{p}_1)$ is the existing shareholders' gain or loss of a multi-stage sell of their shares.

At this point, the firm optimization problem consists in determining the number n of shares to sell in order to maximize its final wealth utility. The solution of this problem is:

$$\max_{n} \int_0^1 u(\tilde{w}_1) f(p_1) dp_1 \tag{2}$$

where $u(\cdot)$ is an utility function with the usual following properties: $u'(\cdot) > 0$ and $u''(\cdot) < 0$.

If the firm decides to issue no share at $t = 0$ ($n = 0$) then it postpones its IPO at $t = 1$ and its final wealth will be:

$$w_0 + q\tilde{p}_1 \tag{3}$$

The firm is risk averse and then its condition to accept to carry out an IPO is:

$$\int_0^1 u(\tilde{w}_1) f(p_1) dp_1 \geq \int_0^1 u(w_0 + q\tilde{p}_1) f(p_1) dp_1 \tag{4}$$

The incentive constraint 4 above means that the firm's expected utility must be stronger if it issues than if it does not.

Now, let's take a look at the investors' side.

2.2 The investors

The investors are candidate to purchase the n shares sold by the firm at $t = 0$ and the remaining at $t = 1$. They are faced with transaction costs $c(n)$. These costs mainly come from the trading fee itself. They could also represent an "evaluation" cost as in Chemmanur [1993]. These costs are exogenous and are investors' private information (They are not common knowledge). We assume that these costs follow a convexe function of n with the following properties:

$$c(0) = a \geq 0, \qquad c'(\cdot) \geq 0, \qquad c''(\cdot) \geq 0 \tag{5}$$

Investors are supposed to have rational homogeneous expectations. So they can be considered as a single agent. Suppose w is the investors' initial wealth and V their utility concave function with $V'(\cdot) > 0$ and $V''(\cdot) < 0$. If investors purchase n shares at the initial stage $t = 0$ then their final wealth at the horizon $t = 1$ will be:

$$w + n\tilde{p}_1 - c(n) \tag{6}$$

Investors are supposed risk averse. As previously for the firm, the incentive constraint for investors is expressed as follows:

$$\int_0^1 V(w + n\tilde{p}_1 - c(n))f(p_1)dp_1 \geq V(w) \tag{7}$$

In others words, the necessary condition 7 means that investors swap their certainty initial utility for the expectation of their final wealth utility as represented by $\int_0^1 V(w + n\tilde{p}_1 - c(n))f(p_1)dp_1$.

For the specific case where investors are risk neutral, the condition 7 can be rewritten as:

$$\int_0^1 (n\tilde{p}_1 - c(n))f(p_1)dp_1 \geq 0,$$
$$nE(\tilde{p}_1) - c(n) \geq 0$$

where E designates the expectation operator.

This latter relation means that the necessary condition for investors to purchase n shares is that the risk premium be positive or zero.

2.3 The maximization program

In order to make the IPO successful, the transaction must be acceptable for both agents (Firm and Investors). This is the case when conditions 4 and 7 are satisfied.

Thus, we are looking for price p_1 and the shares number n which maximize the final wealth expected utility of the firm subject to the constraint of constance of investors' expected utility. In this model, p_1 designates the price at which the share is traded on the secondary market at $t = 1$ knowing that it has been issued at $t = 0$.

The maximization program can be written as:

$$\max_{n,p_1} \bar{u}(p_1, n) \equiv \int_0^1 u(\tilde{w}_1) f(p_1) dp_1 \tag{8}$$

subject to:

$$\bar{V}(p_1, n) \equiv \int_0^1 V(w + np_1 - c(n)) f(p_1) dp_1 \geq k \tag{9}$$

where k is a constant and $k \geq V(w)$.

