Pyramid IPOs on the Chinese Growth Enterprise Market

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Abstract

This paper investigates Initial Public Offerings (IPOs) of high-tech firms on the Chinese Growth Enterprise Market (GEM). Almost half of the high tech IPOs on the GEM are set up in pyramid structures. The likelihood of a pyramid structure increases with the size of the IPO firm and state control. Our results do not suggest that pyramids are set up to overcome financial constraints. However, we document that pyramid IPOs are discounted before the IPO. The price to book ratio estimated at the subscription price is significantly lower for pyramid IPOs compared to stand-alone IPOs. Furthermore, the underpricing is higher for pyramid IPOs. We conclude that IPO investors demand a higher risk-premium when investing in pyramid IPOs which translates into a lower subscription price and higher underpricing.

Key words: pyramid ownership structure, Initial Public Offering, Growth Enterprise Market, Underpricing, Oversubscription

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1. Introduction

This paper explores the causes and consequences of the decision to create a pyramid structure and separate cash flow rights from voting rights at Initial Public Offerings (IPOs). We document that pyramid firms are discounted already before the IPO, i.e. before majority shareholders could have expropriated any minority shareholders. Thus, the discount on pyramid firms documented by e.g. Claessens et al. (2002) appears to be driven, at least partly, by an ex ante risk-premium associated with investing in pyramids and not only by majority shareholders actually expropriating minority shareholders.

Mechanisms that separate voting rights from cash flow rights, e.g. pyramid structures, dual class shares and cross-shareholdings, are widespread around the world and this is well documented (see e.g. La Porta et al., 1999). However, Adams and Ferreira (2008) point out that the empirical literature on the determinants and the effects of the actual decision to separate cash flow rights from voting rights is surprisingly small.

Almeida and Wolfenzon (2006) provide a rationale for pyramidal ownership in family business groups. In their theoretical model a pyramid allows a family to use all retained earnings of a firm it controls to set up new firms. Furthermore, Masulis et al. (2011) argue that pyramids are used to alleviate financing constraints and lower the cost of raising external equity. The empirical literature on pyramid structures has, however, ignored the analysis of how pyramid structures initially were set up and instead focused on the performance and behavior of mature pyramid firms.[1] Furthermore, the IPO literature has overlooked the effect of indirect ownership and pyramid structures on the IPO process.[2]

By looking at the actual set-up of pyramid firms, i.e. the IPO, we shed light on the type of firms that become part of a pyramid. The original owners can choose between holding the controlling stake directly or through a pyramid structure. Based on Almeida and

[1] For a survey of the literature on pyramids, see Morck et al. (2005).
[2] Some studies have analyzed IPOs by firms with dual class shares. See e.g. Taylor and Whittred (1998), Amoako-Adu and Smith (2001), Smart and Zutter (2003), and Holmén and Högfeldt (2004).

Wolfenzon's (2006) and Masulis et al. (2011) we derive hypotheses about capital constraints, firm size, and risk among pyramid IPO firms. We also derive hypotheses about the effect of pyramid structures on the IPO process based on the assumption that pyramid structures are associated with investor expectations about tunneling of corporate resources to the ultimate owner. If expected expropriation is discounted by external investors, they will only invest in pyramid structures if they receive an additional discount on pyramid IPOs.

We use the Chinese Growth Enterprise Market (GEM) in Shenzhen as our laboratory. The GEM was launched in 2009 in order to facilitate for young growing firms to go public and raise external equity. Surprisingly, 46 percent of the high tech IPOs on the GEM during 2010 were set up in pyramid structures. In Europe, the typical pyramidal firm is a large, old firm in a mature industry (see e.g. Holmén and Högfeldt, 2009).

Our sample consists of 173 IPOs on the GEM during 2010. We only find limited support for pyramid firms being capital constrained. The result indicating that pyramid firms have higher leverage is not robust in our sample. Furthermore, there are no indications that pyramid firms have higher capital expenditure. However, in line with Almeida and Wolfenzon's (2006) argument, pyramidal IPOs are significantly larger than the stand-alone IPOs. We find no indications that pyramidal IPOs are riskier than the stand alone IPOs.

Second, we investigate how pyramidal structures affect the IPO process. Using treatment effect models we document that the pre IPO (subscription) price to book ratio is significantly lower for pyramid IPOs. Furthermore, the underpricing, i.e. the price increase the first day of trading, is significantly higher for pyramid IPOs. These results are consistent with Almeida and Wolfenzon (2006) and Masulis et al. (2011). Minority shareholders demand compensation for expected expropriation which results in a larger discount on pyramidal IPOs.

Using detailed information about the IPO process we find evidence that the oversubscription rate among institutional investors is higher for the more underpriced pyramid IPOs. The oversubscription rate among individual investors is not significantly different for pyramidal IPOs. The results appear to be consistent with Rock's (1986) model where informed investors only subscribe to underpriced IPOs. Even if the better informed institutional investors subscribe to all IPOs on GEM, their demand is higher for the more underpriced IPOs.

This paper naturally relates to the literature on tunneling within Chinese pyramids on the main board (see e.g. Gao and Kling, 2008 and Cheung et al., 2009). However, we concentrate on the IPO process and do not investigate tunneling per se. Our results suggest that investors demand a higher risk premium when investing in pyramid structures on the GEM already at the IPO, i.e. before any tunneling could have taken place in the particular firm. Thus, the discount associated with pyramidal structures documented by e.g. Claessens et al. (2002) appears to be driven, at least partly, by an ex ante higher risk premium on pyramidal firms, and not by actual expropriation of minority shareholders.

Our analysis of IPOs on the GEM is also related to Gao's (2010) study of IPOs on China's main board. Gao's (2010) results suggest that underpricing is driven by overpricing of IPOs after listing and not by pre-market deliberate underpricing. Our results suggest that the additional underpricing of pyramid IPOs on the GEM might be related to a deliberate strategy.

The rest of the paper is organized as follows. The next section outlines our hypotheses. Section three gives a brief overview of the new Growth Enterprise Market in China. Section four presents the data while the empirical results are reported in section five. Section six puts our results in perspective and concludes.

2. Hypotheses

We explore the causes and consequences of pyramid structures at the IPO in light of Almeida and Wolfenzon (2006) and Masulis et al. (2011). Almeida and Wolfenzon (2006) argue that pyramid structures will be more prevalent among larger firms. The larger the firm is, the more difficult it is for a controlling shareholder with limited wealth to keep control of the firm without separating ownership and control. Furthermore, since dual class shares are not allowed in China, a pyramid structure is the natural choice for a controlling shareholder who wants to keep control of a large firm.

Hypothesis 1: The pyramid IPO firms are larger than the stand alone firms.

Masulis et al. (2011) argue that pyramids are used to alleviate financing constraints and lower the cost of raising external equity. Compared to direct funding, the pyramidal structure levers the internal capital under control which helps raise external funding for projects with large capital requirements and low initial cash flows. This argument is the basis for our second hypothesis.

