IMPLICATIONS OF STOCK OWNERSHIP RESTRICTIONS AND ASYMMETRIC COMPENSATION FOR EQUILIBRIUM ASSET PRICING: THEORY AND EMPIRICAL EVIDENCE

By

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Abstract

In China the shares open to foreign investors, $B$-Shares, have much lower prices relative to shares open to domestic investors, $A$-Shares. In Chapter I, we study the impact of the monopolistic government within a general equilibrium framework, and explain why $A$-Share prices are higher than $B$-Share prices. Further, we provide a possible explanation of the relative size of $A$- and $B$-Share markets in China. We also apply our analysis to other countries and find implications different from the literature, in addition to the use a unified model of demand elasticity and liquidity in asset pricing. Chapter II explores the link between fund manager compensation and asset pricing in a setting where managers receive a larger reward per $1$ profit than the penalty per $1$ loss. This type of compensation, which we call UMC, is common in China, and leads to interesting results. In the final Chapter, we test the implications of Chapter I and Chapter II. Regarding Chapter I, we examine the values of $A$- to $B$-Share price ratios, the relationship between international betas of individual firms and the share issuance decisions as well as the price ratios of $A$- to $B$-Shares, and the impact of market liquidity on asset prices. All the findings from these tests are consistent with predictions of our model. Further, we show that the regime-switching (governmental) risk from foreign exchange rates also matters. In our empirical examination of the implications of Chapter II, we employ a method with improved efficiency over Fama-MacBeth (1973) and Ferson and Harvey (1999), and find a negative risk-return relationship in China, which is statistically and economically significant.
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Chapter 1

Stock Ownership Restrictions and Asset Pricing in China

1.1 Introduction and Review of Literature

As financial markets evolve and the interest in emerging stock markets grows, more and more attention is being directed to both empirical and theoretical issues in international asset pricing. Examples include the papers by Stulz and Wasserfallen (1995) on Switzerland, Beiley and Jagtiani (1994) on Thailand, Domowitz, et al (1997) on Mexico, Hietala (1989) on Finland, and Bergstorm, et al (1993) on Sweden. The common phenomenon among these countries is a lower price of the shares restricted to domestic investors relative to that of the corresponding shares accessible to foreign
investors. In China, however, the price difference is the other way around: the shares restricted to domestic investors (A-Shares) have a higher price level than the corresponding shares accessible to foreign investors (B-Shares). Considering the sizable scale of Chinese economy and hence its potential of providing huge diversification benefit to international investors, the unique phenomena in Chinese stock markets are even more intriguing\(^1\) In this chapter, we study the situation in China and explain why the A-Share price level is higher than the B-Share price level. In addition, we offer an explanation for the structure of the dual market structure that has been developed in China. We also use our analysis to explain the situations in some other emerging markets outside China, and thanks to a more rigorous setup, our results have different implications than some previous studies in the literature, such as Hietala (1989) on Finland.

In brief, the argument in this paper is as follows. In China, domestic investors cannot invest in foreign markets because of strict investment controls. Therefore, Chinese investors, with fewer investment opportunities, are less sensitive to the price level of domestic shares. Meanwhile, all listed firms in China are state-owned enterprises (SOEs), and the government chooses the optimal issuing price and volume for each listed firm so as to maximize the value of state-owned property. This is akin to what a monopolist supplier would do in a free market. The monopolist government

\(^1\)Based on information from the World Bank in April 2002, the 2000 GDP of China (mainland only) ranks #6 in the world. Furthermore, Chinese economy has a global rank of #2 based on Purchasing Power Parity (PPP), 50% larger than Japanese economy, which ranks #3.
has the ability and incentive to discriminate between domestic and foreign investors by imposing ownership restrictions. We show in this paper that such a monopolist government will make \( A\)-Share prices higher than \( B\)-Share prices in equilibrium.

1.1.1 The Situation in China

There is a growing literature on Chinese stock markets, especially on price differences between \( A\)- and \( B\)-Shares. However, most of the papers take the ownership restrictions and the share supply as given, except for the concurrent study by Gordon and Li (2001) and us who have endogenized the investment restrictions by studying the government’s monopolistic decision in share supply. As explained in most economics textbooks such as Katz and Rosen (1998), third-degree price discrimination results in different prices for the same commodities in different markets. Meanwhile, as discussed later in this chapter, Chinese government is the monopolist behind all firms listed in Chinese stock markets. Therefore, it is important to study the role of the government in the investigation of the \( A\)- versus \( B\)-Share price differences in China. In the following, we are going to first review these papers who do not consider the government’s role as a monopolist in the equity market, and then move on to a comparison between Gordon and Li (2001) and our work.

In an intertemporal setting, Dongwei Su (1999) takes the ownership restrictions
as given, and explains the cross-sectional variations of $A$- and $B$-Share returns with international and domestic market betas. He does not consider the government’s decision on issuing $A$- and $B$-Shares, and offers no explanation for the higher $A$-Share price versus $B$-Share price. The similarity between Dongwei Su (1999) and our work is limited to the implication of the international and domestic betas for the cross-sectional differences between $A$- and $B$-Share price.

Fernald and Rogers (1998) point to the lack of investment opportunities for Chinese investors, and then assert that domestic investors require a lower rate of return which in turn offers an explanation for the higher prices of $A$-Shares relative to $B$-Shares. However, as in the paper by Dongwei Su, they do not model the government’s monopolist role in the supply of $A$- and $B$-Shares, and so can explain neither why the government has the incentive to impose the ownership restrictions, nor why the price of $A$-Share is always higher than that of $B$-Share. Moreover, they do not address the issue of why the size of $A$-Share market is larger than that of $B$-Share market. In fact, the argument in Fernald and Rogers (1998) is similar to what can be derived from a simplified version of our model with exogenous, rather than endogenous, supply of domestic shares.

There are also other types of explanations for the price differences between $A$- and $B$-Shares. Sarkar, Charkravarty, and Wu (1998) propose an explanation with information asymmetry. Chen, Li, and Rui (2000) explain the difference with liquidity.
Gordon and Li (2001) are the closest in spirit to ours. In their model, they also consider the decision-making process of the government and study the impact of the government's discriminating behaviour on pricing of different shares. Both Gordon and Li (2001) and our study are based on a static two-period model, with the supplies of A- and B-Shares being endogenized. In contrast, other papers on Chinese stock markets, such as Dongwei Su (1999) and Fernald and Rogers (1998), only develop a partial equilibrium where supplies of A- and B-Shares are exogenous. This is the major feature which discriminates the model by Gordon and Li (2001) and our work from other papers trying to explain the differences between Chinese A- and B-Share prices.

Despite the similarities between this paper and Gordon and Li (2001), some important differences do exist, such as how the model is set up and how the analysis is carried out. In the setup, Gordon and Li (2001) assume a different set of assets accessible to domestic investors, specifically non-state assets. After the inclusion of investment opportunities in non-state sectors, Gordon and Li (2001) have to argue that the covariance between Chinese non-state sectors and state sectors is smaller than the covariance between Chinese non-state sectors and foreign firms, in addition to other items in their list of presumptions for A-Share prices to be higher than B-Share prices. In our opinion, there is serious doubt whether this claim is true or not, for it is natural for the firms in China to vary more with each other than with foreign firms because of many unique characteristics of the Chinese economy. In fact, as
discussed earlier in this chapter, the opportunity to invest in non-public firms, which should be similar to non-state sectors referred in Gordon and Li (2001), is just the main reason why the level of $C$-Share prices is much lower than the price level of $A$-Shares. Another difference in Gordon and Li (2001) lies in the objective function of the government. After taking the social welfare into consideration, Gordon and Li (2001) infer that the government is giving a very low weight to individuals' utilities from consumption of personal wealth. In our opinion, their analysis means that the government is not really using the social welfare function as the objective function. In fact, we do not have the social welfare function in our setup, for it is our belief that the Chinese government does not care as much about the personal utilities of Chinese investors in $A$-Share markets as the revenue of the government. Moreover, our model derives the development path of Chinese $A$-Share versus $B$-Share markets, and our model explain more clearly the fact that the size of $A$-Share market is larger than the size of $B$-Share market in China, and the $A$-Share market was established earlier than $B$-Share markets.