We use the optimal control theory to solve this program. Let n be the control variable and $z(\tau) \equiv \int_0^\tau (V(w + np_1 - c(n)) - k) f(p_1) dp_1$ the state variable. From previously, we deduct that $z(0) = z(1) = 0$ and $\dot{z}(\tau) \equiv (V(w + np_1 - c(n)) - k)$. The hamiltonian can be written as:

$$H = \{u(w_0 + qp_1 + n(p_0 - p_1)) + \lambda(V(w + np_1 - c(n)) - k)\} f(p_1) \tag{10}$$

The lagrangian λ is constant into equation 10 since the hamiltonian doesn't depend on the state variable. One necessary condition to obtain the optimal number of shares with respect to the constraint $p_1 \geq 0$ is:

$$\begin{aligned} \frac{dH}{dn} &= (p_0 - p_1)u'(w_0 + qp_1 + n^*(p_0 - p_1)) \\ &+ \lambda(p_1 - c'(n^*))V'(w + n^*p_1 - c(n^*)) = 0 \end{aligned} \tag{11}$$

2.4 The post-IPO optimal transaction price and the underpricing situation

In this section, we study the optimality conditions for the IPO price and its consequence on the underpricing of the issue.[3] Into the remaining of the paper, we eliminate the corner case where $p_1 < c'(n)$. Indeed, since this price is less than the marginal cost of the investors, this latter won't purchase the shares at that price.

We distinguish three market conditions. First, we consider that market conditions are fair for both sell and buy sides.

Proposition 1 (non-underpricing situation) *When the Firm and the Investors are only faced with a price volatility risk and market conditions are fair for both sell and buy sides then the optimal transaction price* p_1^* *satisfies the following property characterizing a non-underpricing situation:*

$$p_1^* = p_0 \text{ if } p_1 = c'(n) \tag{12}$$

Proof: see appendix.[4]

A fair market condition for buy side means that the optimal transaction price is equal to the trading marginal cost ($p_1 = c'(n)$). In this case, investors don't lose any money by purchasing the stock at a price p_0. Indeed, the expected post IPO price p_1 (which is equal to p_0) is exactly equal to the trading marginal cost. For sell side, a fair market condition means that the firm is indifferent between issuing at $t = 0$ or at $t = 1$.

Secondly, we assume that the market conditions are favorable for both sell and buy sides.

Proposition 2 (underpricing situation) *When the Firm and the Investors are only faced with a price volatility risk and the market conditions are favorable for*

[3] In this model, we'll conclude that the issue is underpriced if the optimal transaction price p_1 at which the share is traded at $t = 1$ is above the fixed offer price p_0.

[4] All the proofs of propositions are reported in the appendix.

both sell and buy side then the optimal transaction price p_1^* *satisfies the following property characterizing an underpricing situation:*

For $p_1 > c'(n)$,

$$p_1^* \geq \frac{p_0 R_u + c'(n^*) R_V}{R_u + R_V} \quad \text{if } p_1 > p_0 \tag{13}$$

where R_u *and* R_V *are the absolute coefficient of risk aversion for the firm and the investors associated to their utility functions, respectively* $u(\ )$ *and* $V(\ )$*.*

In this case, the favorable market condition for investors means that they have subscribed shares that worth an expected transaction price of p_1 which is above the trading marginal cost $c'(n)$. It is also a favorable condition for the firm which is going to initially issue an optimal fraction n^* at the price p_0 and the remaining of its shares at the price p_1 at $t = 1$. Without the IPO, firm couldn't sell its share at a price above its initial offer price. To understand this point, remember that, at $t = 0$, the realized value of firm is p_0 which is common knowledge. So the initial offer price is not a decision level for the firm.

As we can observe in this model, favorable market conditions for both side characterize an underpricing situation. It is another rational explanation as those developed by previous literature which usually consider that underpricing is a loss for the firm either to compensate uninformed investors (e.g. Rock [1986]) or informed investors (e.g. Benveniste and Spindt [1989]).

Finally, we suppose that market conditions is favorable for buy side and unfavorable for sell side.

Proposition 3 (overpricing situation) *When the Firm and the Investors are only faced with a price volatility risk and the market conditions are favorable for buy side but unfavorable for sell side then the optimal IPO offer price* p_1^* *satisfies the following property characterizing an overpricing situation:*

For $p_1 > c'(n)$,

$$p_1^* \leq \frac{p_0 R_u + c'(n^*) R_V}{R_u + R_V} \;\; if \; p_1 < p_0 \tag{14}$$

The situation here is the reverse as the previous one. When prices satisfy this relation ($p_1 < p_0$), market conditions are unfavorable for the firm and the optimal expected transaction price will characterize an overpricing situation.

