Warrants in IPOs: Evidence from Hong Kong

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Abstract

We examine whether the Hong Kong Stock Exchange listed firms include warrants in their initial public offerings (IPOs) to signal their quality. We show that IPOs with warrants have higher profitability and better asset utilization rates compared to IPOs without warrants. We also report evidence that after controlling for the level of retained ownership, the proportion of the firm value sold as warrants increases in firm's riskiness. The results from the self-selection model reveal that firms include warrants in their offerings to reduce underpricing relative to what it would have been in the absence of warrants. We conclude that warrants are more likely to be used for signaling purposes rather than as mechanisms to reduce the agency costs of free cash flow.

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1. Introduction

Warrants have been widely used in conjunction with debt and equity offerings. When warrants are bundled with equity in an initial public offering (IPO), the package is known as a unit IPO. The warrants provide investors with the right to uncertain gains either through their sale or through their exercise, if the stock price rises above the exercise price. Practitioners often refer to such a financial arrangement as “a sweetener”, which may be used as an incentive to increase interest in the new offerings. Academics regard the practitioners' explanation as unsatisfactory and propose two competing, but not mutually exclusive, hypotheses. The agency cost hypothesis of Schultz (1993) emphasizes that IPOs with warrants are multi-stage financing arrangements that lower agency costs by

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reducing the probability of the excess cash being invested in negative NPV projects. Using US data, Schultz (1993) provides empirical support to the agency cost hypothesis. Chemmanur and Fulghieri (1997) propose a signaling hypothesis that focuses on the interaction of asymmetric information and managers' risk aversion. This hypothesis predicts that high-quality firms include warrants in their offering to distinguish themselves from low-quality firms. How and Howe (2001) and Lee et al. (2003) provide evidence that Australian firms include warrants in their offerings for signaling purposes.

The main objective of this paper is to enhance our understanding of why firms include warrants as a bundle in their IPOs by examining why Hong Kong firms issue IPOs with warrants. Previous studies have examined only IPOs with warrants issued in the US and Australia. The environmental setting in Hong Kong differs from that in Australia and the US not only in terms of exchange listing requirements and taxes, but also in the characteristics of the warrants issued.¹ Given the characteristics of the IPOs with warrants issued in Hong Kong, our dataset provides us with a unique opportunity to test the robustness of the agency cost and signaling explanations of unit issuance in a different environmental setting.

Besides the uniqueness of the dataset, our study employs a self-selection regression methodology [see Heckman (1976) and Lee (1978)] to test whether firms include warrants in their offerings to reduce underpricing relative to what it would have been in the absence of warrants. In the signaling model of Chemmanur and Fulghieri (1997), high-quality firms choose from signaling mechanisms, including the fraction of equity retained by insiders, underpricing of the issue, and/or the inclusion of warrants in their offering, to differentiate themselves from low-quality firms. Holding the effect of other signaling mechanisms, such as fraction of equity retained by insiders, constant, high-quality firms that choose to include warrants as signaling devices should incur lower level of underpricing than if they did not include warrants in their offerings.

The central findings of this study are as follows. Firstly, profitability and asset utilization rates are generally higher for IPOs with warrants than for IPOs without warrants. This finding contradicts the agency cost hypothesis, which predicts that warrants should be used by firms with higher levels of agency conflicts. Secondly, in line with the predictions of the signaling model, we show that after controlling for the level of retained ownership, the proportion of firm value sold as warrants increases in the firm's riskiness. Finally, the results from the self-selection model suggest that firms include warrants in their offerings to reduce underpricing relative to what it would have been in the absence of warrants. This finding is consistent with the view that warrants are perceived as positive signals by the stock market investors. Overall, our results suggest that IPOs with warrants are more likely to be used for signaling purposes rather than as mechanism to reduce the agency costs of free cash flow.

The remaining sections of the paper are structured as follows. In Section 2, we discuss the agency cost and signaling hypotheses and their testable implications. In Section 3, we describe our dataset. Section 4 presents the empirical results. We summarize the results and conclude in Section 5.

2. Hypotheses and testable implications

2.1. Agency cost hypothesis

Schultz (1993) regards IPOs with warrants as a multi-stage financing action used to reduce agency costs of free cash flow (Jensen, 1986). Specifically, since warrants bring in funds only if they are subsequently needed, they can be used as a mechanism to prevent managers from investing in negative net present value (NPV) projects. This hypothesis leads to several predictions. First, firms are more

¹ See Section 3.2 for more details on the characteristics of warrants included in the Hong Kong IPOs.

likely to issue IPOs with warrants when faced with a high level of uncertainty concerning their investments' quality and/or growth opportunities. Therefore, IPOs with warrants will be issued by smaller, younger and riskier firms. Second, firms with lower levels of managerial ownership tend to have greater agency costs and are more likely to choose IPOs with warrants. Third, additional equity financing is delayed for the issuers of IPOs with warrants until the profitability of their investment projects is verified. Consequently, issuers with no positive NPV investments are less likely to survive and those with positive NPV projects are more likely to receive additional equity financing after the offerings. Finally, given their (younger) age and (smaller) size, IPOs with warrants have greater uncertainty about their prospects and will exhibit greater underpricing than IPO without warrants. [Schultz \(1993\)](#) finds a strong empirical support for the agency cost hypothesis.

2.2. Signaling hypothesis

[Chemmanur and Fulghieri \(1997\)](#) propose a signaling model which focuses on the interaction of asymmetric information and managers' risk aversion. In an environment of information asymmetry, underpricing becomes a means of conveying to investors, information about the true value of a high-quality firm.² After some time, these high-quality firms can recoup their upfront loss either in seasoned public offerings and open-market insider sales on more favorable terms or through a favorable market response to future dividend announcements.³ In [Chemmanur and Fulghieri's \(1997\)](#) model, high-quality firms distinguish themselves from low-quality firms using a number of signaling mechanisms, including the fraction of equity retained by insiders, the underpricing of the issue, and the inclusion of warrants in their offerings. All of these mechanisms are costly signals of the firm's quality. Risk-averse insiders of high-quality firms will choose a signaling mechanism that maximizes their utility function. Warrants may be preferred to other signaling devices because they only incur costs if there is a high realization of the firm's future value, at which point the marginal value of the incurred cost to the insiders is relatively low.