A further difference between Gordon and Li (2001) and this chapter is that Gordon and Li allow the interest rate to be a controllable variable without considering intertemporal smoothing of consumption in their static one period model. Consequently, social welfare is always increasing when the government removes the restriction on domestic investors to invest abroad. To justify such restrictions, they have to assume that the government is putting little weight on individual consumption.
Moreover, only without intertemporal smoothing of consumption can they allow the government to raise more money by simply choosing a lower interest rate, as they assume in their model. This paper does not allow the government to raise more money from the stock market by changing the interest rate.

In addition, Gordon and Li (2001) do not relate to the literature as closely as us. They do not point out that the analysis of Chinese stock market can shed more light on the situations in other countries and related studies in the literature, such as Hietala (1989) and Bailey and Jagtiani (1994). We apply our analysis to other countries similar to China, such as Finland and Thailand, and offer an explanation for issues unexplained in previous studies on these countries. Meanwhile, we also derive different arguments for the high B-Share prices in these countries.

Some people may also argue that the price differences between A- and B-Shares may result from the different risk aversions between Chinese and international investors. On one hand, we show later in this chapter that the risk aversion coefficient does not matter in the price differences between A- and B-Shares owing to the monopolistic pricing by the government. On the other hand, Kachelmeier and Shehata (1992) do not find any significant difference in risk preferences between the Chinese and North American people. With student subjects at universities in China versus Canada and the U.S., they conducted a series of well-designed experiments giving real monetary payoffs, and then used the data to empirically determine whether any significant difference exist between the East and the West.
1.1.2 Ownership Restrictions in Other Countries

Both Gordon and Li (2001) and this paper are closely related to Stulz and Wasserfallen (1995), the pioneer study in the area, and Domowitz, Glen, and Madhavan (1997). The common feature among these studies is the setup of an equilibrium where a discriminating monopolist controls the supply of domestic shares. However, the ownership restrictions in China are different from those in Switzerland and Mexico, and so the analysis differs as well. Table 1.1 shows the key differences in market structure among different countries.

From the table, we can see that the situation in China is unique in the sense that domestic investors face ownership restrictions not only in the foreign market, but also in the domestic market.

Stulz and Wasserfallen (1995) are among the first who have developed a general equilibrium model with endogenous supply of listed stocks. However, in Stulz and Wasserfallen (1995) the differential demand of a firm’s shares comes from the difference in deadweight costs of investing abroad versus home, not from different sets of accessible securities as in our model. Such an assumption helps Stulz and Wasserfallen explain why the equivalent of B-Share prices are higher than A-Share prices in Switzerland. Meanwhile, it also fits well into the real situation in Switzerland, which
has a unique financial environment. Domowitz, Glen, Madhavan (1997) considered a similar framework based on ownership restrictions and explained the higher price of Mexican shares issued to foreign investors. Both papers are close to what we do in the modeling of a monopolist supplier in the stock markets.

Another class of papers on international market segmentation, including Eun and Janakiramanan (1986), Errunza and Losq (1985), Eun and Janakiramanan (1986) and Basak (1996), take the supply of shares as given. These papers are mostly based on a static two-period model, and while their analysis is related to ours, it is not as close as Stulz and Wasserfallen (1995) and Domowitz, Glen, and Madhavan (1997). Eun and Janakiramanan (1986) are among the first to study how the price can be different for identical shares issued by the same company in segmented markets. Errunza and Losq (1985) build a two-country model where investors in one country have free access to the stock market of the other country, but not vice versa. Eun and Janakiramanan (1986) further extend the model to a multi-country framework and conduct a welfare analysis. Basak (1996) put together different degrees of market segmentation and examines welfare implications when switching between different market structures.

1.1.3 Outline of This Study

Overall, the Chinese capital market is of particular interest in the study of market segmentation because it differs from other countries not only in the sign of $A$- and
B-Share price differences, but also in the structure of ownership restrictions. Consequently, it is a valuable source for the further study in the area of market segmentation both in theory and empirical analysis. This paper develops a static one-period model to study the situation in China. The price level of A- and B-Shares are determined in the equilibrium with supply of A- and B-Shares being endogenized. Rather than an anomaly, the higher prices of A-Shares than those of B-Shares in China are shown to be the normal situation when the supplier of domestic shares, the Chinese government, has monopoly power. In the setup, we assume there are only two countries, a domestic country and a foreign country, both of which have a limited number of firms and atomistic investors. Domestic firms issue two series of shares which are represented by A-Shares and B-Shares respectively, with A-Shares restricted to domestic investors and B-Shares restricted to foreign investors. Foreign firms issue only one type of shares which are not accessible to domestic (Chinese) investors owing to the capital control in the domestic country. Considering the small scale of Chinese B-Share Market relative to the world capital market, the prices of foreign shares are set to be constant so that we can focus on the pricing of A- and B-Shares in China. The markets for riskless assets are perfectly integrated in and outside China, and the riskless rates are exogenous and identical across countries. Finally, the setting assumes no friction costs or other forms of imperfections in the stock markets except for the ownership restrictions.

To study investors’ problems, we assume that each investor maximizes his period
utility by dividing his endowed wealth among risky and riskless assets. The major
difference between a domestic investor’s problem and a foreign investor’s problem is
that the foreigner has a larger set of investment opportunities which contains not
only domestic shares but also foreign shares. In the analysis of the investors’ demand
functions, it can be inferred that the lack of the opportunity to invest in foreign risky
assets tends to make A-Share prices higher than they would otherwise be, but before
endogenizing the supply, one cannot tell whether A-Share prices shall be higher than
B-Share prices or not.

After studying the investors’ problems, we go on to solve the government’s prob­
lem of share supply, namely how many A- and B-Shares to issue respectively. Unlike a
firm in the foreign market which faces a competitive market, the domestic government
acts as a monopolist and can discriminate between domestic and foreign investors by
imposing ownership restrictions. Trying to maximize the state-owned fraction of do­
mestic firms’ payoff while raising a fixed amount of capital, the government chooses
the optimal level of supply of A- and B-Shares respectively. The government’s prob­
lem here is not the same as in Stulz and Wasserfallen (1995) and Domowitz, Glen,
and Madhavan (1997) although it is close to them in spirit, especially the one in Stulz
and Wasserfallen (1995). On one hand, the setting here is more consistent with the
real situation in China by not allowing domestic investors to invest abroad. On the
other hand, unlike the assumption of a fixed amount of domestic shares to sell in
Stulz and Wasserfallen (1995), this paper assume a fixed amount of capital to raise,
which allows us to derive the explicit relationship between the supply of shares in the
A- and B-Share Markets.

Putting together the results from both the government’s and investors’ budget
maximization problems, we show clearly that A-Share prices are higher than B-Share
prices regardless of relative numbers of investors in the A- and B-Share markets.
Relative to previous studies on Market Segmentation in other countries, our work
obtains streamlined results based on a standard setting with no friction costs in the
market. Such a standard setting in our model allows us to focus on the consequences
of the core issues in Chinese stock markets: unequal investment opportunities and
the government’s discriminating power.

In what follow we see that the optimal choice of supply involves the government
issuing only A-Shares as long as the total capital to be raised falls below a certain
threshold. If the capital to be raised exceeds this threshold, B-Shares are issued. It
offers an explanation of the size of B-Share Market relative to A-Share Market.

We also extend our model to incorporate the liquidity factor, which is an addi­
tional channel to explain A- and B-Share price differences.

This chapter proceeds as the following: Section 2 gives an introduction to the
Chinese stock market, and Section 3 sets up the model and solves the problems of
different groups of investors and the monopolistic government. Then Section 4 goes
on to analyze the differences in prices and amounts of supply between A- and B-
Shares in equilibrium. After giving a simplified approach in Section 5, we extend our study to include the liquidity factor in Section 6, and further possible extensions in Section 7. Section 8 concludes the chapter.

1.2 Chinese Stock Markets

The shares issued by Chinese firms have a complicated structure. For a better understanding of the model used to characterize this structure and investigate its implications, this section provides an introduction of the background information related to Chinese stock markets.