3 The impact of a non-financial risk on the IPO pricing

In this section, we study the impact of a non-financial risk on the IPO pricing. From an economic point of view, the non-financial risk can be analyzed as a non-insurable risk. From now, we develop our model in a multiple risk framework and we assume that markets are incomplete in the sense that the buyers are not numerous enough to purchase all the assets sold on the market.

We consider that the wealth of the agents is subjected to a multitude of random chocks. Kimball [1990] used the notion of background risk which is similar to the one of white noise. This noise is non-insurable and independent to the premium risk. Let $\tilde{x}$ be this white noise normally distributed with a zero expectation $E(\tilde{x}) = 0$ according to the density function $g(\tilde{x})$ over the interval $[0, 1]$.

To avoid adverse selection and moral hazard issues, we assume that the Firm only knows the distribution of financial risk whereas the Investors are aware of the distributions of both financial and non-financial risk. From now, this white noise is added to our model into the final wealth expressions of Firm and Investors and the maximization program 8 and 9 is thus rewritten as:

$$\max_{n,p_1} \bar{u}(p_1, n) \equiv \int_0^1 \int_0^1 u(\tilde{w}_1 + \tilde{x}) f(p_1|x) dp_1 g(x) dx \tag{15}$$

with respect to:

$$\bar{V}(p_1, n) \equiv \int_0^1 \int_0^1 V(w + np_1 - c(n)) f(p_1|x) dp_1 g(x) dx \geq k' \quad (16)$$

where k' is a constant chosen in order to $k' \geq V(w + \tilde{x})$.

We simplify equations 15 and 16 by using the notion of derivative utility as in Kihlstrom, Romer and Williams [1981]. This implies to rewrite the utility expressions:

$$\hat{u}(w_0 + q\tilde{p}_1 + n(F_0 - \tilde{p}_1)) = \int_0^1 u(w_0 + \tilde{x} + q\tilde{p}_1 + n(F_0 - \tilde{p}_1)) g(x) dx \quad (17)$$

and

$$\hat{V}(w + q\tilde{p}_1 - c(n)) = \int_0^1 V(w_0 + \tilde{x} + q\tilde{p}_1 - c(n)) g(x) dx \quad (18)$$

By substituting the utility functions by 17 and 18 in equations 15 and 16, we get:

$$\max_{n, p_1} \bar{u}(p_1, n) \equiv \int_0^1 \hat{u}(\tilde{w}_1) f(p_1|x) dp_1 \quad (19)$$

with respect to:

$$\bar{V}(p_1, n) \equiv \int_0^1 \hat{V}(w + np_1 - c(n)) f(p_1|x) dp_1 \geq k' \quad (20)$$

where k' is a constant chosen in order to $k' \geq V(w + \tilde{x})$.

From the previous section, we redefine the hamiltonian H' as:

$$H' = \left\{ \hat{u}(w_0 + qp_1 + n(p_0 - p_1)) + \lambda(\hat{V}(w + np_1 - c(n)) - k) \right\} f(p_1|x) \quad (21)$$

and

$$\begin{aligned} \frac{dH'}{dn} &= (p_0 - p_1)\hat{u}'(w_0 + qp_1 + n^{**}(p_0 - p_1)) \\ &+ \lambda(p_1 - c'(n^{**}))\hat{V}'(w + n^{**}p_1 - c(n^{**})) = 0 \end{aligned} \quad (22)$$

We try to assess the impact of a non-financial risk on the pricing of an IPO. By definition, a non-financial risk can not be hedged. One of originalities of our approach is to use the economic works about the prudence notion to solve this problem. This notion of prudence was introduced by Kimball [1990] to complete the notion of risk aversion. Conceptually, these two notions have different meanings. In a risk aversion framework, the risk is an exogenous variable influencing the utility function of an agent while in a prudence framework, the risk is an endogenous variable against which an agent tries to protect himself.

This approach has been used many times for economic issues. For instance, the prudence notion allows to explain the growth of precaution saving and Leland [1968] and Sandmo [1969] have shown that this kind of behavior results of the convexity of marginal utility function ($u''' > 0$).

In this paper, we use two concepts introduced by Kimball [1990] allowing to measure the prudence level of each individual in an analogous way than risk premium of Arrow-Pratt: the compensatory precaution premium ψ' and the equivalent precaution premium ψ.