The validity of the signaling hypothesis suggests several empirical predictions. First, after controlling for ownership retained by the insiders, the proportion of firm value sold as warrants should increase with the level of the firm's riskiness. Second, the fraction of equity ownership retained by the insiders of IPOs with warrants is decreasing in the firm's riskiness. Finally, IPOs with warrants are more likely to be issued in cold market conditions when both information asymmetry and the risk of failure are high.

3. Data

3.1. The sample

We analyze all IPOs listed on the Hong Kong Stock Exchange between 1990 and 1997.⁴ The final sample includes 130 (35%) IPOs with warrants and 242 (65%) IPOs without warrants. Information on the offer price, the number of shares and units sold, the names of underwriters, the proportion of the offering sold by existing shareholders, and the relevant accounting data prior to

² [Firth and Liao-Tan \(1997\)](#) also examine the role of underpricing in signaling the quality of IPO firms.

³ See for example [Su and Fleisher \(1999\)](#).

⁴ Note that although information on all IPOs is available to us for a period from 1990 to 2003, we choose to focus only on the period from 1990 to 1997. This is because only 6 out of a total 273 IPOs issued between 1998 and 2003 include warrants in their offerings.

Table 1

Descriptive statistics of warrant design for IPOs with warrants issued in Hong Kong, US and Australia

	Shares per warrant	Exercise price	Exercise price divided by share offer price	Proceeds from the exercise of warrants	Proceeds from the exercise of warrants divided by IPO proceeds	Years to expiration
<i>Panel A: IPOs with warrants Issued in Hong Kong</i>						
Mean	5.23	1.30 HK\$	1.16	123.49 M HK\$	0.89	2.69
Median	5.00	1.20 HK\$	1.15	76.80 M HK\$	0.92	3.00
Minimum	5.00	0.85 HK\$	1.00	19.06 M HK\$	0.44	1.25
Maximum	10.00	4.50 HK\$	1.39	936.00 M HK\$	1.16	5.00
<i>Panel B: IPOs with warrants issued in the US</i>						
Mean	1.79	/	1.37	/	1.30	3.60
Median	2.00	/	1.25	/	0.75	4.75
Minimum	0.33	/	0.50	/	0.16	0.25
Maximum	4.00	/	3.00	/	4.67	5.00
<i>Panel C: IPOs with warrants issued in Australia</i>						
Mean	1.65	0.20 A\$	0.67	0.15 M A\$	0.10	0.33
Median	1.00	2.00 A\$	2.50	49.81 M A\$	1.61	5.02
Minimum	0.50	0.25 A\$	1.00	2.49 M A\$	0.58	2.80
Maximum	10.00	0.40 A\$	1.08	4.99 M A\$	0.58	2.84

Notes: This table provides the description of IPOs with warrants issued in Hong Kong, the US and Australia. A total of 130 Hong Kong IPOs with warrants are included in our analysis.

The warrant design for the US IPOs with warrants is summarized by [Schultz \(1993\)](#), and the warrants design for the Australian IPOs with warrants is summarized by [Howe and How \(2001\)](#).

listing, are collected from the issuers' prospectuses. Daily closing prices of issuing firms are extracted from Datastream.

Our data reveals that IPOs with warrants are highly clustered, with 80.0% of them occurring during the period 1991–1994. The decreased popularity of IPOs with warrants coincides with the regulatory change in the Hong Kong Stock Exchange listing requirements, which became effective from September 15, 1994. The objective of the new regulation is to screen out a subset of poor IPO performers. It is therefore possible to argue that the high quality of information associated with the newly introduced regulations should enable investors to better discriminate between high-and low-quality issuers.⁵ If warrants are used by high-quality firms as signaling devices to distinguish themselves from low-quality firms, as predicted by the signaling model, and if the newly introduced listing requirements are designed to achieve the same objective, IPO issuers may find it no longer necessary to include warrants in their offerings.⁶

⁵ The new listing requirements in Hong Kong include the following: i) IPOs should have a minimum track record of 3 years or longer; ii) the IPO's most recent year's profit attributable to shareholders to be at least HK\$20 million; and iii) the IPO's market capitalization should be at least HK\$100 million at the time of listing.

⁶ The increased popularity of derivative equity warrants post 1994 (see [Table 1](#) in [Chan and Wei, 2001](#)) offers another possible explanation for the disappearance of IPOs with warrants in the Hong Kong market. It appears as if investors view derivative warrants as substitutes for the warrants offered with the IPOs. In the rest of the paper, we choose to focus on the reasons for including warrants in the IPOs and leave the empirical proof on the disappearance of IPOs with warrants for the future research.

3.2. The characteristics of Hong Kong IPOs with warrants

Table 1 compares the main characteristics of the warrants attached to the IPOs issued in Hong Kong, the US and Australia. Unlike the US and Australia where unit offerings usually contain one warrant for every two shares, the unit IPOs issued in Hong Kong typically contain one warrant for every five shares. The exercise price of the Hong Kong warrants is set at a premium of up to 39% above the selling price of the IPO shares. How and Howe (2001) and Lee et al. (2003) report that the exercise price of Australian IPO warrants is typically the same as the selling price of IPO shares. Schultz (1993) and Garner and Marshall (2005) show that US IPO warrants are issued at a premium of 25%. The average of the expected proceeds from warrant conversion relative to the IPO proceeds in Hong Kong is 89%, which is much higher than the average of 75% reported by Schultz (1993) and the average of 58% reported by How and Howe (2001). The life of the warrants ranges from 1.25 years to 5 years with a mean (median) life of 2.69 (3.00) years. This is shorter than the average life of 4.1 years for the US warrants (Garner and Marshall, 2005) and longer than the mean life of 2.7 years for the Australian warrants (Lee et al., 2003). While not reported in Table 1, the Hong Kong warrants are neither callable nor include embedded (B) warrants, where an embedded (B) warrant confers additional warrant when exercised. How and Howe (2001) show that at least two Australian firms' warrants include embedded (B) warrants and Schultz (1993) reports that nearly 25% of the US unit IPOs contain embedded (B) warrants.