Hypothesis 2: The pyramidal IPO firms are more financially constrained than the stand-alone IPO firms.

In the empirical analysis we will use capital expenditures and leverage as proxies for capital constraints.

Masulis et al. (2011) also argue that families have incentives to place risky firms in a pyramid. By using a pyramid structure the families can leverage their invested capital and control many firms but at the same time minimize the risk and this argument is particularly valid for risky firms. Similar arguments can be found in Almeida and Wolfenzon (2006) and Attig et al. (2004).

Hypothesis 3: The pyramidal IPO firms are more risky than the stand-alone IPO firms.

Almeida and Wolfenzon's (2006) pyramiding model combines the idea that the levered control over the firm's cash flow creates a financial advantage with the key assumption that tunneling of corporate resources is significant when protection of minority shareholders is weak.[3] The controlling owner use the capital of an already existing firm together with new equity capital from external investors to finance a new firm that they also control at the pyramid level below. If the new external investors rationally anticipate the cost of expropriation they will only co-invest alongside the controlling shareholders in pyramid structures if they receive an additional discount when investing in pyramidal IPO firms.[4] These arguments are the basis for our fourth hypothesis.

Hypothesis 4: The subscription price to book ratio is lower for pyramid firms compared to stand alone firms.

If the subscription price on pyramid IPOs is set low deliberately in order to attract investors it will lead to an expected larger initial returns, i.e. larger underpricing. Beatty and Ritter (1986) also argue that the expected initial return is an increasing function of the uncertainty investors feel about the market price of the IPO firm after listing. Thus, if a pyramid structure increases the uncertainty investors feel about the IPO firm, it will translate into larger underpricing.

Hypothesis 5: The underpricing of pyramid IPO firms is higher than for stand-alone IPO firms.

3. The Shenzhen Growth Enterprise Market

The Shenzhen Growth Enterprise Market (GEM) is an independent exchange market with the purpose to create a good platform for small-and-medium sized high-tech companies to raise

[3] Several recent papers find evidence of tunneling in Chinese listed firms from different perspectives. See e.g. Gao and Kling (2008) and Cheung et al. (2009). China is also perceived as a country with poor investor protection, for example, according to a corporate governance rating research conducted by Governance Metrics International (GMI) in 2009, China only got 3.01 (where 10 is the highest score) and belonged to the lowest ranked countries. Ireland ranked highest (7.44) followed by the UK (7.36), Canada (7.35), Australia (7.32) and the U.S. (7.18).

[4] Due to private benefits of control, the new firm has positive present value for the controlling owner even if the subscription price is discounted at the IPO.

equity funding. There are several differences between GEM and the Chinese main board market. For example, listing requirements, trading methods and regulations are different on the GEM. GEM encourages innovation-oriented enterprises, especially those with independent innovations, industrialization of agriculture, and regional characteristics to go public.

In order to protect investors, the Shenzhen GEM is highly regulated. For example, a firm listed on GEM must disclose a transaction with an absolute amount over 5 million Yuan or if it reaches 10% of the company's total revenue of the latest audited fiscal year. Moreover, the ultimate owners cannot sell or repurchase their shares for a period of three years from the date of listing.

Compared to growth markets in most other countries, the Shenzhen GEM also has the following features: i) a more stringent "net profit" requirement, i.e., the firm has to be profitable for the latest two years and the net income is at least 10 million Yuan, ii) higher requirement on firm size, net asset must be at least 20 million, iii) there shall be no accumulated losses in firms before listing, and iv) venture firms in seed stage are not eligible to list on the Shenzhen GEM (Source: website of Shenzhen Stock Exchange).

Shenzhen GEM is rapidly developing. New firms are listed almost every month. For instance, at the end of 2009 there were only 36 listed firms and in August 2013 the number has increased to 355. However, the Shenzhen GEM is still a small market in term of size. At the end of July 2013, the total market value of firms listed in Shenzhen GEM is 1,306,178 million of Chinese Yuan, which is only about 16.3% or 9.1% of the market value of Shenzhen Stock Exchange or Shanghai Stock Exchange, respectively.

4. Data

4.1 Sample and data sources

Our sample consists of 173 firms that were listed on the GEM in 2009 and 2010. These firms are typically young and in high-tech sectors. No financial or utility firms exist in the sample.

Starting in 2001, publicly traded firms in China have to report the detailed ownership information in their annual reports. The information includes a figure of the ownership structure of the firm, the name and status of the ultimate controlling owner as well as the other nine biggest shareholders for both tradable and non-tradable shares. This regulation makes it possible to identify the ultimate owner and the pyramidal chain if it is applicable. For a detailed example of a pyramidal structure on the Chinese growth enterprise market, see Appendix.

Since the largest shareholders of the firms are not allowed to sell their shares or buyback shares for at least three years after IPO, to date, there is no change in controlling shareholders in the sample. In addition to the manually collected ownership structure, we collect the financial data from Thomson Reuter, IPO data from RESSET (www.resset.cn) and industry classification is from China Securities Regulatory Commission (CSRC) Industry Classification.

4.2 The IPO process on Growth Enterprise Market

To date, the type of the investment banking contract in the IPO process on GEM is a standby commitment, with which the issuing firm and its underwriter first issue a preliminary prospectus and solicit interests from potential investors.[5] After approval from the China Securities Regulatory Commission (CSRC), the issuing firm and its underwriter hold a pricing meeting where the offer price and the number of shares to be sold are agreed upon, and finally they reach the stage of the share issuance. Unlike other markets, the share issuance in GEM involves both on-line issuance and off-line issuance. The on-line issuance is mainly for individual investors. The procedure is, once an individual investor applies for a certain

[5] All firms in our sample have a Chinese investment bank as lead underwriter.

amount of shares, he or she receives a "lottery number". After the issuance of on-line shares, the firm announces the numbers that win the "lottery", and only investors with those numbers can actually get a certain amount of shares. The number of shares is usually much smaller than the amount that the investor applied for beforehand. And for those who do not win the lottery, the money is to be returned.

The off-line issuance is mainly aimed for institutions, and it basically follows the same rule as the on-line issuance. Since the number of institutions is much smaller than the number of individual investors, usually all of the eligible institutions can get a certain amount of shares of the IPO. The actual number of shares that each institution is able to acquire depends on the number the institutions that applied during the off-line issuance. Under a standby commitment contract, the underwriter is responsible for buying any remaining shares that are not subscribed in the two- to four- week standby period.