From Kimball [1990], we can write in one hand:

$$\hat{u}'(\tilde{w}_1) = \int_0^1 u'(\tilde{w}_1 + \tilde{x})g(x) = u'(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1)) \tag{23}$$

where $\psi(\tilde{x}, \tilde{w}_1)$ defines the compensatory precaution premium which is the amount a firm implanted in an emerging country is willing to pay in order to avoid the impact of risk exposure on her marginal utility.

And in other hand:

$$\begin{aligned} \hat{V}'(w + q\tilde{p}_1 - c(n)) &= \int_0^1 V'(w_0 + \tilde{x} + q\tilde{p}_1 - c(n))g(x)dx \\ &= V'(w + q\tilde{p}_1 - c(n) + \psi'(\tilde{x}, w_2)) \end{aligned} \tag{24}$$

where $w_2 = w + q\tilde{p}_1 - c(n)$ and $\psi'(\tilde{x}, w_2)$ is the compensatory saving premium which is a surplus of wealth to and on an investor marginal utility such that he will be willing to accept risk exposure.

The expressions 23 and 24 imply a transformation of optimality condition 22 as follows:

$$(p_0 - p_1)\hat{u}'(w_0 + qp_1 + n^{**}(p_0 - p_1) - \psi(\tilde{x}, \tilde{w}_1)) +$$
$$\lambda(p_1 - c'(n^{**}))\hat{V}'(w + n^{**}p_1 - c(n^{**}) + \psi'(\tilde{x}, w_2)) = 0 \qquad (25)$$

We already state that IPO Firm is risk averse. In addition, as in Kimball [1990], we assume that Firm is prudent and we admit that prudence is decreasing with wealth implying that precaution premiums are always positive.

From this new situation set, we state the three following propositions.

Proposition 4 (non-underpricing situation) *With the presence of an independent white noise $\tilde{x}$ and if the market is fair then the optimal transaction price p_1^{**} presents the following property characterizing an absence of underpricing:*

For $p_1 = c'(n^{**})$, $p_1^{**} = p_0$

Proposition 5 (underpricing situation) *With the presence of both an independent white noise $\tilde{x}$ and a price volatility risk and if the market is favorable for both sell and buy sides then the optimal transaction price p_1^{**} presents the following property characterizing an underpricing situation:*

For $p_1 > c'(n^{**})$

$$p_1^{**} \geq \frac{p_0 R_{\hat{u}} + c'(n^{**}) R_{\hat{V}}}{R_{\hat{u}} + R_{\hat{V}}} \text{ if } p_1 > p_0 \qquad (26)$$

where $R_{\hat{u}}$ and $R_{\hat{V}}$ are the absolute coefficient of risk aversion for the Firm and the Investors associated to their utility functions, respectively $\hat{u}(\ )$ and $\hat{V}(\ )$.

Proposition 6 (overpricing situation) *With the presence of both an independent white noise $\tilde{x}$ and a price volatility risk and if the market is favorable for buy side and unfavorable for sell side then the optimal transaction price p_1^{**} presents the following property characterizing an overpricing situation:*

For $p_1 > c'(n^{**})$

$$p_1^{**} \leq \frac{p_0 R_{\hat{u}} + c'(n^{**}) R_{\hat{V}}}{R_{\hat{u}} + R_{\hat{V}}} \text{ if } p_1 < p_0 \tag{27}$$

where $R_{\hat{u}}$ *and* $R_{\hat{V}}$ *are the absolute coefficient of risk aversion for the Firm and the Investors associated to their utility functions, respectively* $\hat{u}(\ )$ *and* $\hat{V}(\ )$*.*

For each case where the firm is prudent, the resulting transaction price p_1^{**} is different from the transaction price calculated without the presence of a non-financial risk.

Before studying the order relation between p_1^* and p_1^{**}, we need to demonstrate a very important result concerning the order relation between the coefficients of risk aversion R_u, $R_{\hat{u}}$ and R_V, $R_{\hat{V}}$. The demonstration is identical for the two sets of coefficients.

Proposition 7 *The utility functions* $\hat{u}(\ )$ *and* $\hat{V}(\ )$ *are monotonous, increasing and more risk averse than respectively* $u(\ )$ *and* $V(\ )$*. Formally, we have:*

$$R_u \leq R_{\hat{u}} \text{ and } R_V \leq R_{\hat{V}} \tag{28}$$

Proposition 7 is consistent with the intuition according to which the white noise enhances the risk aversion of both agents (Firm and Investors).