4. Empirical results

4.1. Descriptive statistics

Table 2 provides descriptive statistics for IPOs with warrants and IPOs without warrants over the period 1990–1997. We adjust all Hong Kong dollar-denominated variables for inflation using the consumer price index taken from the Global Market Information database (GMID). We express all values in 1997 Hong Kong dollars. Consistent with the evidence reported in the US and Australia, our results indicate that the issuers of IPOs with warrants are younger than the issuers of IPOs without warrants. The mean (median) age of the IPOs with warrants is 18.50 (14.50) years and is significantly different from the mean (median) age of 22.95 (17.00) years observed in the sub-sample of IPOs without warrants. In line with the previous literature, we observe that the issuers of IPOs with warrants are significantly smaller than the issuers of IPOs without warrants. This evidence is robust to different size measures, including IPO proceeds, total assets and profits.

Table 2 also provides results for the relationship between unit issuance and market conditions. This relationship has largely been ignored in the literature. We maintain that incorporating market conditions into the analysis contributes to our understanding of the role of both agency cost and signaling hypotheses, in explaining the inclusion of warrants in IPOs. We use the average first-day return generated by all the IPOs listed over the period from month t-3 to the offering month as a measure of the market condition.⁷ The finding that IPOs with warrants are more likely to be issued in cold periods where both information asymmetry and risk are at their highest, is supportive to the predictions of both agency cost and signaling hypotheses.

⁷ We also use the number of IPOs issued between month t-3 and the offering month as a measure of the market conditions and we observe a significant negative relationship between the inclusion of warrants in the offerings and hot market conditions. Details are available upon request.

Table 2

Descriptive statistics for IPOs with warrants and IPOs without warrants issued in Hong Kong

	IPOs without Warrants (N=242)			IPOs with warrants (N=130)			p-value from Mann–Whitney test
	Mean	Median	S.D.	Mean	Median	S.D.	
Age (years)	22.95	17.00	21.19	18.50	14.50	12.82	0.122
Hotissue	23.21%	22.75%	18.90%	18.02%	16.82%	14.45%	0.026**
IPO proceeds (M HK\$)	712.72	195.68	2149.70	197.75	128.63	221.90	0.000***
Total assets (M HK\$)	2092.84	456.38	4502.35	584.62	312.88	1055.32	0.000***
Profits (M HK\$)	135.38	57.45	314.38	60.99	42.39	68.29	0.001***
Net assets (M HK\$)	647.70	136.45	1565.90	150.96	92.79	234.05	0.000***
1/(IPO price)	0.69	0.78	0.29	0.92	0.98	0.15	0.003***
SD_PEG	80.67%	37.00%	1.12	133.08%	65.50%	3.08	0.003***
%Retained	73.66	75.00	4.43	74.42	75.00	1.96	0.132
P/E	10.77	7.39	18.79	6.67	6.49	1.87	0.000***
D_Under		16%			8%		0.000***

Notes: This table shows the summary statistics of IPOs with warrants and IPOs without warrants listed in Hong Kong between 1990 and 1997. The definitions of the variables are as follows: Age is the number of years from incorporation to listing; Hotissue is the average one-day initial return for initial public offerings issued during month t-3 of the offering; IPO proceeds are the proceeds raised from the IPO (not taking account of the future exercise of warrants); 1/IPO price is the inverse of the offer price; SD_PEG is the standard deviation of the growth rate in earnings for the three years prior to the listing; %Retained refers to the level of ownership retained by the insiders of the IPO firm after the IPO and D_Under is a binary variable on underwriter's reputation. This variable is based on the underwriter's international reputation. It takes a value of 1 for US and European underwriters and zero otherwise.

The accounting data are taken from the prospectus for the year before the IPO. All the Hong Kong dollar values are expressed in 1997 Hong Kong dollar.

***, **, and * indicate significance at 1%, 5%, and 10% level, respectively.

There is no official ranking of underwriters' reputation in Hong Kong. To examine whether the choice of underwriters depends on the issuers' decision to include warrants in their offerings, we use international operations as a proxy for underwriters' reputation. We split underwriters into local and international (US and European).⁸ Table 2 shows that the percentage of IPOs without warrants that use international underwriters is significantly higher than that of IPOs with warrants. This finding is consistent with US and Australia evidence, where IPOs with warrants are also found to be brought to the market by less reputable underwriters.⁹

The agency cost hypothesis predicts that firms with lower managerial ownership are more likely to include warrants in their offerings. Due to the difficulty in obtaining information on the shareholdings of managers, previous studies use retained ownership instead. Table 2 shows that the level of ownership retained by the insiders after the offering is not significantly different between the issuers of IPOs with warrants and the issuers of IPOs without warrants. This result should not necessarily be viewed as evidence against the predictions of the agency cost hypothesis. Instead, this finding may well be the outcome of the clustering in the retained ownership among Hong Kong IPOs. In fact, the Hong Kong listing regulations specify a

⁸ We are grateful to the anonymous referee for suggesting this underwriters ranking approach.