1.2.1 Development of Chinese Stock Markets

In 1984, Shanghai Feile Audio Corporation made its initial public offering, the first of its kind since the founding of the People's Republic of China in 1949. Two years later, after a few other IPOs, Shanghai, Shenyang and Shenzhen began engaging in unofficial over-the-counter trading of stocks until the Shanghai and Shenzhen Stock Exchanges officially went into operation at the beginning of 1990s. The Shanghai Stock Exchange was established in December 1990, and the Shenzhen stock exchange formally went into operation in July 1992 after obtaining final approval in April of the
same year. These are the only two stock exchanges in China where $A$- and $B$-Shares\textsuperscript{2} are traded.

There were also two other small stock markets in Beijing: Security Trading and Automatic Quote System (STAQS) and National Electronic Trading System (NETS). These exchanges went into operation in July 1992 and April 1993 respectively. However, only C shares\textsuperscript{3} were listed, and the number of listing firms in each market was very small — 8 in STAQS and 7 in NETS as of 1997. The stocks were very thinly traded in these two markets, and it was not uncommon for a firm to have no trading for many consecutive days. In 1999 the government closed these two markets.

In addition, there are also 6 other securities trading centers for bonds and money funds including Shenyang, Wuhan and Tianjin. No stocks are listed in these trading centers.

In 1992, the first $B$-Series was listed in Shanghai Stock Exchange. By October 1999, in total there were 462 $A$-Series and 54 $B$-Series shares listed on the Shanghai Stock Exchange, and 441 $A$-Series and 54 $B$-Series shares listed on the Shenzhen Stock Exchange. By the end of December 2001, in total there were 636 $A$-Series and 54 $B$-Series shares listed on the Shanghai Stock Exchange, and 494 $A$-Series and 56

\textsuperscript{2}In this subsection, the term B-Shares does not include H Shares. H Shares are those available only to investors in Hong Kong Stock Exchange.

\textsuperscript{3}C Shares are also called Legal Person Shares, which are issued only to corporations and/or institutional investors. See next subsection for details.
B-Series shares listed on the Shenzhen Stock Exchange. The numbers of all listed firms are 646 and 517 in the Shanghai Stock Exchange and Shenzhen Stock Exchange respectively. Based on the statistics of year 2001, the combined market value of the firms listed on the two stock exchanges has now exceeded that of the Hong Kong Stock Exchange, and the average daily turnover is more than double that of the HKSE.

One other important feature to note is that short sales are prohibited in both A- and B-Share markets.

1.2.2 The classes of shares issued by Chinese firms

In China, many different classes of shares are issued by the same firms. Different series of shares generally have the same voting rights and identical claims on the issuing firms’ payoffs, though they have different ownership restrictions and negotiability. In the following, the different classes of shares are divided into two big categories based on the nationality of shareholders: domestic investors and foreign investors.

1. Shares Accessible to Domestic Investors

   • Public Individual Shares (A-Shares): Accessible to all domestic investors. Listed in Shanghai Stock Exchange or Shenzhen Stock Exchange. Denominated in RMB.

   • Employee Shares: Only accessible to the employees of a listing firm before
it went public. Not negotiable at time of issuance, but generally convertible to *A-Shares* a few years after the time of initial public offering upon approval by the government.

- **Legal-person shares (Corporate shares, or C shares):** accessible to domestic corporations or institutions, but not to individuals. In general, such shares are non-negotiable, though a few companies’ C shares were listed and thinly traded in STAQS and NET. However, as mentioned earlier, both STAQS and NET were closed in 1999, and none of the firms listed in STAQS or NET had ever been cross-listed in other domestic or international stock exchanges.

- **State Shares:** The shares kept by the national government. They are nontransferable.

2. Shares Accessible to Foreign Investors

- **B-Shares**: Listed in the Shanghai Stock Exchange (SHSE) or the Shenzhen Stock Exchange (SZSE). These are denominated in US$ on the Shanghai Stock Exchange and in HK$ on the Shenzhen Stock Exchange.

- **H shares**: Listed in the Hong Kong Stock Exchange (HKSE), denominated in HK$.

- **ADR/N shares**: Listed in the New York Stock Exchange, denominated in US$. So far only a few firms in China have issued such shares, and few
of them are cross-listed in other stock exchanges such as SHSE, SZSE, or HKSE.

Although our analysis in this chapter covers only *A-Shares* and *B-Shares*, it may also be used to justify the existence of other types of share, such as *C-Shares*. Like *B-Share* prices, *C-Share* prices are also much lower than *A-Share* prices[^4]. This may be explained with different price elasticities of demand between different group of investors as well. Corporations can invest in non-public sectors (non-state sectors or private state sectors that are not available in stock markets) inside China, and hence have different investment opportunities than individual investors because of the difficulty for individuals to invest in non-public sectors in China. Therefore, the government can benefit from price discrimination between the two different groups of investors in China: corporations and individuals. This offers an explanation why *C-Shares* exist, and why *C-Share* prices are much lower than *A-Share* prices. However, we choose not to discuss issues related to *C-Shares* any further since the logic is quite similar to our following analysis of *A-Shares* and *B-Shares* in this chapter.

For these people who are concerned about why institutional investors still purchase *A-Shares* with opportunities to purchase *C-Shares* and/or invest in non-state sectors, please note that institutional investors in *A-Share* markets normally demand high

[^4]: Such a comparison of prices are based on information from two dimensions. First, P/E ratios, MV/BV ratios, and P/Sales ratios in the STAQS and NET are lower than corresponding ratios in SHSE and SZSE on average. Second, the IPO prices of *C-Shares* are lower than IPO prices of *A-Shares* issued by the same firms.
liquidity of their investment, while C-Shares obviously have very poor liquidity.

In this chapter, we focus our attention to the classes of shares that are negotiable — A-Shares and B-Shares. In what follows, the term B-Shares refers to all the shares owned by foreign investors.

1.3 The Model

1.3.1 Setup

For simplicity, this paper uses a static one-period model. There are only two countries, domestic country D and Foreign country F. The domestic country represents China, and the foreign country stands for the rest of the world.

There are $m_d$ domestic firms and $m_f$ foreign firms. Foreign firms issue only one type of share, $F$, which are available only to foreign investors because of capital outflow restrictions in the domestic country. Domestic firms issue two types of shares denoted by A-Share and B-Share respectively. A-Shares are open to domestic investors only, and B-Shares are open to foreign investors only. A-Shares and B-Shares are identical in every sense except for ownership restrictions\(^5\).

\(^5\)Although the distribution policy of a Chinese firm might differ slightly across different types of shares so as to match the diverging interests of different shareholders, most firms choose exactly the same distribution policy for both A- and B-Shares
The following assumptions are made in this model:

1. Differential investment opportunities. As stated above, the set of risky assets available to foreign investors consists of foreign shares and domestic B-Shares, while that available to domestic investors includes only A-Shares.

2. Market perfection. The markets are perfect except for ownership restriction. That is, there are no transaction fees, no friction costs, no information costs, etc.

3. Atomistic investor and monopolistic government. The demand in both domestic and foreign market is competitive, hence each investor has little power to influence the market price. However, it is different for the supply side because the domestic government that chooses the number of A- and B-Shares to issue acts as a monopolist.

4. Interest rate parity. The money market is well integrated, and the two countries have the same real interest rate.

5. Constant Absolute Risk Aversion (CARA) utility function. Both domestic and foreign investors have the following CARA utility function: \( U(\tilde{w}) = -\exp\{-a\tilde{w}\} \), \( a > 0 \). The coefficient \( a \) is identical across different investors. Kachelmeier and Shehata (1992) have conducted a test on the risk preferences with experiments done in China, Canada, and the US. They do not find any difference between Chinese and North American people, and so there is no reason for us to assume
otherwise in this chapter. Anyhow, it is shown later that our result holds even if the risk aversion coefficients do differ.

The government is also assumed to have a CARA utility function of state-owned wealth, which means that the objective of the government is to maximize the standard mean variance equivalent of state-owned assets. In fact, in the case of one single asset in Chinese equity market, the choice between a risk-averse and risk-neutral government does not make any difference in the results of this model, for maximizing the mean variance equivalent of state shares is equivalent to maximizing the mean of state shares. In the case of multiple assets, an alternative assumption of a risk-neutral government will drive the government to issue more shares of less risky state-owned firms so as to take advantage of the higher valuation of firms with less risk by the investors. Meanwhile, the government still discriminates between $A$- and $B$-Share investors, and hence the aggregate price differences between $A$- and $B$-Shares are expected to remain similar. This will become clearer by end of the analysis in this chapter, though we are not going to give formal analysis based a risk-neutral government since we believe that both the decision makers of the government and the Chinese citizens, whose interests are supposed to be represented by the government, are risk-averse individuals as well.