The following proposition shows in which extent the IPO underpricing is affected by this white noise.

Proposition 8 *Suppose that prudence and risk aversion are decreasing. If we assume that the Firm is more risk averse than the Investors and that an independent white noise* $\tilde{x}$ *exists, whatever the market conditions, the optimal transaction price presents the following properties:*

For $c'(n^{**}) = c'(n^*) = c'(n)$ *and* $p_0 > c'(n)$ *then:*

$$p_1^{**} \geq p_1^* \text{ if } \frac{\Delta R_u}{R_u} > \frac{\Delta R_V}{R_V} \tag{29}$$

where ΔR_u *and* ΔR_V *are infinitesimal variations of absolute risk aversion.*

This last proposition shows that the underpricing is more pronounced as a white noise exists. The white noise can be represented by the country risk as a non-hedging risk. Then, a part of the cross-countries underpricing could be explained by the country risk. This proposition is true only when the firm is more averse that the investors. One intuition is that the firm located in emerging country is more averse than investors because this kind of firm are confronted to many non diversifiable risks whereas investors can diversify their investment across different countries.

4 Concluding remarks

This study shows that the country risk could explain, as a non-financial risk, a part of underpricing. When the issuing firm is more risk averse than the investors, underpricing is stronger because of country risk. The intuition for a stronger aversion of risk by the issuing firm is that its diversification opportunities are less important than thus of the investors. This intuition is strengthened when we consider that the investors purchasing IPO shares in a developing country are mostly international ones. To our knowledge, this explanation for underpricing has never been argued previously. Our results are consistent with several empirical regularities:

- The cross-countries differences in underpricing.
- The stylized fact that waves in IPOs coincide with times of relative positive investors sentiment.
- The cross-countries differences in timing for issuing an IPO.

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Appendix

Proof of proposition 1 *When $p_1 = c'(n)$ the relation 11 can be re-written as:*

$$(p_0 - p_1)u'(w_0 + qp_1 + n^*(p_0 - p_1)) = 0 \tag{30}$$

As $u'(\ ) > 0$ (concavity of utility function), the unique solution is $p_1^* = p_0$.■

Proof of proposition 2 *The second order optimality condition is obtained by differentiating a second time the equation 11 with respect to* n^**:*

$$\begin{aligned}\frac{d^2H}{dn^2} &= (p_0 - p_1)^2 u''(w_0 + qp_1 + n^*(p_0 - p_1)) \\ &+ \lambda(p_1 - c'(n^*))^2 V''(w + n^*p_1 - c(n^*)) \leq 0 \end{aligned} \tag{31}$$

From equation 11, we get:

$$\lambda = -\frac{(p_0 - p_1)^2 u'(w_0 + qp_1 + n^*(p_0 - p_1))}{(p_1 - c'(n^*))V'(w + n^*p_1 - c(n^*))} \tag{32}$$

By replacing 32 into 31, we get:

$$(p_0 - p_1)^2 u''(\tilde{w}_1) - \frac{(p_0 - p_1)(p_1 - c'(n^*))V''(w + n^*p_1 - c(n^*))u'(\tilde{w}_1)}{V'(w + n^*p_1 - c(n^*))} \leq 0 \tag{33}$$

When $p_1 > p_0$ *then* $(p_0 - p_1) < 0$*; by multiplying the both sides of 33 by* $\frac{1}{(p_0 - p_1)}$*, we get:*

$$(p_0 - p_1)u''(\tilde{w}_{1d}) - \frac{(p_1 - c'(n^*))V''(w + n^*p_1 - c(n^*))u'(\tilde{w}_{1d})}{V'(w + n^*p_1 - c(n^*))} \geq 0 \tag{34}$$

By multiplying the both sides of 34 by $\frac{1}{u'(\tilde{w}_{1d})}$*, we get:*

$$(p_0 - p_1)\frac{u''(\tilde{w}_1)}{u'(\tilde{w}_1)} - \frac{(p_1 - c'(n^*))V''(w + n^*p_1 - c(n^*))}{V'(w + n^*p_1 - c(n^*))} \geq 0 \tag{35}$$

which can be rearranging as:

$$(p_1 - p_0)\left(-\frac{u''(\tilde{w}_1)}{u'(\tilde{w}_1)}\right) + (p_1 - c'(n^*))\left(-\frac{V''(w + n^*p_1 - c(n^*))}{V'(w + n^*p_1 - c(n^*))}\right) \geq 0 \tag{36}$$