⁹ We also use both the underwriter's underwriting proceeds during the study period (in the case of joint underwriters, the proceeds are split equally amongst the members of the syndicate) and underwriting frequency (the number of times an underwriter was chosen as the lead underwriter) as proxies for reputation. Under these reputation measures, we find no evidence that IPOs with warrants are brought to the market by less reputable underwriters. The details of the results are available upon request.

minimum of 25% of any class of listed securities to be held by the public. Our data reveals that the vast majority of Hong Kong IPOs offer only the minimum amount required by the regulations to the public. Specifically, the ownership retained by insiders in nearly 87% of IPOs with warrants and 70% of IPOs without warrants is clustered at 75% level. The clustering problem makes ownership a less interesting variable for the purpose of our analysis.

Both the agency cost and signaling hypotheses predict that IPOs with warrants are riskier than IPOs without warrants. We use the standard deviation of past earnings growth (SD_PEG) (see, [Chen et al., 2001](#)) and $1/(\text{IPO price})$ (see, [Bradley and Jordan, 2002](#)) as risk measures. Consistent with both hypotheses, [Table 2](#) shows that the sub-sample of IPOs with warrants exhibits higher SD_PEG and $1/(\text{IPO price})$ than the sub-sample of IPOs without warrants. Both hypotheses also suggest that firms issue IPOs with warrants when their future viability is relatively uncertain. Given the fact that the viability of investment opportunities varies across industries, some degree of industry clustering is expected. [Schultz \(1993\)](#) and [Jain \(1994\)](#) find that IPOs with warrants belong typically to service and high-tech industries. [Lee et al. \(2003\)](#) show that a large number of firms in investment and financial services industry issue IPOs with warrants. Using the Hang Seng industrial classification, we do not report any evidence that IPOs with warrants issued in Hong Kong cluster in any specific industry.¹⁰

4.2. Choice of offer type and underpricing

The signaling model of [Chemmanur and Fulghieri's \(1997\)](#) predicts that firms include warrants in their offerings to signal their high-quality to the stock market investors. If the inclusion of warrants is perceived as a positive signal, issuers of IPOs with warrants should incur lower underpricing than had they issued IPOs without warrants instead.

The decision to include warrants is nonrandom and may be affected by the IPO characteristics and the market-wide conditions, which may also affect the level of underpricing. Thus, a potential self-selection bias may be introduced in assessing the impact of warrants on the level of underpricing. We address this limitation by employing a self-selection regression model (see [Heckman \(1976\)](#) and [Lee \(1978\)](#)).¹¹

To test whether the probability of a firm issuing warrants is related to the firm-specific characteristics and market-wide conditions, and whether IPOs with warrants and IPOs without warrants differ in terms of underpricing, we estimate the following set of equations:

$$\text{Unit}_i = Z_i\lambda + \varepsilon_i \quad (1)$$

$$\text{IR}_{1i} = X_i\beta_1 + v_{1i} \quad (2)$$

$$\text{IR}_{2i} = X_i\beta_2 + v_{2i} \quad (3)$$

Eq (1) refers to the offer choice equation and Eqs (2) and (3) are the underpricing equations for IPOs with warrants and IPOs without warrants, respectively.¹² Unit_i is the latent variable representing the firm's decision to issue IPOs with warrants ($\text{Unit}_i=1$) or IPOs without warrants ($\text{Unit}_i=0$). IR_{1i} and IR_{2i} are the observed first-day return associate with issuing IPOs with

¹⁰ Details are available upon request.

¹¹ We are very grateful to the anonymous referee for suggesting this approach.

¹² Note that we also use the first day market-adjusted return as a measure of underpricing and our overall conclusions remain unchanged.

warrants and IPOs without warrants, respectively. Z_i is a vector of variables that might affect both the decision to include warrants in the offerings and the level of underpricing. The vector Z_i includes: A dummy variable with a value of unity following changes in the Hong Kong Stock Exchange regulatory requirements, which became effective on the 15th of September 1994 (DChange); the average of first-day return generated by all of the IPOs listed over the period from $t-3$ and the offering month (Hotissue); underwriter's reputation dummy with a value of 1 for US and European underwriters and zero otherwise (D_Under); the age of the firm (LnAge); a proxy for the size of the firm (LnProceeds); and the risk associated with a firm i measured both as 1/IPO price and as SD_PEG.

The presence of the self-selection bias suggests that the Ordinary Least Squares (OLS) may lead to biased estimates of the parameters associated with the underpricing equations. The self-selection regression model allows the residual of the offer choice equation to be correlated with the residuals of the underpricing equations, so that the unobserved or missing variables in the offer choice equation are allowed to affect the level of underpricing. The covariance matrix of the residual terms ε_i , v_{1i} , and v_{2i} is assumed to be trivariate normally distributed, and the conditional mean of v_{1i} and v_{2i} can be shown as follows (see Heckman (1976), Lee (1978), Maddala (1983), and Shehata (1991)):

$$E[v_{\text{with}_i} | \varepsilon_i < Z_i \lambda] = E[\sigma_{1\varepsilon} | \varepsilon_i < Z_i \lambda] = \sigma_{1v} \left[\frac{\phi(Z_i \lambda)}{\vartheta(Z_i \lambda)} \right], \text{ and}$$

$$E[v_{\text{without}_i} | \varepsilon_i > Z_i \lambda] = E[\sigma_{2\varepsilon} | \varepsilon_i > Z_i \lambda] = \sigma_{2v} \left[\frac{\phi(Z_i \lambda)}{1 - \vartheta(Z_i \lambda)} \right]$$

where $\sigma_{1\varepsilon}$ and $\sigma_{2\varepsilon}$ are the $\text{Cov}(v_{1i}, \varepsilon_i)$ and $\text{Cov}(v_{2i}, \varepsilon_i)$, respectively, ϑ is the cumulative distribution of the standard normal distribution function, and ϕ is the density function of ϑ . The terms $\left[-\frac{\phi(Z_i \lambda)}{\vartheta(Z_i \lambda)} \right]$ and $\left[\frac{\phi(Z_i \lambda)}{1 - \vartheta(Z_i \lambda)} \right]$ are the inverse Mills ratios used to correct of the self-selection bias in Eqs. (1) and (2), respectively.