6. Different numbers of investors. The number of investors in $A$-Share market is $n_a$, and the number of investors in $B$-Share market is $n_b$. These parameters
are included to measure the potential impact on share prices from differential demands across markets.

7. Normal distribution of the final payoff. The liquidating payoffs of both domestic and foreign firms at end of the period follow a multi-normal distribution, with the covariance being strictly positive\(^6\). \(\bar{\pi}_d\), the vector of \(m_d\) domestic firms' payoffs, follows multi-normal distribution \(N(\bar{\mu}_d, \Omega_D)\). \(\bar{\pi}_f\), the vector of \(m_f\) foreign firms' payoffs, follows multi-normal distribution \(N(\bar{\mu}_f, \Omega_F)\). The covariance matrix among domestic and foreign firms' future payoffs is \(\Omega_{DF}\).

8. The prices of foreign shares are given. This is consistent with the fact that the Chinese stock market is very small relative to the size of international capital markets.

9. Unlimited riskless lending and borrowing. In the market, each investor can either borrow or lend unlimited amount of money at the riskless rate \(r\). The net amount of investors' aggregate lending or borrowing can be nonzero, which

\(^6\)There is a potential problem with the normal distribution. The payoffs of stocks are lower bounded by 0, while the normal distribution allows for negative payoff, though the possibility can be made very small by choosing reasonable parameters. In this aspect, lognormal distribution may be better in modeling. However, this chapter uses only a one-period model limiting the difficulties, and the lognormal distribution also has its disadvantages. For example, a linear combination of lognormal variables does not follow lognormal distribution any more, while a linear combination of normal variables is still a normal variable. This gives normal distribution a great advantage over lognormal distribution when two or more risky assets are involved in the modeling, as in this chapter.
is supposed to be cleared by an outside agent.

10. No short sales. Short sales are not allowed in Chinese stock markets.

For ease of notation, we define

\[
\gamma = \begin{bmatrix}
\gamma_D & \gamma_{DF} \\
\gamma'_{DF} & \gamma_F
\end{bmatrix} = \begin{bmatrix}
\Omega_D & \Omega_{DF} \\
\Omega'_{DF} & \Omega_F
\end{bmatrix}^{-1} = \Omega^{-1}, \quad (1.1)
\]

where \( \Omega \) is the variance-covariance matrix of both domestic and foreign firms. The vector of expected payoffs for the \( m_d \) domestic firms and \( m_f \) foreign firms is \( \bar{\mu} = [\bar{\mu}_D, \bar{\mu}_F]' \), the demand of domestic investor \( i \) for domestic assets is \( \bar{D}_i = \bar{D}_{A,i} \), the vector of foreign investor \( j \)’s demand for domestic and foreign firms is \( \bar{D}_j = [\bar{D}'_{B,j}, \bar{D}'_{F,j}]' \), the price vector of domestic assets for domestic investor \( i \) is \( \bar{P}_i = \bar{P}_A \), and the price vector of domestic and foreign shares for foreign investor \( j \) is \( \bar{P}_j = [\bar{P}'_B, \bar{P}'_F]' \).

Note that supplies of \( A- \) and \( B-Shares \), \( \bar{S}_a \) and \( \bar{S}_b \), are proportions of domestic firms’ equity. The total outstanding shares of each firm is normalized to 1 unit, which is infinitely divisible among investors. Correspondingly, the demand of each investor is also a relative demand. For consistency with normal terminology, despite the normalization to a single divisible share, we nevertheless use the term \( shares \), the plural form of the word \( share \), when referring to the amount of demand or supply in this chapter.

In this one period model, the vector of foreign share prices and the riskless interest rate are exogenous. At the beginning of the period, every investor maximizes his
expected utility at end of the period. Meanwhile, by choosing the optimal amount of
A- and B-Shares to issue, the government minimizes the proportion of \( \bar{\pi}_d \) rendered
to all A- and B-Share investors while meeting the requirement of raising the pre-
determined amount of capital, \( K \). Thus, both the share prices and the amount of
supply in the domestic market are endogenized in the equilibrium.

1.3.2 Domestic Demand

At the beginning of the period, a representative domestic investor \( i \) maximizes his
expected end-of-period utility by choosing his investment portfolio subject to bud­
get constraints. Since B-Shares and foreign shares are not accessible to domestic
investors, investor \( i \) can only allocate his endowed wealth \( W_0^i \) between \( m_d \) domestic
firms and riskless assets. Denoting investor \( i \)'s investment in domestic firms as vector
\( \bar{D}_{A,i} \) and the amount of investment in riskless assets as \( C_i \), we can write investor \( i \)'s
maximization problem as:

\[
\max_{\bar{D}_{A,i}, C_i} E[U(\bar{w}_1^i)] = E[-\exp{-aw_1^i}] \quad (1.2)
\]
s.t.

\[
W_0^i = \bar{D}_{A,i}^i \bar{P}_A + C_i
\]
\[
\bar{w}_1^i = \bar{D}_{A,i}^i \bar{\pi}_d + (1 + r)C_i
\]
\[
\bar{D}_{A,i} \geq \bar{0}
\]
In the problem above, the first constraint is the budget constraint, and the second one gives the end-of-period wealth \( \bar{w}^i \). \( \bar{P}_A \) is the price vector of A-Shares, which is taken as given by investor i because the market is competitive. \( \bar{D}_{A,i} \) is investor i's demand for A-Shares, and the end of period payoff from such investment is \( \bar{D}'_{A,i} \bar{p}_d \). The riskless rate is \( r \), and so \( r C_i \) is the end-of-period return on the investment \( C_i \). From the no short sale constraint, we know that \( \bar{D}_{A,i} \) is non-negative.

Since the end-of-period payoffs of domestic firms follow multi-variate normal distribution, it is well-known that investor i's objective is equivalent to maximizing the certainty equivalent of his end-of-period wealth:

\[
\max_{\bar{D}_{A,i}} \text{CEQ}_i = \bar{D}'_{A,i} (\mu_d - (1 + r) \bar{P}_A) + (1 + r) W_0 - \frac{a}{2} \bar{D}'_{A,i} \Omega_D \bar{D}_{A,i} 
\]

(1.3)

Taking the first order condition w.r.t. \( \bar{D}_{A,i} \), and rearranging, yields

\[
\bar{P}_A = \frac{\bar{\mu}_D - a \Omega_D \bar{D}_{A,i}}{1 + r} 
\]

(1.4)

The market price vector of A-Shares must satisfy the market clearing condition \( n_a \bar{D}_{A,i} = \bar{S}_A \). Substituting (1.4) into \( n_a \bar{D}_{A,i} = \bar{S}_A \) and solving out \( \bar{P}_A \), yields

\[
\bar{P}_A = \frac{\bar{\mu}_D - \frac{a}{n_a} \Omega_D \bar{S}_A}{1 + r} 
\]

(1.5)

where \( \bar{S}_A \) is the total supply of A-Shares set by the government, and \( n_a \) is the total number of A-Share investors. The first term on the right side of (1.5), \( \bar{\mu}/(1 + r) \), is
the expected payoff discounted at riskfree rate. The second term on the right hand side of (1.5), \(-\frac{a}{n_A} \Omega_D \tilde{S}_A/(1 + r)\), is investor i’s price of risk.

From equation (1.4), we can get the elasticities of investor i’s demand with regard to A-Share prices. Since it is easier to see the economic meaning of the formula under a scalar case, we consider the situation where only one domestic firm is listed in the stock market. In this case, the elasticity of investor i’s demand is as follows

\[
\varepsilon_i = \frac{\partial D_{A,i}}{\partial P_A} \frac{P_A}{D_{A,i}} = \frac{1}{1 - \mu_D[P_A(1 + r)]^{-1}}
\]  

(1.6)

From the aggregate demand function for domestic investors, which is the same as equation (1.5), we get exactly the same elasticity of demand as shown in equation (1.6). This indicates that the number of investors doesn’t change the aggregate elasticity of demand because they are identical. Following the same logic, we can also infer that the coefficient \(a\) doesn’t change the aggregate elasticity of demand either. However, the different investment opportunities may result in different elasticities of demand, which is to be shown in next subsection through consideration of the foreign investors’ demand function.