We can rewritten 36 as:

$$(p_1 - p_0)R_u + (p_1 - c'(n^*))R_V \geq 0 \tag{37}$$

From 37, it immediately follows:

$$p_1(R_u + R_V) - (p_0 R_u + c'(n^*)R_V) \geq 0 \tag{38}$$

And finally,

$$p_1^* \geq \frac{p_0 R_u + c'(n^*)R_V}{R_u + R_V}.\blacksquare$$

Proof of proposition 3 *The demonstration is similar to the one of proposition 2. The only difference is the sign of the inequality. In the same way as the previous demonstration we get the following inequality:*

$$p_1(R_u + R_V) - (p_0 R_u + c'(n^*)R_V) \leq 0 \tag{39}$$

From which we get,

$$p_1^* \leq \frac{p_0 R_u + c'(n^*)R_V}{R_u + R_V}.\blacksquare$$

Proof of proposition 4 *The proof is identical as the one of proposition 1 by replacing n^* by n^{**}, p_1^* by p_1^{**}, $u(\ )$ by $\hat{u}(\ )$ and $V(\ )$ by $\hat{V}(\ )$.*$\blacksquare$

Proof of proposition 5 *The proof is identical as the one of proposition 2 by replacing n^* by n^{**}, p_1^* by p_1^{**}, $u(\ )$ by $\hat{u}(\ )$ and $V(\ )$ by $\hat{V}(\ )$.*$\blacksquare$

Proof of proposition 6 *The proof is identical as the one of proposition 3 by replacing n^* by n^{**}, p_1^* by p_1^{**}, $u(\ )$ by $\hat{u}(\ )$ and $V(\ )$ by $\hat{V}(\ )$.*$\blacksquare$

Proof of proposition 7 *By using the prudence notion, we have shown that:*

$$\hat{u}'(\tilde{w}_1) = u'(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1)) \tag{40}$$

By deriving the right side subject to $\tilde{w}_1$, we get:

$$\hat{u}''(\tilde{w}_1) = (1 - \psi'(\tilde{x}, \tilde{w}_1))u''(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1)) \tag{41}$$

From this latter expression, it follows:

$$-\frac{\hat{u}''(\tilde{w}_1)}{\hat{u}'(\tilde{w}_1)} = (1 - \psi'(\tilde{x}, \tilde{w}_1)) \left(-\frac{u''(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1))}{u'(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1))} \right) \tag{42}$$

Assuming the prudence decreasing with wealth means:

$$\psi'(\tilde{x}, \tilde{w}_1) < 0 \tag{43}$$

which implies that:

$$-\frac{\hat{u}''(\tilde{w}_1)}{\hat{u}'(\tilde{w}_1)} \geq \left(-\frac{u''(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1))}{u'(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1))} \right) \tag{44}$$

Since we have supposed the decreasing of risk aversion, it follows that:

$$-\frac{\hat{u}''(\tilde{w}_1)}{\hat{u}'(\tilde{w}_1)} \geq \left(-\frac{u''(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1))}{u'(\tilde{w}_1 - \psi(\tilde{x}, \tilde{w}_1))} \right) \geq -\frac{u''(\tilde{w}_1)}{u'(\tilde{w}_1)} \tag{45}$$

which means that:

$$R_{\hat{u}} \geq R_u \tag{46}$$

The proof is identical to demonstrate that $R_{\hat{V}} \geq R_V$.■

Proof of proposition 8 *We try to define the sign of $p_1^{**} - p_1^*$:*

$$\begin{aligned} p_1^{**} - p_1^* &= \frac{p_0 R_{\hat{u}} + c'(n^{**}) R_{\hat{V}}}{R_{\hat{u}} + R_{\hat{V}}} - \frac{p_0 R_u + c'(n^*) R_V}{R_u + R_V} \\ &= \frac{(R_u + R_V)(p_0 R_{\hat{u}} + c'(n^{**}) R_{\hat{V}}) - (R_{\hat{u}} + R_{\hat{V}})(p_0 R_u + c'(n^*) R_V)}{(R_{\hat{u}} + R_{\hat{V}})(R_u + R_V)} \end{aligned} \tag{47}$$