The self-selection methodology is employed as follows. In the first stage, we estimate the offer choice equation for the total sample, which includes IPOs with warrants and IPOs without warrants, using the probit model (Eq. (1)). The estimated value of $Z_i \hat{\lambda}$ is then used to generate the inverse Mills ratios for IPOs with warrants and IPOs without warrants separately. In the second stage, we add the relevant inverse Mills ratios to Eqs. (2) and (3) to obtain:

$$\text{IR}_{1i} = X_i \beta_1 + \sigma_{1\varepsilon} \left[-\frac{\phi(Z_i \hat{\lambda})}{\vartheta(Z_i \hat{\lambda})} \right] + \omega_{1i} \quad (4)$$

$$\text{IR}_{2i} = X_i \beta_2 + \sigma_{2\varepsilon} \left[\frac{\phi(Z_i \hat{\lambda})}{1 - \vartheta(Z_i \hat{\lambda})} \right] + \omega_{2i} \quad (5)$$

The OLS estimation of Eqs. (4) and (5) provides a consistent estimation of β_1 and β_2 , since the inclusion of the inverse Mills ratios in the right-hand-side of the equations corrects for a non-zero expectation of errors.

Table 3
Probit regressions predicting the choice of offer type

Choice of the offer type <i>Unit</i> (Eq. (1))		
	Coef ¹	Coef
Constant	–1.281**	1.804***
DChange	–0.908***	–0.765***
Hotissue	–1.186***	–1.019**
D_Under	–0.017	0.025
LnAge	–0.299**	
LnProceeds		–0.354***
1/IPO Price	2.778***	
SD_PEG		0.054*
Wald chi2	84.43	69.41
Prob>chi2	0	0

Notes: This table presents the probit regression results for the choice of offer type. $Unit_i$ is the latent variable representing the firm's decision to issue IPOs with warrants ($Unit_i=1$) or IPOs without warrants ($Unit_i=0$); DChange is a dummy variable with a value of unity after the Hong Kong regulatory changes, which became effective on the 15th of September 1994, and zero otherwise; Hotissue is the average one-day initial return for initial public offerings issued during month t-3 of the offering; D_Under is a dummy variable for underwriter's reputation which takes a value of 1 for US and European underwriters and zero otherwise; LnAge is measured by the logarithm of the number of years from incorporation to listing; LnProceeds is measured by the logarithm of the proceeds; 1/IPO price is the inverse of the offer price; and SD_PEG is the standard deviation of the growth rate in earnings for the three years prior to the listing.

¹ Coef is the coefficient on the different independent variables in the regression.

***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

Finally, the difference in underpricing for the entire sample, which includes both IPOs with warrants and without warrants, or $\hat{IR}_{1i} - \hat{IR}_{2i} = (X_i - \hat{\beta}_1 - X_i\hat{\beta}_2)$, is added to Eq. (1) to obtain consistent estimates of parameters ξ and λ of the following structural probit model:¹³

$$Unit_i = \xi(\hat{IR}_{1i} - \hat{IR}_{2i}) + Z_i\lambda + \eta_i \quad (6)$$

Table 3 shows estimation results of the first stage probit estimates of the offer choice equation (Eq. (1)). The variables LnAge and LnProceeds are significantly and negatively related to the choice of unit offerings. This evidence supports the agency cost and signaling hypotheses, which expect IPOs with warrants to be issued by younger and smaller firms. In line with the predictions of both hypotheses, the coefficients on proxies for risk (1/IPO price and SD_PEG) and Hotissue are significantly positive and negative, respectively. The significantly negative coefficient on DChange suggests that IPOs with warrants are more likely to be issued in an environment with high level of information asymmetry (i.e., before the regulation changes).¹⁴

The results of the second stage estimates are presented in Table 4. Panels A and B report the OLS estimates of the underpricing equations (corrected for self-selection bias) for IPOs with warrants and IPOs without warrants, respectively. Our results suggest that the explanatory power of the some underpricing variables differ systematically between the sub-sample of IPOs with warrants and that of IPOs without warrants. Specifically, the coefficients on Hotissue and 1/IPO

¹³ Note that the consistent parameter estimates of $\hat{\beta}_1$ and $\hat{\beta}_2$ are obtained from Eqs. (4) and (5), respectively.

¹⁴ We also use year dummies instead of DChange in Eq (1), we find a positive relationship between unit issuance and years 1990 through 1994 and a negative relationship between unit issuance and the rest of the years. The results are available upon request.

Table 4

Self-selection bias adjusted underpricing regressions

	Coef. ¹	Coef.
Panel A: 130 IPOs with Warrants		
Constant	−0.726	0.067
DChange	−0.298	−0.370
Hotissue	0.212	0.078
D_Under	−0.056	−0.057
LnAge	−0.052	
LnProceeds		−0.091
1/IPO Price	0.732	
SD_PEG		0.013
IMR	0.454	0.611
R ²	0.071	0.078
F-Value	3.75	3.58
Panel B: 242 IPOs without Warrants		
Constant	0.037	0.516
DChange	−0.135	−0.050
Hotissue	0.405**	0.530**
D_Under	0.141	0.160
LnAge	−0.017	
LnProceeds		−0.066
1/IPO Price	0.448*	
SD_PEG		−0.011
IMR	0.282	0.095
R ²	0.076	0.077
F-Value	4.81	4.9

Notes: This table reports estimation results for the two second-stage underpricing equations, panel A for the 130 IPOs with warrants and the other for the 242 IPOs without warrants. DChange is a dummy variable with a value of unity after the Hong Kong regulatory changes, which became effective on the 15th of September 1994, and zero otherwise; Hotissue is the average one-day initial return for initial public offerings issued during month t-3 of the offering; D_Under is a dummy variable for underwriter's reputation which takes a value of 1 for US and European underwriters and zero otherwise; LnAge is measured by the logarithm of the number of years from incorporation to listing; LnProceeds is measured by the logarithm of the proceeds; 1/IPO price is the inverse of the offer price; SD_PEG is the standard deviation of the growth rate in earnings for the three years prior to the listing, IMR is the inverse mills ratio used to adjust for self-selection bias.