As discussed in economics textbooks and earlier literature on price discrimination, such as Tirole (1988) and Stulz and Wasserfallen (1995), a monopoly can benefit from price discrimination when different groups of customers have different elasticities of demand and cannot trade with each other. In next subsection, we will study the demand function of foreign investors and see whether they have a different elasticity
of demand.

1.3.3 Foreign Demand

Unlike domestic investors, foreign investors can invest not only in domestic shares, but also foreign shares. In this subsection, we study how such a different set of investment opportunities will affect the foreign investors' demand function. A representative foreign investor, j, has access to B-Shares, F-Shares, and riskless assets. Endowed with an initial wealth of $W_0^j$ at the beginning of the period, investor j chooses the optimal portfolio of stocks and riskless assets so as to maximize his expected utility at end of the period. Mathematically, investor j’s budget maximization problem can be written as:

$$\max_{\bar{D}_{B,j}, \bar{D}_{F,j}, C_j} \quad E[U(\bar{w}_j^i)] = E[-exp\{-a\bar{w}_j^i\}]$$

s.t.

$$W_0^j = \bar{D}_{B,j}^i \bar{P}_B + \bar{D}_{F,j}^i \bar{P}_F + C_j$$

$$\bar{w}_j^i = \bar{D}_{B,j}^i \bar{\pi}_d + \bar{D}_{F,j}^i \bar{\pi}_f + (1 + r)C_j$$

$$\bar{D}_{B,j} \geq 0$$

where $\bar{D}_{B,j}$ and $\bar{D}_{F,j}$ denote the numbers of B and F shares in investor i’s portfolio, and $\bar{P}_B$ and $\bar{P}_F$ are the prices for B and F Shares at the beginning of the period. Other notations are the same as earlier in this chapter.
Similar to investor i’s maximization problem, we get the first order conditions of (1.7):

$$
\begin{align*}
\begin{bmatrix}
\bar{D}_{B,j} \\
\bar{D}_{F,j}
\end{bmatrix}
&= \frac{1}{a}
\begin{bmatrix}
\Omega_D & \Omega_{DF} \\
\Omega'_{DF} & \Omega_F
\end{bmatrix}^{-1}
\begin{bmatrix}
\bar{\mu}_D - (1 + r)\bar{P}_B \\
\bar{\mu}_F - (1 + r)\bar{P}_F
\end{bmatrix} \\
&= \frac{1}{1 + r}
\begin{bmatrix}
\Omega_D & \Omega_{DF} \\
\Omega'_{DF} & \Omega_F
\end{bmatrix}
\begin{bmatrix}
\bar{D}_{B,j} \\
\bar{D}_{F,j}
\end{bmatrix}
- \begin{bmatrix}
\bar{\mu}_D \\
\bar{\mu}_F
\end{bmatrix}
\end{align*}
$$

That is,

$$
\begin{align*}
\begin{bmatrix}
\bar{P}_B \\
\bar{P}_F
\end{bmatrix}
&= \frac{1}{1 + r}
\begin{bmatrix}
\Omega_D & \Omega_{DF} \\
\Omega'_{DF} & \Omega_F
\end{bmatrix}
\begin{bmatrix}
\bar{D}_{B,j} \\
\bar{D}_{F,j}
\end{bmatrix}
- \begin{bmatrix}
\bar{\mu}_D \\
\bar{\mu}_F
\end{bmatrix}
\end{align*}
$$

Rearranging to obtain $\bar{P}_B$

$$
\bar{P}_B = \frac{1}{1 + r}[\mu_D - a(\Omega_D - \Omega_{DF}\Omega^-1_{DF})\bar{D}_{B,j} - \Omega_{DF}\Omega^-1_F(\bar{\mu}_F - (1 + r)\bar{P}_F)]
$$

Substituting the market clearing condition $n_b\bar{D}_{B,j} = \bar{S}_B$ into the equation above, gives

$$
\bar{P}_B = \frac{1}{1 + r}[\mu_D - \frac{a}{n_b}(\Omega_D - \Omega_{DF}\Omega^-1_{DF})\bar{S}_B - \Omega_{DF}\Omega^-1_F(\bar{\mu}_F - (1 + r)\bar{P}_F)]
$$

The first term on the right side, $\mu_D/(1 + r)$, is the expected payoff discounted at the riskfree rate. We leave aside the economic meaning of the second term until after we have discussed the meaning of the third term.

The third term on the right side, $\Omega_{DF}\Omega^-1_F(\bar{\mu}_F - (1 + r)\bar{P}_F)/(1 + r)$, is the price of domestic firms’ foreign risk. $\bar{\mu}_F - (1 + r)\bar{P}_F$ can be taken as the price of foreign risk, and $\Omega_{DF}\Omega^-1_F$ is the Beta Matrix which measures the amount of undiversified foreign
risk of domestic firms' payoffs\textsuperscript{7}.

Now we return to the meaning of the second term. We can rewrite the second term as \( \frac{\sigma}{\mu}(I-\Omega_{DF}^{-1}\Omega_F^{1}\Omega_{DF}^{-1})\Omega_D\tilde{S}_B \), where \( I \) is the identity matrix of dimension \( m_d \) and \( \Omega_{DF}^{-1}\Omega_F^{1}\Omega_{DF}^{-1} \) is the correlation matrix between domestic and foreign firms\textsuperscript{8}. Hence, the second term is the price of aggregate foreign investors' portfolio's pure domestic risk that is uncorrelated to foreign firms' payoffs. In short, equation (1.11) shows that the price of \textit{B-Shares} is composed of three parts: the expected payoff, the price of foreign risk, and the price of pure domestic risk.

From the above, we see that the \textit{B-Share} price has different components from the \textit{A-Share} price because of the different investment opportunities available to domestic and foreign investors. Therefore, it is natural to conjecture that foreign investors' aggregate elasticity of demand is different from that of domestic investors, in which case the government will have the incentive to offer the same shares at different prices to the two groups of investors. To have a close look at the difference between foreign and domestic investors' elasticity of demand, we calculate foreign investor j's elasticity of demand in the case of one firm in each country. Since (1.10) collapses to

\textsuperscript{7}If we assume there is only foreign asset, which is the market index of the foreign stock market, then \( \Omega_{DF}^{-1}\Omega_F^{1} \) is exactly the vector of domestic firms' betas with the foreign market index being the benchmark portfolio.

\textsuperscript{8}In the case of one domestic firm and one foreign firm, it is easy to see that the correlation matrix \( \Omega_{DF}^{-1}\Omega_F^{1}\Omega_{DF}^{-1} \) reduces to \( \rho^2 \), where \( \rho \) is the standard moment correlation between the domestic firm's payoff and that of the foreign firm.
\[ D_{B,j} = -[\alpha \Omega_D(1 - \rho^2)]^{-1}\{(1 + \tau)P_B - \mu_d \Omega_D \Omega_F^{-1}[\mu_f - (1 + \tau)P_F]\} \] in the case of \( m_d = m_f = 1 \), investor j’s elasticity of demand is

\[ \varepsilon_j = \frac{\partial D_{B,j}}{\partial P_B} \frac{P_B}{D_{B,j}} = 1/(1 + \frac{-\mu_d + \Omega_D \Omega_F^{-1}(\mu_f - (1 + \tau)P_F)}{P_B(1 + \tau)}) \] (1.12)

Comparing (1.6) with (1.12), we can see that foreign investors' elasticity of demand is different from that of domestic investors. From previous studies on price discrimination such as documented in Tirole (1988), such a difference in elasticity of demand should enable the government to profit from price discrimination.

The sign of elasticity of demand should be negative, while the sign of \( \Omega_D \Omega_F^{-1}(\mu_f - (1 + \tau)P_F) \) should be positive in general, and so (1.6) has a smaller absolute value than (1.12) as long as \( P_A = P_B \). This means that domestic investors, because of the investment restrictions on foreign stocks, have more inelastic demand than foreign investors. Hence, we can infer that it is better for the government to charge the domestic investors a higher price when issuing shares of domestic firms.