Since the absolute risk aversion coefficients are positive, the sign of $p_1^{**} - p_1^*$

just depends on the denominator of the fraction:

$$(R_u + R_V)(p_0 R_{\hat{u}} + c'(n^{**}) R_{\hat{V}}) - (R_{\hat{u}} + R_{\hat{V}})(p_0 R_u + c'(n^*) R_V) \tag{48}$$

Since the marginal costs are equal, this expression can be simplified as:

$$(R_u + R_V)(p_0 R_{\hat{u}} + c'(n) R_{\hat{V}}) - (R_{\hat{u}} + R_{\hat{V}})(p_0 R_u + c'(n) R_V) \tag{49}$$

which is equal to:

$$(p_0 - c'(n))(R_{\hat{u}} R_V + R_u R_{\hat{V}}) \tag{50}$$

The sign of the latter expression depends on $(R_{\hat{u}} R_V + R_u R_{\hat{V}})$ *since* $p_0 > c'(n)$. *By considering the infinitesimal variations of risk aversion, we have:*

$$R_{\hat{u}} = R_u + \Delta R_u \text{ and } R_{\hat{V}} = R_V + \Delta R_V \tag{51}$$

It follows that:

$$\begin{aligned} R_{\hat{u}} R_V + R_u R_{\hat{V}} &= (R_u + \Delta R_u) R_V - (R_V + \Delta R_V) R_u \\ &= R_V \Delta R_u - R_u \Delta R_V \end{aligned} \tag{52}$$

By hypothesis we have $\frac{\Delta R_u}{R_u} > \frac{\Delta R_V}{R_V}$ *and thus* $R_V \Delta R_u > R_u \Delta R_V$ *which allows us to write:*

$$R_V \Delta R_u - R_u \Delta R_V > 0 \tag{53}$$

And to conclude that $p_1^{**} - p_1^*$ *is positive.*■

Table 2: Regressions of underpricing to country risks.

The sample includes 33 countries for which underpricing of IPO and both measures of country risk are available. *Log* IR designates the logarithm of initial returns which are extracted from Ritter (2003). The measure of country credit ratings (CCR) comes from the study of Campbell et Al. (1996). The source of this data is Institutional Investor's semi-annual survey of bankers. It has been downloaded from $http://www.duke.edu/\ charvey/Country_risk/ccr/ccrtab5.htm$. The credit ratings providing by Standard and Poor's agency (S & P ratings) apply to the sovereign debt in local currency. They have been downloaded at $http://www.standardandpoors.com/ratings/$. Observations for Israel, Korea and Nigeria were omitted because of missing data. Observations for Switzerland and China were deleted for extreme data.

Countries	Log IR	S&P Ratings	Ind S&P	CCR
Australia	11,42%	AAA	1	73
Austria	6,11%	AAA	1	84
Belgium	13,63%	AA+	1,5	78
Brazil	57,94%	BB	6,5	30
Canada	6,11%	AAA	1	85
Chile	8,43%	AA	2	36
Denmark	5,26%	AAA	1	74
Finland	9,62%	AAA	1	75
France	10,98%	AAA	1	85
Germany	24,45%	AAA	1	92
Greece	39,88%	A	3,5	49
Hong Kong	15,96%	AA-	2,5	67
India	30,23%	BB+	6	45
Indonesia	17,98%	BB	6,5	49
Italy	19,64%	AA-	2,5	76
Japan	25,00%	AA-	2,5	94
Malyasia	71,34%	A+	3	62
Mexico	28,52%	A	3,5	37
Netherlands	9,71%	AAA	1	88
New Zealand	20,70%	AAA	1	66
Norway	11,78%	AAA	1	81
Philippines	20,46%	BB+	6	25
Poland	24,22%	A-	4	21
Portugal	10,07%	AA-	2,5	59
Singapore	25,93%	AAA	1	78
South Africa	28,29%	A	3,5	40
Spain	10,17%	AAA	1	73
Sweden	26,62%	AAA	1	78
Taiwan	27,08%	AA-	2,5	76
Thailand	38,32%	A	3,5	58
Turkey	12,31%	BB	6,5	40
United Kingdom	16,04%	AAA	1	87
United States	16,81%	AAA	1	91