¹ Coef is the coefficient on the different independent variables in the regression.

***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

price are statistically significant for the sub-sample of IPOs without warrants, but not significantly different from zero for the sub-sample of IPOs with warrants.

The positive sign on 1/IPO price suggests that IPOs without warrants are more likely to incur higher underpricing when they are offered by high risk issuers. The coefficient on Hotissue is significantly positive for the sub-sample of IPOs without warrants, indicating that the underpricing associated with IPOs without warrants is higher in hot market conditions. Other variables, such as D_Under and LnAge are not significantly related to the underpricing in either sub-sample.

Table 5 compares the realized and predicted underpricing associated with both IPOs with warrants and IPOs without warrants. Panel A shows that the mean (median) actual underpricing obtained by IPOs without warrants is 22.09% (10.56%), 28.89% (16.77%) higher than the hypothetical −6.80% (−6.21%). The Standard *t*-test (Wilcoxon Signed Rank Test) suggests that the actual and the theoretical means (medians) are significantly different from zero at

Table 5

Actual versus hypothetical underpricing

	Actual		Hypothetical		P-value from T test	p-value from Mann–Whitney test
Underpricing	Mean	Median	Mean	Median		
<i>Panel A: Comparison for IPOs without Warrants</i>						
	22.09%	10.56%	−6.80% ¹	−6.21%	0.000***	0.000***
<i>Panel B: Comparison for IPOs with Warrants</i>						
	13.76%	5.80%	20.41%	19.74%	0.019**	0.000***

Notes: This table compares the means and medians of the actual underpricing with their hypothetical counterparts for IPOs without warrants (Panel A) and those IPOs with warrants (Panel B).

¹ The results reported in this table are based on the inclusion of DChange, Hotissue, D_Under, LnAge, and 1/IPO price in the underpricing equations (Eqs. (4) and (5)). Very similar results are obtained by including DChange, Hotissue, D_Under, LnProceeds, and SD_PEG in Eqs. (4) and (5). More details are available upon request.

***, ** and * indicate significance at 1, 5 and 10 percent levels, respectively.

conventional 1% level. In contrast, Panel B indicates that for issuers of IPOs with warrants, the actual mean (median) underpricing of 13.76% (5.80%) is significantly lower than the theoretical mean (median) underpricing of 20.41% (19.74%). This evidence indicates that IPO issuers may be able to reduce their initial underpricing by including warrants in their offerings.

Table 6 reports results from the final stage of the self-selection model [Eq. (6)]. The sign and the significance of the different independent variables in the offer choice equation remain generally unchanged. However, the OLS estimation of the offer choice equation consistently

Table 6

Probit regressions predicting the choice of offer type for IPOs issued in Hong Kong, 1990–1997

Choice of the Offer Type $Unit_i$ (Eq. (6))		
	Coef ¹	Coef
Constant	–1.355**	3.269***
$IR_{1i} - IR_{2i}$	1.630***	3.412***
DChange	–0.847***	–0.757***
Hotissue	–1.012**	–0.796
D_Under	0.015	0.203
LnAge	–0.230*	
LnProceeds		–0.538***
1/IPO Price	2.927***	
SD_PEG		0.036
Wald χ^2	114.58	105.3
Prob > χ^2	0	0

Notes: This table presents the probit regression results for the choice of offer type. $Unit_i$ is the latent variable representing the firm's decision to issue IPOs with warrants ($Unit_i = 1$) or IPOs without warrants ($Unit_i = 0$); $IR_{1i} - IR_{2i}$ is the difference in underpricing for the entire sample, which includes both IPOs with warrants and without warrants; DChange is a dummy variable with a value of unity after the Hong Kong regulatory changes, which became effective on the 15th of September 1994, and zero otherwise; Hotissue is the average one-day initial return for initial public offerings issued during month t-3 of the offering; D_Under is a dummy variable for underwriter's reputation which takes a value of 1 for US and European underwriters and zero otherwise; LnAge is measured by the logarithm of the number of years from incorporation to listing; LnProceeds is measured by the logarithm of the proceeds; 1/IPO price is the inverse of the offer price; and SD_PEG is the standard deviation of the growth rate in earnings for the three years prior to the listing.

¹ Coef is the coefficient on the different independent variables in the regression.

***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

provides lower predictions than those obtained after adjusting for the self-selection bias. The coefficient ξ in Eq. (6), which is the consistent estimate of the expected reduction in underpricing caused by the inclusion of warrants, is positive and statistically significant. This evidence is consistent with the view that firms include warrants in their offering to reduce underpricing relative to what it would have been in the absence of warrants.