As in the case of aggregate demand function of domestic investors, the aggregate demand function of foreign investors depends on neither the number of foreign investors nor the value of coefficient \( \alpha \) in foreign investors' utility function. Therefore, the different elasticities of demand between domestic and foreign investors result from different investment opportunities, not different numbers of investors or different degrees of risk aversion. In other words, the ownership restrictions imposed by the government make price discrimination not only feasible, but also profitable to the
1.3.4 The Supply

In this section we investigate the government's choice of the optimal amount of $A$- and $B$-Shares to issue for each listed firm. It is assumed that the government must raise a certain amount of capital, $K$, by selling a percentage ownership of state-owned firms. $A$-Shares and $B$-Shares are the claims sold to the domestic and foreign investors respectively, and State Shares are the remaining claims to be kept by the government. The objective of the government is to maximize its utility from the consumption of State Shares at end of the period subject to the budget constraints. Assuming the utility function of the government is also of CARA type, the government's objective is equivalent to maximizing the certainty equivalent of state-owned claims on listed firms' future payoffs.

Here is a key difference between the model by Gordon and Li (2001) and ours. In Gordon and Li (2001), the government's objective function is a social welfare function where the government tries to maximize a combined utility from individuals' consumption of state-owned property and personal investment. In this chapter, it is implied that the government gives no or little weight to stock investors' utility from consumption of personal investment. As discussed later, the real situation in China indicates that the government does give little weight, if any, to stock investors'
personal utility.

There have been expressed interests in discussing possible alternative objective functions of the government. For example, the government may try to maximize the foreign reserve rather than just only the market value of state-owned shares. A government may need to do so when facing a deficit in foreign reserve, in which case the fund raised from issuing *B-Shares* means more to the government than its market value. However, this is not true in China, for there is a huge foreign reserve in the Central Bank of China. In fact, the foreign reserve in China ranks #3 in the world, which guarantees the government credible ability of paying back foreign loans in a timely manner. Therefore, this alternative objective function is not considered in our model.

There are a number of reasons why the assumptions in this model, as discussed in the above, are consistent with the real situations in China. First, only state-owned firms can go public, and the government picks up the firms and sets the amount of shares to issue as well as the level of initial offering price. Therefore, in China one need not worry much about the interplay among different firms’ strategies, for in reality the government is the single decision maker behind all the firms. Second, each firm must specify the amount of capital to raise and which project to invest in their IPO or SEO application, which is to be reviewed by the government for approval. It implies that the number of shares to offer should depend on the amount of capital needed to finance the firm's project. Third, the investors in China composes only a
small portion of the Chinese nationals, and this offers a reason why the government need not consider the stock investors' utility from personal investment.

In short, the objective of the government in our model is to maximize the certainty equivalent of State Shares' end-of-period payoffs. Mathematically, the government faces the following problem:

$$\max_{S_A, S_B} \tilde{\mu}_D(\bar{I}_m - \bar{S}_A - \bar{S}_B) - \frac{a}{2}(\bar{I}_m - \bar{S}_A - \bar{S}_B)'\Omega_D(\bar{I}_m - \bar{S}_A - \bar{S}_B)$$  \hspace{1cm} (1.13)

s.t.

$$\tilde{P}_A'(S_A)S_A + \tilde{P}_B'(S_B)S_B = K$$ \hspace{1cm} (1.14)

$$\bar{S}_A \geq 0, \bar{S}_B \geq 0$$ \hspace{1cm} (1.15)

where $\tilde{P}_A'(S_A)S_A$ and $\tilde{P}_B'(S_B)S_B$ are defined as in (1.5) and (1.11). Assuming that (1.15)

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9By the end of 1999, around 2% of Chinese have opened accounts in the stock markets, and only a portion of the account holders actively invest in the markets. Moreover, to protect the interests of the general public rather than just only the stock investors, the government prohibit Chinese insurance companies and various funds from investing in the Chinese stock markets, for the government considers the stock markets are too risky to be reliable investment instruments for these funds whose performance has important impact on social stability. Thus, most of the Chinese do not invest in the stock markets, no matter directly or indirectly. Recently the government begins to relax such investment restrictions on some insurance companies and investment funds, but there are still significant barriers imposed by the government for these funds to freely invest in stock markets.
is not binding, get the first order conditions of (1.13) as the following:

\[ a\Omega_D(T_{m_d} - S_A - S_B) - \mu_D - \lambda[P_A + \left(\frac{\partial P_A(S_A)}{\partial S_A}\right)'S_A] = 0 \]

and

\[ a\Omega_D(T_{m_d} - S_A - S_B) - \mu_D - \lambda[P_B + \left(\frac{\partial P_B(S_B)}{\partial S_B}\right)'S_B] = 0 \]

where \( \lambda \) is a Lagrangian multiplier. Since constraint (1.14) must be binding, \( \lambda \) is not equal to 0. Rearranging the first order conditions, yields

\[ P_A + \left(\frac{\partial P_A(S_A)}{\partial S_A}\right)'S_A = P_B + \left(\frac{\partial P_B(S_B)}{\partial S_B}\right)'S_B \]  

(1.16)

In equation (1.16), the left side is the marginal revenue from issuing one unit portfolio of \( A\)-Shares, and the right side is the marginal revenue from issuing one unit portfolio of \( B\)-Shares. Therefore, the equation (1.16) indicates that the marginal revenue from issuing any more of \( A\)-Shares must be equal to the marginal loss from reducing the same amount of \( B\)-Shares. In this case, the government cannot raise more capital by reallocating the amount of \( A\)- and \( B\)-Shares without increasing the total amount of shares issued to both domestic and foreign investors.

In the case of one firm in each country, equation (1.16) can also be rewritten as

\[ P_A(1 + \frac{1}{\varepsilon_A}) = P_B(1 + \frac{1}{\varepsilon_B}) \]  

(1.17)

where \( \varepsilon_A = \frac{\partial S_A P_A}{\partial P_A S_A} \) and \( \varepsilon_B = \frac{\partial S_B P_B}{\partial P_B S_B} \). \( \varepsilon_A \) is the aggregate elasticity of demand by domestic investors, and \( \varepsilon_B \) is the aggregate elasticity of demand by foreign investors\(^{10}\).

\(^{10}\)As discussed earlier, the aggregate elasticity of demand is the same as corresponding represen-
From the equation above, it is easy to see that the government would have no incentive to sell *A-Shares* and *B-Shares* at different prices if the domestic and foreign investors had the same elasticities of demand.

Based on a setting where the objective function of the monopolist supplier is to maximize the amount of capital to be raised with the sum of *A* - and *B-Shares* being fixed, Stulz and Wasserfallen (1995) get the same result on elasticities of demand as shown above. In our model, it is not the total number of domestic shares being issued, but the amount of capital to be raised, that is fixed. On one hand, this setup is closer to the real situation in China; on the other hand, it offers us a chance to explicitly study the relationship between the size of the market and the relative supply of *A* - and *B-Shares*. The fact that we reach the same conclusion with different setup also implies the generality of the result. In addition, Domowitz, Glen, and Madhavan (1997) assume a fixed production technology in their model with the firm trying to maximize the profits from issuing new shares, and we find that the result above also holds based on the unconstrained maximization problem under their setting. This gives further support to the validity of this result.

By intuition, the statement above is consistent with the fact that the *A-Share* prices are higher than *B-Share* prices. Compared with the riskless assets, foreign shares are better substitutes for domestic shares as long as the liquidating payoffs of
tative investor's elasticity of demand for both *A-Shares* and *B-Shares*, and so $\varepsilon_A = \varepsilon_i$, which is defined in (1.6), and $\varepsilon_B = \varepsilon_j$, which is defined in (1.12).
foreign firms are positively correlated with those of domestic firms. Since the domestic
investors cannot purchase foreign shares, the price elasticity of demand for A-Shares
should be less sensitive than that for B-Shares, and so from (1.17), the price of A-
Shares tends to be higher than the price of B-Shares. Anyhow, this inference is kind
of ambiguous in the sense that $\varepsilon_x$ itself depends on optimal values of $S_x^*, x = a, b$.
Here are two comments on this: First, the firm would choose to discriminate between
the domestic and foreign investor groups if $\lim_{S_a, S_b \to 0} \frac{\frac{\partial \bar{S}_a}{\partial \bar{S}_0}}{\varepsilon_0} \neq 1$ and $K$ is small enough.
Second, it is necessary to get more specific information about the demand functions
so as to get more accurate inference. In the following analysis of the equilibrium, the
demand functions derived from the investors' maximization problems will be employed
in further study.