In China, non-voting shares or other devices for discriminating against different shareholders are not permitted. B-shares or H-shares carry the same voting rights as A-shares.[6] Firms in GEM are too small to issue B-shares or H-shares. We also find that two ratios are fixed. The portion of a firm sold at the IPO is fixed at 25% and the tradable shares sold to individual investors (i.e., online issuance) are fixed as four times that sold to institutions (i.e., offline issuance). These fixed ratios reflect the strict regulation features of GEM. In order to protect the investors, especially the minority shareholders, the owners can only sell a moderate portion of their firms at the IPO, i.e., 25%, and 80% of the tradable shares have to be sold to individual investors.

4.3 Sample, variables and summary statistics

[6] A and B shares are the most commonly traded shares in China, and H shares (also known as *Hang Seng China Enterprises Index*) are mainly traded in the Hong Kong Stock Exchange. A-shares are traded and denominated by Chinese Yuan, but B-shares are traded and denominated by US dollars in the Shanghai Stock Exchange and Hong Kong dollars in the Shenzhen Stock Exchange. H-shares are denominated and traded in Hong Kong dollars.

We categorize the IPOs on GEM during 2010 into three groups with respect to the characteristics of the ultimate owners, i.e. family-owned, state-owned and widely held. In our sample 156 firms are family controlled[7], 11 firms are state controlled, and only 6 firms are widely held. Since the widely held firms do not have a controlling shareholder they can by definition not be set up in a pyramid structure and these 6 firms are not included in our tests of the probability of a pyramid structure.[8] . Thus, our tests of the probability of a pyramid structure use 167 firms. State owned firms only make up 7 percent of our sample. In comparison, Fan et al. (2005) find that in 2001, the government was the ultimate owner of about 76% of Chinese publicly listed firms. This difference reflects that the Chinese government has encouraged more private corporations to list their shares publicly during the latest ten years.

The main variable of interest and dependent variables in the probit regressions is *Pyramid*. It is a dummy variable that takes the value of one if the firm is set up in a pyramidal structure and zero otherwise. 73 IPO firms (43.7%) are set up in a pyramid structure.

In the treatment effect regressions we use four different dependent variables. The first is the (subscription) price to book ratio pre IPO. *PBpreIPO* is calculated as the offering price divided by net asset value per share (NAP) before IPO. The second is the underpricing of the IPO. *IPO underpricing rate* is calculated as $(P_c-P_o)/ P_o$ where P_c is first day closing price and P_o is offering price.

The third and fourth dependent variables are the online and offline, respectively, oversubscription rates. The *oversubscription online (offline)* is defined as the number of shares individual (institutional) investors have applied for, divided by the number of shares available for sale to individual (institutional) investors.

[7] In line with Masulis et al. (2011), a firm where a family (this includes siblings, relatives, etc) or an individual is the largest ultimate shareholder is defined as family controlled.
[8] Since we use treatment effect models, where the probability of a pyramid structure is estimated in the first step, to estimate the effect of pyramid structures, the widely held firms drop out of these estimations as well.

Table 1 panel A provides summary statistics for the dependent variables. The numbers of *Oversubscription online/offline* as well as the *IPO underpricing* rate imply a very strong interest among investors toward the IPO firms on GEM. The average *Oversubscription online* (*offline*) is 149 (60), which is about 8 (3) times compared to that of IPOs in UK (Brennan and Franks, 1997). Furthermore, the average underpricing level is 0.463 which is higher than in most other markets (see e.g. Loughran et al., 1994).[9]

[Insert Table 1 here]

Our control variables include: *Sales* denotes the total sales of the firm in 2010 in logarithmic form and is used as a proxy for firm size. As an alternative size measure we use the number of employees in the firm (*EMPL*). *Leverage* is calculated as the firm's total debt divided by total asset in the year of 2010. *CAPEX* stands for the capital expenditures related to property plant and equipment and is used to proxy for the firm's investment. *Leverage* and *CAPEX* are used as proxies form capital constraints. We use yearly stock market volatility (*Volatility*) as proxy for risk.[10] It is calculated as the standard deviation of daily stock returns from February 2011 to September 2011 of each firm and multiplied by the square root of 252 in order to have an estimate of yearly volatility.[11] As a proxy for the firm's growth potential we construct a *Salesgrowth* variable. It is estimated as the total sales in 2010 divided by total sales in 2009 minus one. In order to control for the effect of state ownership, we construct a dummy named *State* which takes the value of one if the ultimate controller is the state, and zero otherwise. Similar control variables are used in earlier studies on pyramids, e.g. Masulis et al.'s (2011) international study, Fan et al.'s (2005) Chinese study and Attig et al.'s (2004) Canadian study.

[9] However, the average underpricing rate in our sample is lower than in Gao's (2010) sample (on average 1.57) which covers 217 IPOs from 2006 to 2008.
[10] Ex-post IPO stock market volatility has been used as a proxy for IPO risk by e.g. Gompers (1996) and Zhu (2009).
[11] There are typically 252 trading days during a year. Because firms listed on the GEM randomly across the year, we choose the window in order to have all stock prices available for our sample.

Descriptive statistics for the control variables are reported in Table 1 panel B. The median IPO firm is growing rapidly and has relatively little debt. Median *Salesgrowth* is 0.310, median *CAPEX* is 6.01, and median *Leverage* is 12.527%.

5. Empirical results

5.1 Univariate comparison of pyramid, non-pyramid and widely-held firm characteristics

Table 2 reports the median difference tests for the firm characteristics of pyramid firms, non-pyramid firms and widely-held firms. The significance level of the difference in median is based on Wilcoxon ranksum test.[12]

We first compare the pyramid firms to the closely held non-pyramidal firms. The Wilcoxon ranksum tests suggest some significant differences. Pyramidal firms i) are larger (*Sales* and number of employees (*EMPL*)), ii) invest more (*CAPEX*), iii) have higher *Leverage*, and iv) have higher *Salesgrowth* than non-pyramidal firms. We find no significant difference in terms of the other variables.

Second we compare the widely held firms to the closely held pyramid and non-pyramidal firms. Widely-held firms have significantly higher capital expenditures (*CAPEX*) than closely held firms. These are no significant differences between widely-held firms and closely held firms in other firm characteristics.

[Insert Table 2 here]

5.2. Causes of pyramids

We first estimate a probit regression to analyze what factors that influence the ultimate owners' endogenous decision to set up the IPO firm in the pyramid structure or not. The dependent variable is the pyramid dummy, which equals one if the IPO firm is part of a pyramid structure, and zero otherwise.

[12] T-tests on mean differences generate similar results.

Our first hypothesis is that larger firms are more likely to be set up in a pyramid structure. We use *Sales* or *EMPL* as proxies for firm size. Our second hypothesis is that pyramidal firms are capital constrained. We therefore include capital expenditure over property plant and equipment (*CAPEX*) and the ratio of total debt over total asset (*Leverage*) as independent variables in the regressions. Finally, our third hypothesis states that pyramidal firms are more risky and we therefore include our proxy for firm risk, stock market volatility after listing (*Volatility*), as an independent variable.