Table 7

Direct test of the agency cost hypotheses

	IPOs without warrants ($N=242$)	IPOs with warrants ($N=130$)	
	Mean (Median)	Mean (Median)	p-value from MW test
<i>Panel A: Profitability and Asset Utilization Rates</i>			
Turnover/total assets	1.634 (1.184)	2.041 (1.619)	0.000***
EBIT/total assets	0.181 (0.140)	0.208 (0.150)	0.139
Profits/total assets	0.152 (0.120)	0.179 (0.130)	0.054*
<i>Panel B: Profitability and Asset Utilization Rates by Industry</i>			
Oil & Resources	$N=2$		
Turnover/total assets	0.646 (0.646)		
EBIT/total assets	0.085 (0.085)		
Profits/total assets	0.050 (0.050)		
Industrial Goods	$N=47$	$N=35$	
Turnover/total assets	1.949 (1.111)	2.077 (1.617)	0.000***
EBIT/total assets	0.171 (0.140)	0.174 (0.150)	0.375
Profits/total assets	0.143 (0.110)	0.156 (0.130)	0.135
Consumer Goods	$N=69$	$N=37$	
Turnover/total assets	1.926 (1.354)	2.683 (1.817)	0.045**
EBIT/total assets	0.187 (0.150)	0.302 (0.150)	0.351
Profits/total assets	0.162 (0.130)	0.257 (0.140)	0.387
Services	$N=56$	$N=19$	
Turnover/total assets	1.498 (1.179)	1.957 (1.446)	0.089*
EBIT/total assets	0.201 (0.160)	0.192 (0.200)	0.484
Profits/total assets	0.170 (0.130)	0.173 (0.170)	0.376
Utilities	$N=3$	$N=1$	
Turnover/total assets	0.420 (0.513)	0.410 (0.410)	0.655
EBIT/total assets	0.043 (0.040)	0.070 (0.070)	0.346
Profits/total assets	0.063 (0.050)	0.060 (0.060)	0.655
Financials	$N=11$	$N=6$	
Turnover/total assets	0.612 (0.283)	0.545 (0.448)	0.705
EBIT/total assets	0.104 (0.050)	0.077 (0.080)	0.786
Profits/total assets	0.084 (0.040)	0.068 (0.065)	0.650
Properties & Construction	$N=37$	$N=20$	
Turnover/total assets	1.274 (0.791)	1.707 (1.746)	0.004***
EBIT/total assets	0.222 (0.130)	0.165 (0.155)	0.657
Profits/total assets	0.179 (0.100)	0.137 (0.130)	0.498
Information Technology	$N=13$	$N=9$	
Turnover/total assets	1.839 (1.768)	1.319 (1.351)	0.271
EBIT/total assets	0.116 (0.100)	0.226 (0.160)	0.030**
Profits/total assets	0.093 (0.080)	0.199 (0.130)	0.065*
Conglomerates	$N=4$	$N=3$	
Turnover/total assets	0.644 (0.697)	1.188 (1.085)	0.480
EBIT/total assets	0.135 (0.150)	0.063 (0.050)	0.285
Profits/total assets	0.103 (0.105)	0.037 (0.030)	0.114

Table 7 (continued)

	IPOs without warrants (N=242)		IPOs with warrants (N=130)	
	Percent Issuing (Shares)	Percent Issuing (Shares+ Convertible Notes)	Percent Issuing (Shares)	Percent Issuing (Shares+Convertible Notes)
<i>Panel C: Subsequent Financing Activities</i>				
1 year	4.1% (N=10)	5.8% (N=14)	3.8% ^c (N=5)	5.4% (N=7)
2 years	6.6% (N=16)	10.3% (N=25)	11.5% (N=15)	14.6% (N=19)
3 years	19.4% (N=47)	23.1% (N=56)	20.0% (N=26)	25.4% (N=33)

Notes: Panel A reports the means and medians (medians in parentheses) of three profitability and asset utilization rates. Pre-IPO information is obtained from the prospectus. Panel B reports the means and medians (medians in parentheses) of three profitability and asset utilization rates by industry defined by the Hong Kong Stock Exchange. *EBIT* refers to the earnings before interest and tax. Panel C reports the patterns of subsequent financing activities by IPOs with warrants and IPOs without warrants firms for periods of one, two and three years after their IPOs.

***, ** and * indicates significance at 1, 5 and 10 percent levels.

4.3. Direct tests of the agency-cost hypothesis

How and Howe (2001) suggest that the most straightforward test of the agency cost hypothesis is to examine whether the issuers of IPOs with warrants experience a greater level of agency costs than the issuers of IPOs without warrants. To compare the level of agency costs associated with IPOs with warrants and IPOs without warrants, we use the following profitability and asset utilization rates: i) turnover over total assets, ii) earnings before interest and taxes (EBIT) over total assets, and iii) the after tax profit over total assets. Contrary to the predictions of the agency cost hypothesis, Panel A of Table 7 shows that the profitability and asset utilization rates are higher for IPOs with warrants than for IPOs without warrants.

Panel B of Table 7 compares the profitability and asset utilization rates of IPOs with warrants and IPOs without warrants across different industries. Profit/total assets and EBIT/total assets are significantly higher for the sub-sample of IPOs with warrants than for that of IPOs without warrants only in the information technology industry. In the rest of industries, the two sub-samples are not significantly different in term of profit/total assets and EBIT/total assets ratios. However, the sub-sample of IPOs with warrants has a significantly higher turnover/total assets ratio than that of IPOs without warrants in 4 out of the total 8 industries.¹⁵ In the remaining 4 industries, the turnover/total assets ratio associated with sub-sample of IPOs with warrants is not significantly different from that of IPOs without warrants. This indicates that the prediction of the agency cost hypothesis that IPOs with warrants should have lower profitability and asset utilization ratios is not supported in any industry.

As suggested by the agency cost hypothesis, additional equity financing is delayed for IPOs with warrants until the profitability of their investment project(s) is verified. Therefore, if the issuers of IPOs with warrants survive, they are more likely to receive additional equity financing

¹⁵ Although Table 7 includes 9 industries, Oil and Resources contains only 2 IPOs without warrants and no IPOs with warrants.