1.4 General Equilibrium

In earlier sections, we have studied the decision-making processes of both the investors
and the government. Now we are going to put together the domestic investors, foreign
investors, and the government so as to study the characteristics of the domestic market
in equilibrium. All investors and the government should reach their optimal solution
in equilibrium, and so the results in section Modeling of Demand and section Modeling
of Supply must hold simultaneously. Denoting the optimal amount of A-Share and
B-Share supply as \( S_A^* \) and \( S_B^* \), (1.5) and (1.11) can be rewritten as:

\[
\bar{P}_A = \frac{\bar{\mu}_D - \frac{a}{n_a} \Omega_D S_A^*}{1 + r} \tag{1.18}
\]

and

\[
\bar{P}_B = \frac{1}{1 + r} \left[ \bar{\mu}_D - \frac{a}{n_b} (\Omega_D - \Omega_{DF} \Omega_F^{-1} \Omega_{DF}^T) S_B^* - \Omega_{DF} \Omega_F^{-1} (\bar{\mu}_F - (1 + r) \bar{P}_F) \right] \tag{1.19}
\]

Taking derivatives of price vectors with regard to the corresponding quantities of supply, we get

\[
\left[ \frac{\partial \bar{P}_A(S_A)}{\partial S_A^*} \right] = \frac{-a/n_a \Omega_D}{1 + r} \tag{1.20}
\]

and

\[
\left[ \frac{\partial \bar{P}_B(S_B)}{\partial S_B^*} \right] = \frac{-a/n_b \Omega_D^{-1}}{1 + r} \tag{1.21}
\]

where \( \Omega_D \) is as defined in (1.1).

From the equations above, it is clear that each derivative is constant independent of the corresponding amount of supply.

Substituting (1.18), (1.19), (1.20), and (1.21) into (1.16), rearranging, yields

\[
a \Omega_D S_A^* / n_a = a \Omega_D^{-1} S_B^* / n_b - \frac{1}{2} \Omega_D^{-1} \Omega_{DF} [\bar{\mu}_F - (1 + r) \bar{P}_F] \tag{1.22}
\]

The equation above shows the relationship between the optimal A-Share and B-Share supply in equilibrium. This is the core relationship in equilibrium, which also determines the price difference between A-Shares and B-Shares. In the following, we are going to first discuss the differences between A- and B-Share prices, and then the differences between A- and B-Share supplies.
1.4.1 A-Share and B-Share Price Differences

After we have put together the characteristics of both the demand and the supply, we can finally calculate the price differences between A- and B-Shares, as shown in the following.

**Statement 1** Under the assumption $\beta_{DF} \geq 0$, in equilibrium the prices of A-Shares are higher than those of B-Shares. The Beta Matrix, $\beta_{DF}$, is $\Omega_{DF}\Omega_F^{-1}$ by definition.

**Proof:** Combining (1.18), (1.18), and (1.22), have

$$\bar{P}_A - \bar{P}_B = -\frac{1}{1 + r} \cdot \frac{1}{2} \cdot \pi_D^1 \pi_{DF}(\bar{\mu}_F - (1 + r)\bar{P}_F)$$

(1.23)

From (1.1), we can infer that $\pi_{DF} = -\pi_D\Omega_{DF}\Omega_F^{-1}$, and so $\pi_D^{-1}\pi_{DF} = -\Omega_{DF}\Omega_F^{-1}$. Substituting $\pi_D^{-1}\pi_{DF} = -\Omega_{DF}\Omega_F^{-1} = -\beta_{DF}$ into (1.23), have

$$\bar{P}_A - \bar{P}_B = \frac{1}{1 + r} \cdot \frac{\beta_{DF}}{2} \cdot (\bar{\mu}_F - (1 + r)\bar{P}_F)$$

(1.24)

Therefore, as long as the random payoffs of domestic firms are positively correlated with those of foreign firms, or say $\beta_{DF} \geq 0$ with at least one nonzero element in each row of the Beta Matrix, the prices of A-Shares should be higher than those of B-Shares. Proof Complete.

The Beta Matrix, $\beta_{DF}$, determines the pricing of domestic shares' foreign risk based on the variance-covariance matrix of domestic and foreign firms' liquidating.
payoffs. It is easier to see the economic meaning of $\beta_{DF}$ when $m_f = 1$, which is a feasible assumption when there exists a well-defined market portfolio in the foreign country. In such a case, $\beta_{DF} = \Omega_{DF} \Omega_F^{-1}$ is simply a vector of domestic firms' betas with the foreign market portfolio being the benchmark.

The formula of price difference, (1.24), is very neat. From (1.24), it is clear that $A$-Share prices should be higher than corresponding $B$-Share prices no matter how many investors there are in each country, for neither $n_d$ nor $n_f$ shows up in the formula. This clarifies the doubt that $B$-Share prices might be higher than $A$-Share prices because of more foreign investors relative to domestic investors. Moreover, equation (1.24) holds even if the coefficient of risk aversion, $a$, differs across domestic and foreign investors. The proof is straightforward and available upon request. It is the monopolistic government and the different sets of investment opportunities, not the numbers of investors or the risk aversion coefficients, that make $A$-Share prices higher than $B$-Share prices.

The right side of equation (1.24) does not depend on the amount of $A$- and $B$-Shares issued to the public. This indicates that price gaps between $A$- and $B$-Shares do not depend on the size of Chinese equity market.

Equation (1.24) also demonstrates the benefit of our model. We cannot have such a clear-cut result of higher $A$-Share prices than $B$-Share prices if we put other factors into the model, such as non-state sector investment opportunities and/or
consideration of individual investors' utility from personal investment in government's objective function, as done in Gordon and Li (2001).

1.4.2 Relative Supply of A- and B-Shares

Next we study the relationship between the optimal supply of A-Shares and B-Shares so as to explain the relative size of A- and B-Share markets in China. A few years before the first B-Share was issued to the public in 1992, a considerable amount of A-Shares had been sold and listed in Chinese stock exchanges. B-Shares followed the issuance of A-Shares, although the size of A-Share market remains much larger than the B-Share market. In this subsection, we investigate whether our model can shed some light on such a phenomenon, namely, that A-Shares were issued first, and then later B-Shares were issued alongside A-Shares.

From equation (1.22) and (1.1), we derive the relationship between the optimal supply of A- and B-Shares in equilibrium:

$$\tilde{S}_A = \frac{n_A}{n_B} (I_{m_D \times m_D} - \Omega_D^{-1} \Omega_{DF} \Omega_F^{-1} \Omega_{DF}') \tilde{S}_B + \frac{n_A}{2a} \Omega_D^{-1} \Omega_{DF} \Omega_F^{-1} (\bar{\mu}_F - (1 + \tau) \bar{F}_F)$$ (1.25)

Equation (1.25) show that the supply of A- and B-Shares are still positively correlated under plausible assumptions, and B-Shares shall not be issued as long as the amount of capital to be raised in the stock market is below a threshold value. This offers an explanation why only A-Shares were issued in the early stage of Chinese stock markets.
In the rest of this subsection, we derive the functional relationship between the optimal supply of A- and B-Shares as the amount of capital to raise, $K$, varies. The purpose is to find a logical relationship between the size of A- and B-Share Market and see whether it is consistent with the development history of Chinese stock markets. To do so, it is not necessary to consider the case of multiple firms since the focus is at the market level, and so for ease of analysis, in the rest of this section we only consider the case of one firm in each country. Consequently, the equation (1.25) becomes:

$$S_a^* = \gamma_b S_b^* + \gamma_0$$  \hspace{1cm} (1.26)

where

$$\gamma_b = \frac{n_a(1 - \rho^2)}{n_b}$$  \hspace{1cm} (1.27)

and

$$\gamma_0 = \frac{\beta_f[\mu_f - (1 + r)P_f]}{2\sigma^2_d/n_a}$$  \hspace{1cm} (1.28)

In this case of one firm in each country, it is clear that a linear relationship exists between the optimal amount of A-Share supply, $S_a^*$, and the optimal amount of B-Share supply, $S_b^*$. Meanwhile, $\partial S_a^*/\partial S_b^* = \gamma_b = \frac{n_a(1 - \rho^2)}{n_b} \geq 0$, hence $S_a^*$ and $S_b^*$ are positively correlated.