To control for growth opportunities we include *Salesgrowth*. In China, state-owned companies (SOEs) still dominate the economy, so we include a *State* dummy to capture the potential governmental effect. In some estimated models we also include 16 industry dummies based on the industry classification by China Securities Regulatory Commission (CSRC). Thus, we estimate the following probit regression.

$$Pyramid_i = \alpha + \beta_1 Size_i + + \beta_2 CAPEX_i + \beta_3 Leverage_i + \beta_4 Volatility_i + \beta_5 Salesgrowth_i + \beta_6 State_i + \sum_{j=1}^{16} \gamma_j Industry_j + \varepsilon_i$$

The results are reported in table 3. In line with our first hypothesis, *Sales* and *EMPL* are positive and significant in most of the estimated models indicating that larger size increases the likelihood that a firm will be set up in the pyramidal structure. The result that pyramid firms are larger in size is supported by the theoretical arguments in Almeida and Wolfenzon (2006) and can also be found by Attig et al. (2004) and Masulis et al. (2011).

We do not find any support for our second hypothesis stating that pyramidal firms are capital constrained. *CAPEX* and *Leverage* are insignificant in all estimated models. Thus, while *CAPEX* has been found to significantly increase the likelihood of pyramid structures on the Chinese main market (Fan et al., 2005), in Canada (Attig et al., 2004), and in multiple countries (Masulis et al., 2011), it does not appear to be significant on GEM. One possible explanation is that almost all firms on the GEM are rapidly growing high-tech firms.

They are all investing intensively and it might be difficult to document a difference between pyramidal firms and stand-alone firms even if differences exist.

Earlier results concerning the relation between leverage and the likelihood of pyramid structures are mixed. Masulis et al. (2011) find that leverage is negatively related to the likelihood of pyramids. Attig et al. (2004), on the other hand, find no significant relation between leverage and the likelihood of pyramid structures.

Similarly, we find no support for our third hypothesis that pyramidal firms are riskier.[13] Earlier results concerning the relation between firm risk and the likelihood of pyramid structures are mixed. Masulis et al. (2011) find that risk is positively related to the pyramid layer. Attig et al. (2004), on the other hand, find no significant relations between risk and the likelihood of pyramid structures.

State is positively significant and this finding is supported by the decentralization theory by Fan et al. (2005). They argue that the government cannot relinquish control by selling off its stake in the firm freely due to strict regulation prohibiting the dilution of state ownership. Therefore, a pyramid can serve as a device for the government to decentralize control rights to the firm managers. *Salesgrowth* is mainly insignificant in table 3. It is positive and significant at the 10 percent level in one of the estimated models.

[Insert Table 3 here]

5.3 Treatment effect models

In this section we analyze whether and how the decision to set up IPO firms in pyramid structures affects the investors' interest and valuation in the IPO. Endogeneity concern is an important issue in studies of corporate and investor behavior, respectively, and ownership structure (Demsetz and Lehn, 1985). In order to control for the fact that original owners' endogenous decide whether to set up the firm in a pyramid structure we estimate treatment

[13] In fact, *Volatility* is negative and significant at the 10 percent level in one of the estimated models.

effect models. Treatment effect models consider the effect of an endogenously chosen binary treatment--the pyramid dummy--on another endogenous continuous variable, conditional on two sets of independent variables. Related papers, for example, Villalonga and Amit (2006) and Masulis et al. (2011) also apply treatment effect models. The treatment effect model consists of two steps. The first step is a probit model with the binary treatment variable (i.e., the *Pyramid* dummy) as the dependent variable, and instrument(s) as independent variable(s). The second step is a regression of the continuous dependent variable, *y,* on the *Pyramid* dummy controlling for *Salesgrowth*, firm risk (*Volatility*), *State* ownership, firm size (*Sales*), and industry effects.[14] Thus, we estimate

$$y_i = \alpha + \beta_1 Pyramid_i + \beta_2 Salesgrowth_i + \beta_3 Volatility_i + \beta_4 State_i + \beta_5 Sales_i + \sum_{j=1}^{16} \gamma_i Industry_j + \varepsilon_i$$

where y_i represents i) the pre IPO Price to book ratio (*PBPreIPO*), ii) *Underpricing*, iii) *Oversubscription online,* and *Oversubscription offline*, respectively.

In the first step we use *EMPL* as our instrument variable since i) Almeida and Wolfenzon's (2006) theoretical model suggests that pyramidal firms are large, ii) in our sample, pyramidal firms are indeed larger in size and have more employees than stand-alone firms, iii) *EMPL* is orthogonal (unrelated) to all the dependent variables in the second step (see table 4).[15] Our other size measure, *Sales* turned out to be highly correlated with oversubscription rates.[16]

[Insert Table 4 here]

[14] The fraction of the firm floated at the IPO has been shown to affect underpricing (see e.g. Brennan and Franks, 1997 and Habib and Ljungqvist, 2001). However, on GEM the fraction sold is fixed at 25% for all firms and can therefore not be used in cross-sectional analysis.

[15] A valid instrument in the treatment effect model should be significant related to the binary variable (pyramid dummy) in the first step, and be orthogonal (unrelated) to the dependent variables (*PBpreIPO*, *Underpricing*, *Oversubscription rate*) in the second step.

[16] Himmelberg et al. (1999), Villalonga and Amit (2006) and Masulis et al. (2011) employ idiosyncratic risk as their instrument for ownership structure, e.g. pyramid structures in the first step. We tried the idiosyncratic risk from the single factor model and it turned out to be highly correlated with *Underpricing*. Furthermore, the other significant variable in the probit models reported in table 3, the *State* dummy, is also significantly related to *Underpricing* and therefore not a valid instrument.

In the first step, the treatment $Pyramid_i$ is modeled as the outcome of an unobserved latent variable, $Pyramid_i$*.

$$Pyramid_i = \begin{cases} 1, & if\ Pyramid_i^* > 0 \\ 0, & otherwise \end{cases}$$

All models are estimated with Maximum Likelihood and reported with heteroskedasticity corrected standard errors in parenthesis (White, 1980).[17]

5.3.1 Subscription price to book ratio before IPO

We start by testing our fourth hypothesis stating that the subscription price to book ratio is lower for pyramid firms. *PBpreIPO* is used as the dependent variable and it is calculated as the subscription (offering) price divided by net asset value per share (NAP) before IPO. Thus, it is an *ex ante* measure which should capture the underwriters' information about the investors' interest in the IPO. A lower *PBpreIPO*, ceteris paribus, is consistent with investors using a higher discount rate when valuing the firm. Holmen and Högfeldt (2004) run similar tests on Swedish IPOs.