Table 8

The value of the firm sold as warrants, firm riskiness, and retained ownership

	Coef. ¹	Coef.
<i>Panel A: XPPOST as a measure of the fraction of the firm value sold as warrants</i>		
Constant	−0.358***	−0.319*
1/IPOPrice	0.334***	
SD_PEG		0.005
% Retained	0.357**	0.648***
Adjusted R ²	0.170	0.010
F-value	67.14	5.29
<i>Panel B: MBSWV as a Measure of the Fraction of the Firm Value Sold as Warrants</i>		
Constant	−0.197**	−0.179
1/IPOPrice	0.177***	
SD_PEG		0.008**
% Retained	0.222	0.373**
Adjusted R ²	0.096	0.015
F-value	30.66	5.37

Notes: This table reports the results of the OLS estimation of Eq. (7) using a sample of 242 IPOs without warrants and 130 IPOs with warrants issued in Hong Kong during 1990–1997 period. The dependent variable is the value of the firm sold as warrant measured both as XPPOST and as MBSWV. XPPOST is the firm *i*'s proceeds derived from the exercise of warrants divided by the sum of the proceeds from the IPO plus the proceeds from the exercise of warrants (XPPOST is zero for SIPO firms). MBSWV is the fraction of the firm sold as warrant obtained from modified Black–Scholes option valuation formula (MBSWV is zero for SIPO firms). The rest of the variables are defined as follows: %Retained measures the level of ownership retained by the insiders of a given firm; SD_PEG is the standard deviation of the growth rate in earnings for the three years prior to the listing; and 1/IPO price is the inverse of the offer price.

The results are reported after conducting White heteroskedasticity adjustments.

***, ** and * indicate significance at 1%, 5% and 10% level, respectively.

¹ Coef is the coefficient on the different independent variables in the regression.

in the post IPO periods. Panel C of Table 7 shows that 56 (23.1%) of the issuers of IPOs without warrants and 33 (25.4%) of the issuers of IPO with warrants raised additional funds within three years of their IPOs. Although this result is consistent with the agency cost hypothesis, the difference is not statistically significant.

Overall, the results of this sub-section do not support the hypothesis that Hong Kong IPO firms include warrants in their offerings to reduce the agency costs of free cash flow. This evidence is consistent with How and Howe (2001), but contradicts Schultz (1993).

4.4. A direct test of the signaling hypothesis

One important prediction of the signaling hypothesis is that for IPOs with warrants, after controlling for the fraction of the retained ownership by insiders, the proportion of firm value sold as warrants should increase in the firm's riskiness. To test this prediction, we estimate the following OLS regression:

$$\text{VFSAW}_i = \theta_0 + \theta_1 \% \text{Retained}_i + \theta_2 \text{Risk}_i + \zeta_i \quad (7)$$

where VFSAW_{*i*} is the value of the firm sold as warrant. VFSAW_{*i*} is measured both as XPPOST_{*i*} and MBSWV_{*i*}. XPPOST_{*i*} is the firm's proceeds derived from the exercise of warrants divided by the sum of the proceeds from the IPO plus the proceeds from the exercise of warrants. MBSWV_{*i*} is the fraction of the firm sold as warrants obtained from modified Black–Scholes option

valuation formula.^{16,17} $\%Retained_i$ is the proportion of shares held by the issuer after the IPO. The variable $Risk_i$ refers to the firm's riskiness and measured both as 1/IPO price and SD_PEG.

Table 8 presents the results of the OLS estimation of Eq. (7) with $VFSAW_i$ measured as $XPPOST_i$ and $MBSWV_i$ respectively. Panel A of Table 8 shows that after controlling for the level of retained ownership, $XPPOST_i$ is positively and significantly related to 1/IPO price. Similarly, the results in Panel B of Table 8 show that, after controlling of the level of ownership retained by insiders, $MBSWV_i$ is positively and significantly related to both 1/IPO price and SD_PEG. This evidence is line with the predictions of the signaling hypothesis.

5. Summary and conclusions

The primary objective of the study is to investigate two hypotheses regarding the attachment of warrants to the shares of IPOs. The agency-cost hypothesis outlined by Schultz (1993) stresses the importance of multi-stage financing for smaller, younger and riskier firms. However, the signaling hypothesis of Chemmanur and Fulghieri (1997) focuses on the choice of securities as a signaling mechanism in a market characterized by information asymmetry.

The two hypotheses make similar predictions about the size, age, and riskiness of issuers of IPOs with warrants, and our results are in line with these predictions. Both hypotheses are also supported by the finding that IPOs with warrants are issued in cold market conditions when information asymmetry and risk are high.

We examine the unique implications of the agency cost hypothesis. We show that IPOs with warrants and IPOs without warrants are not significantly different in terms of the propensity for subsequent offerings. We also show that the profitability and asset utilization rates associated with IPOs with warrants are higher than those of IPOs without warrants. These findings contradict the predictions of the agency cost hypothesis.

Chemmanur and Fulghieri (1997) argue that their signaling model can be tested by examining the relationship between retained ownership, the value of the firm sold as warrants, and firm riskiness. Consistent with the unique predictions of the signaling model, after controlling for the level of retained ownership, we find that the fraction of firm value sold as warrants is increasing in the firm's riskiness. The signaling hypothesis also suggests that high-quality firms may use the fraction of retained ownership, underpricing, or the inclusion of warrants, as signaling devices to distinguish themselves from low-quality issuers. This implies that holding other signaling mechanisms, such as the level of retained ownership, constant, IPOs with warrants should incur lower underpricing compared to what it would have been if they issued IPOs without warrants. Our results from the self-selection regression model confirm this proposition.

Viewed collectively, our results are more in favor of the view that warrants are used for signaling rather than as mechanisms to reduce the agency cost of free cash flow.

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¹⁶ We thank the anonymous referee for suggesting the use of modified Black-Scholes option valuation formula as an alternative way to measure the value of the firm sold as warrants.

¹⁷ Garner and Marshall (2005) also employ modified Black-Scholes option pricing formula to compute the fraction of the firm's value sold as warrants.

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