The results are reported in table 5 model 1. In line with hypothesis 4 we find that the coefficient on the *pyramid* dummy is negative and significant. The result suggests that underwriters anticipate that the investors will discount the price of pyramidal firms due to concerns of expropriation or asset appropriation. Wang (2013) finds that, other things being equal, pyramidal structures on GEM have a detrimental effect on firm performance, while Gao and Kling (2008) document that a firm belonging to a pyramidal business group will experience exacerbated asset appropriation on the Chinese main market. Among other variables, only *Salesgrowth* is significantly associated with a higher subscription price to book ratio pre IPO.

[Insert Table 5 here]

[17] Estimating the Treatment Effect models with the two-step Heckman procedure generate similar but somewhat statistically weaker results.

5.3.2 IPO underpricing

We next test hypothesis 5 stating that underpricing of pyramid IPO firms is higher than for stand-alone IPO firms. The motivation for investors to take the potential additional risk associated with co-investing along with the controlling shareholder in a pyramid structured IPO might be that they are compensated by larger returns during the first days of stock listing, i.e. higher underpricing. The lower price to book ratio of pyramid IPOs suggests that this might be the case. The dependent variable is calculated as $(P_c-P_o)/P_o$ where P_c is first day closing price and P_o is offering (subscription) price.

The results are reported in table 5 model 2. In line with hypothesis 5, the coefficient on the *Pyramid* dummy is indeed positive and significant, suggesting that underpricing is more substantial for pyramid firms. We interpret this result from both the investors' and the underwriters' points of views. First, from the investors' side, this result is consistent with Beatty and Ritter (1986) who argue that the expected initial return is an increasing function of the uncertainty investors feel about the market clearing price of an IPO. Investors anticipate or seek more compensation when uncertainty is larger. For example, the uncertainty to invest in a relatively more complicated firm structure (pyramid firms) is larger than to invest in a relatively simpler structured firm (stand-alone firm). Second, from the underwriters' point of view, a pyramid structure should increase the likelihood that investors might not be interested in the IPO and not subscribe to shares. Thus, in order to reduce the risk of not being able to sell all shares, the underwriters intentionally underprice pyramid IPOs more.[18]

In line with earlier research (e.g. Habib and Ljunqvist, 2001) larger IPOs in terms of total sales are associated with significantly lower underpricing. And in line with e.g. Gompers et al. (1996), more risky firms experience significantly higher underpricing.

[18] As we noted above, the contract between the IPO firm and the investment bank is a standby commitment, with which the investment banker has to buy all remaining shares.

Furthermore, the coefficient over the *State* dummy is positive and significant. One interpretation of this result is that state-owned firms tend to underprice more in order to benefit investors, consistent with the "*helping hand*" hypothesis of central government as controlling shareholder.[19] Cheung et al. (2010) find that consistent with the helping hand hypothesis, central government connections benefit the minority shareholders of listed firms. In contrast, consistent with the "*grabbing hand*" hypothesis, the minority shareholders in firms controlled by the local government are expropriated as they lose up to half of the value of related party transactions.

5.3.3 Online/Offline oversubscription rate

We have shown above that pyramidal firms are discounted already before the IPO. Underwriters of firms in pyramids appear to be aware of the potential risk of not being able to sell all the shares and therefore intentionally underprice pyramid IPOs more. So do investors actually stay away from pyramid IPOs due to concerns of expropriation? Or do investors show higher interest in pyramid IPOs in order to obtain higher first day initial returns? We next examine if and how the pyramid structures affect the IPO subscription online and offline.[20]

We report the results in table 6 models 1 (online) and 2 (offline). The coefficient of the *Pyramid* dummy is insignificant in model 1 but significantly positive in model 2. Recall that online subscription is mainly for individual investors while offline subscription is mainly for institutional investors, and that a higher oversubscription rate implies a larger interest among investors.

[19] 9 out of 11 state-owned enterprises in our sample are controlled by the central government.

[20] Unlike the allocation rule proposed by London Stock Exchange where discrimination can only appear on the basis of the size of the applications (Brennan and Franks, 1997), CSRC allows for no discrimination against any investors (e.g., the size of application and identity) in the allocation process of the IPOs in Chinese firms. Firms and their investment bankers should notarize their lottery processes, so the allocation is on a fair basis, and this alleviates our concern about any potential selection bias of the successful subscribers.

The results suggest that individual investors' interest in IPOs appear not be affected by pyramid structures. Institutions, on the other hand, are keener on pyramid firms than standalone firms. Institutional investors' larger demand for the more underpriced pyramid IPOs appear to be in line with the general perception that institutional investors, compared to individual investors, have more experience, expertise, and better information.[21] On the one hand and in line with Rock's (1986) theoretical model of underpricing of IPOs, informed investors (institutions) has an opportunity to profit from superior information by bidding for "mispriced" securities (pyramidal IPOs). They are compensated for their costly information processing about e.g. complicated pyramid structure, by larger first day returns. On the other hand, individual investors are usually regarded as less sophistication and they might have little knowledge about the pyramid structure. For example, Feng and Seasholes (2003) examine a sample of 90,478 actively investing individuals in China, and document that Chinese individual investors are much younger and have less investing/trading experiences than typical individual investors in U.S.

In addition, *Volatility* is positive and significant suggesting that investors regard IPO investments as lotteries with positively skewed returns. The likelihood that a particular IPO will be the next Apple increases with firm risk and therefore risk might increase investor interest.

[Insert Table 6 here]

5.4 Additional tests

We have performed a battery of unreported robustness test. First, we have deleted the 11 state owned firms from all tests. Our main results remain unchanged. Second, we have included *CAPEX* and *Leverage* in the second step of treatment effect models. It does not alter our main

[21] See Chakravarty (2001), Sias and Starks (1997), and Walther (1997).

results. Third, we include Return on Assets (ROA) in the models but it does not change our main results.

Furthermore, Masulis et al (2011) argue that pyramid structures might be used to overcome financial constraints. In the reported tests we have used *CAPEX* and *Leverage* to proxy for financial constraints. Another measure of financial constraints is of course dividend payments. Financial constrained firms should be less likely to pay dividends. However, we note that most firms in our sample are rapidly growing firms and most of them do not pay dividends, or pay very small dividends, irrespective of being within a pyramid structure or not.

Almeida and Wolfenzon (2006) argue that pyramids are set in order to derive private benefits of control and expropriate minority shareholders. Proxies for the value of the private benefits of control are difficult to construct using public information since they are by definition private (Zingales, 1998). The most commonly used measures, the voting premium on high voting stock and the premium at block transfer transactions, are not possible to construct for our sample since all firms are one share - one vote and no major ownership changes have taken place in the sample yet. However, we try to construct a measure by collecting the salaries paid by the IPO firms to the ultimate owners. Paying herself a very large salary could be one private benefits of control. We do not find any significant difference between pyramids firms and stand-alone IPOs in terms of the salaries paid to the ultimate owner.

The ultimate owner may of course place friends and relatives on well-paid executive positions in the (pyramidal) firms as well and this would be another type of private benefits of control. However, as far as we understand, this is very uncommon in China since it would generate an outcry among investors.

We have also considered various interaction effects. For example, inspired by Khanna and Palepu (1997) and Attig et al. (2004), we have included the interaction effects of *Pyramid* and *Salesgrowth*, and *Pyramid* and *Volatility* in OLS regressions. The interaction terms are insignificant and the other results are not changed in a significant way.

Finally, we have replaced the pyramid dummy with the actual separation of control rights from cash flow rights created by the pyramid structure. This variable is not significant in similar tests as the ones reported above. Thus, it appears as if the pyramid structure has an indicator effect at the IPO, i.e. there is no linear relation between the actual degree of separation of control rights from cash flow rights and price to book, underpricing, and oversubscription.

6. Conclusion and Discussion

In this paper we have investigated Initial Public Offerings (IPOs) of high-tech firms on the Chinese Growth Enterprise Market (GEM). As far as we know, this is the first paper that investigates the IPO process in combination with pyramidal structures on the new GEM in China. We first show that almost half of the high-tech IPOs on the GEM are set up in pyramid structures.

Based on Almeida and Wolfenzon (2006) and Masulis et al (2011) we formulate five hypotheses and we find support for three of them. The likelihood of a pyramid structure increases with the size of the IPO firm (Hypothesis 1). The subscription price to book ratio is significantly lower for pyramid IPOs compared to stand-alone IPOs, i.e. pyramid IPOs are discounted before the IPO (Hypothesis 4). Furthermore, the underpricing is higher for pyramid IPOs (Hypothesis 5). We conclude that investors demand a higher risk-premium when investing in pyramid IPOs and this translates into a higher underpricing. Our results do not suggest pyramid IPOs are capital constrained (Hypothesis 2) or riskier (Hypothesis 3).

We think our results contribute to the existing literature along at least two dimensions. First, most prior studies use information about mature pyramidal firms and document that at least under some conditions, pyramid structures are associated with lower firm value and worse firm performance (see e.g. Claessens et al., 2002, Lemmon and Lins, 2003 and Fan et al. 2005). These results are often interpreted in terms of expropriation of minority shareholders by the controlling shareholder. Our IPO results supplement these results and suggest that pyramid affiliated firms are discounted already at the IPO.

Second, we think our approach and the use of detailed information about the IPOs on GEM let us document a more complete picture than is typically done.[22] The analysis of i) the price to book ratio at the subscription price, ii) the underpricing, and iii) oversubscription ratios also provides a consistent story. A higher underpricing could be due to a large interest in the IPO which creates overvaluation once the firm shares begin to trade. Or, a higher underpricing could be due to underwriters setting a lower subscription price in order to attract investors. Our results for pyramid IPOs on the GEM suggest that the second explanation is more plausible.

[22] One exception is Gao (2010), who makes a detailed analysis of IPOs on the Chinese main board.

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Table 1
IPO characteristics of sample firms

In this table we report summary statistics for our sample. The sample consists of 173 firms that listed on the growth enterprise market (GEM) in China in 2010. Accounting data and stock market data are collected from Thomson One and IPO data are from RESSET (www.resset.cn), industry classification is from China Securities Regulatory Commission (CSRC) Industry Classification, and ownership information is manually collected by the authors. The main variable of interest, *Pyramid*, is a binary variable that takes the value of one if the firm is in a pyramid structure and zero otherwise, there is no change in the ownership structure in our sample during 2010. *PBpreIPO* refers to (subscription) price to book ratio pre IPO, and is calculated as the offering price divided by net asset value per share (NAP) before IPO. *IPO underpricing* is equal to $(P_c-P_o)/P_o$, where P_c is first day closing price and P_o is offering price. *Oversubscription online (offline)* is equal to the number of shares individual (institutional) investors have applied for, divided by the number of shares available for sale to individual (institutional) investors. *State* is a dummy variable equals to one if the ultimate owner is the state, and zero otherwise. *Sales* denotes the total sales in Chinese Yuan of the firm in 2010 in logarithmic form. *EMPL* stands for employee number, which is the logarithmic of total employee number of the firm. *Volatility* is equal to the yearly stock market volatility and it is estimated as the standard deviation of daily stock returns from February 2011 to September 2011 of each firm multiplied by the square root of 252. *Salesgrowth* is the growth of total sales in 2010. *Leverage* is equal to the firm's total debt divided by total asset in the year of 2010, and it is in a percentage scale. *CAPEX* is equal to the capital expenditure over property plant and equipment.

Panel A: Descriptive statistics Dependent variables

	25% percentile	Median	75% percentile	Mean	Standard deviation
Pyramid	0	0	1	0.437	0.498
PBpreIPO	9.189	11.455	14.444	12.456	5.094
IPO underpricing	0.176	0.364	0.718	0.463	0.398
Oversubscription online	99	144	188	149	67
Oversubscription offline	37	58	79	60	33

Panel B: Descriptive statistics Control variables

	25% percentile	Median	75% percentile	Mean	Standard deviation
State	0	0	0	0.066	0.249
Sales (in log)	3.420	3.827	4.270	3.882	0.674
Volatility (%)	41.9	48.8	55.6	49.2	9.8
Salesgrowth	0.142	0.310	0.480	0.337	0.355
Leverage (%)	6.897	12.527	21.305	16.830	14.530
EMPL (in log)	5.800	6.366	6.860	6.353	0.781
CAPEX	2.950	6.010	11.960	9.798	11.439

Table 2
Differences between pyramid firms, non-pyramid firms and widely-held firms, respectively

In this table we report difference in median test between pyramid firms, non-pyramid firms and widely held firms. The sample consists of 173 firms that listed on the growth enterprise market (GEM) in China in 2010. Accounting data and stock market data are collected from Thomson One and IPO data are from RESSET (www.resset.cn), industry classification is from China Securities Regulatory Commission (CSRC) Industry Classification, and ownership information is manually collected by the authors. *PBpreIPO* refers to (subscription) price to book ratio pre IPO, and is calculated as the offering price divided by net asset value per share (NAP) before IPO. *IPO underpricing* is equal to $(P_c-P_o)/P_o$, where P_c is first day closing price and P_o is offering price. *Oversubscription online (offline)* is equal to the number of shares individual (institutional) investors have applied for, divided by the number of shares available for sale to individual (institutional) investors. *Sales* denotes the total sales in Chinese Yuan of the firm in 2010 in logarithmic form. *EMPL* stands for employee number, which is the logarithmic of total employee number of the firm. *Volatility* is equal to the yearly stock market volatility and it is estimated as the standard deviation of daily stock returns from February 2011 to September 2011 of each firm multiplied by the square root of 252. *Salesgrowth* is the growth of total sales in 2010. *Leverage* is equal to the firm's total debt divided by total asset in the year of 2010, and it is in a percentage scale. *CAPEX* is equal to the capital expenditure over property plant and equipment. Median differences tested by means of Wilcoxon ranksum test. ***denotes significant at 1% level. ** denotes significant at 5% level. *denotes significant at 10% level.

	(1)With Pyramid	(2)No Pyramid	(3)Widely Held	Wilcoxon ranksum test		
variable	n=73 median	n=94 median	n=6 median	(1) and (2)	(1) and (3)	(2) and (3)
PBpreIPO	11.390	11.500	13.946	-0.110	-2.556	-2.446
IPO underpricing	0.346	0.397	0.261	-0.051	0.085	0.136
Oversubscription online	136	153	136	-17	0	17
Oversubscription offline	50.3	58.9	54.9	-8.7	-4.6	4.0
Sales (in log)	4.065	3.566	3.970	0.499***	0.095	-0.404
EMPL (in log)	6.522	6.226	6.359	0.296***	0.163	-0.133
Volatility (%)	48.8	49.8	49.6	-1.0	-0.8	0.2
Salesgrowth	0.336	0.278	0.270	0.058*	0.066	0.008
Leverage	14.537	10.312	11.760	4.225**	2.777	-1.448
CAPEX	8.070	4.800	11.050	3.270***	-2.980*	-6.250***

Table 3
Probit regression, the dependent variable is the pyramid indicator variable

In this table we use 167 closely held firms that listed on the growth enterprise market (GEM) in China in2010. Accounting data and stock market data are collected from Thomson One, and ownership information is manually collected by the authors. The dependent variable, *Pyramid*, is a binary variable that takes the value of one if the firm is in a pyramid structure and zero otherwise. *EMPL* stands for employee number, which is the logarithmic of total employee number of the firm. *Salesgrowth* is the growth of total sales in 2010. *Volatility* is equal to the yearly stock market volatility and it is estimated as the standard deviation of daily stock returns from February 2011 to September 2011 of each firm multiplied by the square root of 252. *State* is a dummy variable equals to one if the ultimate owner is the state, and zero otherwise. *Leverage* is equal to the firm's total debt divided by total asset in the year of 2010, and it is in a percentage scale. *CAPEX* is equal to the capital expenditure over property plant and equipment. Robust standard errors are reported in the parentheses. ***denotes significant at 1% level. ** denotes significant at 5% level. *denotes significant at 10% level.

	M1	M2	M3	M4	M5	M6
Sales	0.603***	0.552***	-	-	0.756***	-
	(0.216)	(0.194)			(0.166)	
EMPL	-	-	0.151	0.268*	-	0.377***
			(0.152)	(0.145)		(0.138)
Salesgrowth	0.356	0.348	0.588	0.605*	-	-
	(0.353)	(0.322)	(0.392)	(0.354)		
Volatility	-1.969	-1.331	-2.230*	-1.404	-	-
	(1.244)	(1.08)	(1.229)	(1.160)		
State	0.910*	1.087**	1.190***	1.307**	-	-
	(0.472)	(0.466)	(0.454)	(0.468)		
Leverage	0.006	0.006	0.010	0.010	-	-
	(0.009)	(0.008)	(0.011)	(0.0078)		
CAPEX	0.007	0.009	0.017	0.014	-	-
	(0.012)	(0.012)	(0.011)	(0.001)		
Constant	-1.407	-2.030**	-0.164	-1.779	-3.100***	-2.559***
	(1.1)	(0.885)	(1.209)	(1.094)	(0.651)	(0.889)
Industry Dummies	Yes	No	Yes	No	No	No
Pseudo-R^2	0.2348	0.1393	0.2057	0.1204	0.1009	0.0383
N	167	167	167	167	167	167

Table 4
Validity of instrument

This table reports the results of the bivariate regression between dependent variables in the second step of treatment effect models and the instrument. The instrument is *EMPL*, which is the logarithmic of total employee number of the firm. Our dependent variables are: *PBpreIPO* refers to (subscription) price to book ratio pre IPO, and is calculated as the offering price divided by net asset value per share (NAP) before IPO. *Underpricing*, is equal to $(P_c-P_o)/P_o$, where P_c is first day closing price and P_o is offering price. *Oversubscription online (Oversubscription offline)* is equal to the number of shares individual (institutional) investors have applied for, divided by the number of shares available for sale to individual (institutional) investors, note that both measures are in logarithmic form. Robust standard errors are reported in the parentheses.

	PBPreIPO	*Underpricing*	*Oversub. online*	*Oversub. offline*
EMPL	-0.255	-0.034	-0.029	0.065
	(0.366)	(0.035)	(0.051)	(0.065)
R^2	0.0016	0.0045	0.0018	0.0053
p-value F	0.486	0.334	0.572	0.319
N	167	167	167	167

Table 5
Treatment effect models with the (subscription) price to book ratio pre IPO (PBpreIPO) and IPO underpricing, respectively, as dependent variables.

In this table we use 167 closely held firms that listed on the growth enterprise market (GEM) in China in 2010. Accounting data and stock market data are collected from Thomson One and IPO data are from RESSET (www.resset.cn), industry classification is from China Securities Regulatory Commission (CSRC) Industry Classification, and ownership information is manually collected by the authors. In M1, the dependent variable, *PBpreIPO* refers to (subscription) price to book ratio pre IPO, and is calculated as the offering price divided by net asset value per share (NAP) before IPO. In M2, the dependent variable, *IPO underpricing*, is equal to $(P_c-P_o)/P_o$, where P_c is first day closing price and P_o is offering price. *Sales* denotes the total sales in Chinese Yuan of the firm in 2010 in logarithmic form. *Salesgrowth* is the growth of total sales in 2010. *Volatility* is equal to the yearly stock market volatility and it is estimated as the standard deviation of daily stock returns from February 2011 to September 2011 of each firm multiplied by the square root of 252. *State* is a dummy variable equals to one if the ultimate owner is the state, and zero otherwise. The endogenous binary variable, *Pyramid*, takes the value of one if the firm is in a pyramid structure and zero otherwise. The models are estimated by Maximum Likelihood, and robust standard errors are reported in parentheses. ***denotes significant at 1% level. ** denotes significant at 5% level. *denotes significant at 10% level. We use *EMPL* (employee number) as the instrument in the first step. In order to save space, only the results from the second step of treatment effect model are reported.

	Model 1 Second step *PBpreIPO*	Model 2 Second step *IPO underpricing*
Pyramid	-8.265***	0.446**
	(2.263)	(0.178)
Salesgrowth	2.986**	-0.054
	(1.262)	(0.291)
Volatility	-0.384	1.504***
	(3.215)	(0.291)
State	1.814	0.371***
	(1.677)	(0.141)
Sales	0.419	-0.081*
	(0.663)	(0.046)
Constant	15.872***	-0.093
	(3.371)	(0.195)
Industry dummies	*Yes*	*Yes*
N	167	167

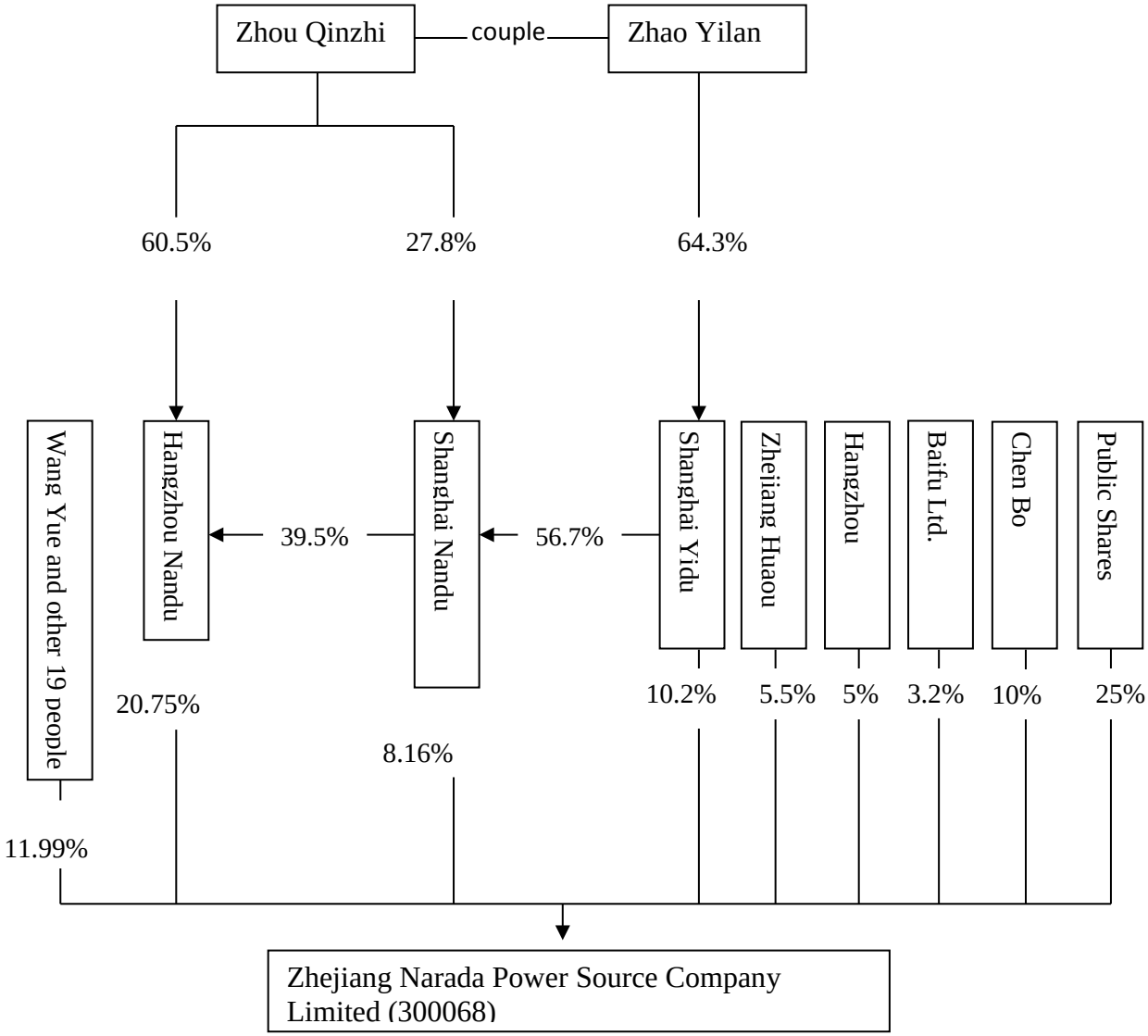
Table 6

Treatment effect models with oversubscription rate online/offline as dependent variables

In this table we use 167 closely held firms that listed on the growth enterprise market (GEM) in China in 2010. Accounting data and stock market data are collected from Thomson One and IPO data are from RESSET (www.resset.cn), industry classification is from China Securities Regulatory Commission (CSRC) Industry Classification, and ownership information is manually collected by the authors. In M1 (M2), the dependent variable *Oversubscription online (Oversubscription offline)* is equal to the number of shares individual (institutional) investors have applied for, divided by the number of shares available for sale to individual (institutional) investors, note that both measures are in logarithmic form. *Salesgrowth* is the growth of total sales in 2010. *Volatility* is equal to the yearly stock market volatility and it is estimated as the standard deviation of daily stock returns from February 2011 to September 2011 of each firm multiplied by the square root of 252. *State* is a dummy variable equals to one if the ultimate owner is the state, and zero otherwise. The endogenous binary variable, *Pyramid*, takes the value of one if the firm is in a pyramid structure and zero otherwise. The models are estimated by Maximum Likelihood, and robust-standard errors are reported in parentheses. ***denotes significant at 1% level. ** denotes significant at 5% level. *denotes significant at 10% level. We use *EMPL* (employee number) as the instrument in the first step. In order to save space, only the results from the second step of treatment effect model are reported.

	Model 1 Second step *Oversubscription online*	Model 2 Second step *Oversubscription offline*
Pyramid	0.085	1.033***
	(0.259)	(0.161)
Sales growth	-0.196	-0.038
	(0.148)	(0.095)
Volatility	1.722***	3.058***
	(0.439)	(0.360)
State	0.116	0.595
	(0.147)	(0.183)
Sales	-0.103	-0.171*
	(0.072)	(0.095)
Constant	4.192***	2.588***
	(0.375)	(0.503)
Industry Dummies	Yes	Yes
N	167	167

Appendix: Examples of pyramid ownership on the Growth Enterprise Market[23]



[23] Source: Wang (2013). One example of a pyramid structure on the Growth Enterprise Market is illustrated. The example shows how a (married) couple Zhou Qinzhi and Zhao Yilan controls Zhejiang Narada Power Source Company Limited through three intermediate companies-- Hangzhou Nandu, Shanghai Nandu Group and Shanghai Yidu. Zhou owns 60.53% of Hangzhou Nandu and 27.84% of Shanghai Nandu Group while Zhao owns 64.25% in Shanghai Yidu. Shanghai Yidu has a 56.67% stake in Shanghai Nandu Group which owns 39.47% of Hangzhou Nandu. The weakest link in the control chain is 20.75%+8.16%+10.24%=39.15%. However, cash-flow ownership is more complicated since each chain has to be multiplied separately, i.e. ((0.6053*0.2075+0.2784*0.0816+0.2784*0.3947*0.2075)+(0.6425*0.1024+0.6425*0.5667*0.0816+0.6425*0.5667*0.3947*0.2075))*100%=29.64%. Thus, this company is ultimately controlled by Zhou and Zhao through a pyramidal holding. In this case, there is a 9.51% difference between the control rights and cash flow rights due to the existence of the pyramid.