The following statement gives an accurate account why no B-Shares are issued when the capital to be raised by the government is very small.

**Statement 2** Under the assumption $\mu_d - \beta_f[\mu_f - (1 + r)P_f] \geq 0$, no B-Shares shall be issued as long as the amount of capital to be raised, $K$, is not more than the critical
value $K_0$, where

$$K_0 = \frac{\{\mu_d - \frac{1}{2}\beta_f[\mu_f - (1 + r)P_f]\} \beta_f[\mu_f - (1 + r)P_f]}{2(1 + r)a\sigma_d^2/n_a}$$

(1.29)

Meanwhile, $S_a^*$ and $S_b^*$ are increasing w.r.t. $K$.

**Proof**: From (1.26), we can see that the domestic firm will choose to sell only $A$-Shares if the total shares for sale is less than or equal to $\gamma_0$, that is, if $K \leq K_0$ where $K_0 = \gamma_0P_d(\gamma_0)$. Substituting (1.5) and (1.28) into above, yields

$$K_0 = \gamma_0\frac{\mu_d - a\gamma_0\sigma_d^2/n_a}{1 + r} = \frac{\{\mu_d - \frac{1}{2}\beta_f[\mu_f - (1 + r)P_f]\} \beta_f[\mu_f - (1 + r)P_f]}{2(1 + r)a\sigma_d^2/n_a}$$

As for the proof of $S_x^*$ being increasing in $K$ for $x = a, b$, it follows from the following discussion. *Proof Complete.*

By intuition, the existence of the critical value $\gamma_0$ can also be deduced in the following way. From (1.5) and (1.11), one can see that $P_a$ approaches $\mu_d$ when $S_a^* \to 0$, while $P_b$ approaches $\mu_d - \beta_f[\mu_f - (1 + r)P_f]$ when $S_b^* \to 0$. So, if there is only a relatively small amount of capital to raise, the firm should prefer to issue only $A$-Shares unless the marginal revenue from issuing one more unit of $A$-Share is less than $\mu_d - \beta_f[\mu_f - (1 + r)P_f]$, or say, unless the amount of shares being issued exceeds the critical value $\gamma_0$. Assuming the total amount of capital to be raised from the stock market before 1992 is less than the critical value $\gamma_0$, one can use this to endogenize the Chinese government’s decision of not issuing $B$-Shares in the early stage of the stock markets.
Now we calculate the amount of domestic share supply as a function of $K$, the amount of capital to be raised. First, we consider the case $K \leq K_0$, where $K_0$ is defined as in (1.29). Since the assumption $\mu_d > \beta_f[\mu_f - (1 + r)P_f]$ is equivalent to $\gamma_0 < S_1$, we have

$$S_a^* = \frac{\mu_d n_a}{2a\sigma_d^2} - \frac{1}{\sigma_d} \left( \frac{1}{a} \left( \frac{\mu_d^2 n_a}{4(1 + r)a\sigma_d^2} - K \right) \right)^{\frac{1}{2}}, \quad 0 \leq K \leq K_0$$

and

$$S_b^* = 0, \quad 0 \leq K \leq K_0$$

(1.30)

(1.31)

When $K \geq K_0$, the government issues both $A-Shares$ and $B-Shares$. Substituting (1.18), (1.19), (1.26) and (1.29) into (1.14), yields

$$K - K_0 = \frac{1 + \gamma_b}{1 + r} \frac{\{ -1 + \rho^2 \} [S_b^* - \mu_d - \beta_f[\mu_f - (1 + r)P_f]]^2}{n_b + 4a(1 - \rho^2)\sigma_d^2/n_b} + \frac{\{ \mu_d - \beta_f[\mu_f - (1 + r)P_f] \}^2}{4a(1 - \rho^2)\sigma_d^2/n_b}$$

(1.32)

where $\gamma_0$, $\gamma_b$, and $K_0$ are those parameters defined in (1.28), (1.27), and (1.29) respectively.

The expression $K - K_0$ in (1.32) takes its maximum value $K_2$ at $S_b^* = S_{2b}$, where

$$K_2 = \frac{1 + \gamma_b}{1 + r} \frac{\{ \mu_d - \beta_f[\mu_f - (1 + r)P_f] \}^2}{4a(1 - \rho^2)\sigma_d^2/n_b}$$

(1.33)

and

$$S_{2b} = \frac{\mu_d - \beta_f[\mu_f - (1 + r)P_f]}{2a(1 - \rho^2)\sigma_d^2/n_b}$$

(1.34)

Meanwhile, the total amount of domestic shares issued to the public, $S_2$, is

$$S_2 = \frac{(1 + \gamma_b)\mu_d - \beta_f[\mu_f - (1 + r)P_f]}{2a(1 - \rho^2)\sigma_d^2/n_b}$$

(1.35)
The feasible amount of total domestic $A$- and $B$-Shares cannot exceed 1 because short sales are not allowed, and so we need to check whether $S_2 > 1$ when calculating the maximum amount of capital, $K_{\text{max}}$, that can be raised by issuing $A$- and $B$-Shares. $S_2 > 1$ means that the original owner of the firm can always raise more capital by issuing new equities until all the claims on the firm's payoff are sold out. Otherwise, if $S_2 < 1$, then the maximum amount of capital that can be raised by selling off the claims on the firm's payoffs is obtained when a proportion $S_2$ of total claims is put in the capital market. In the latter case, the original owner of the firm will never sell off all the claims on the firm's payoff no matter how much capital he needs. Considering both $S_2 \leq 1$ and $S_2 > 1$, we have

$$K_{\text{max}} = \begin{cases} K_0 + K_2, & S_2 \leq 1 \\ K_0 + K_2 - \frac{1+\gamma_b a(1-\rho^2)\sigma_a^2}{1+r} \frac{1-\rho}{1+\gamma_b} (1-S_2) & S_2 > 1 \end{cases}$$

Then, from (1.32) we can get the optimal supply schedule $(S_a^*, S_b^*)$:

$$S_b^* = S_{2b} - \sqrt{(K_0 + K_2 - K) \frac{1 + r}{1 + \gamma_b a(1-\rho^2)\sigma_a^2} \frac{n_b}{1 + \gamma_b a(1-\rho^2)\sigma_a^2}}, K_0 < K \leq K_{\text{max}}$$

and, in conjunction with (1.26),

$$S_a^* = \gamma_b S_b^* + \gamma_0, K_0 < K \leq K_{\text{max}}$$

Combining (1.30), (1.31), (1.38), and (1.37), we get the complete supply schedule of domestic shares. Figure 1.1 shows a numerical example.
In short, we have derived in the above the relationship between the size of \( A\)-Share market and \( B\)-Share market when the capital to be raised by the government varies. The result contributes to the understanding of the market development in China. Meanwhile, the relationship is derived from a static one-period model, and there are issues to be heeded when making specific claims on the dynamic properties of the market. We are going to discuss this further in next section.

1.5 A Simplified Approach and Analysis of Finland

In this section, we first develop a simplified approach to derive the key results in our model with some simple geometric analysis, and then compare our model for China with those for other countries discussed in the literature, especially Finland.

1.5.1 A Simplified Approach

Figure 1.2 presents a simplified approach to solve the government’s maximization problem and derive the main results of our model in the case of a single domestic asset. In the graph, \( S_A \) and \( S_B \) stand for aggregate demand curves of domestic and foreign investors respectively. The aggregate demand curves are given from the solutions of domestic and foreign investors’ maximization problems, as in equations
For any two points $X$ and $Y$ in the graph, we denote the length of the interval $XY$ as $XY$.

First, marginal revenues from selling $A$-Share and $B$-Shares are $MR_A$ and $MR_B$ respectively. These marginal revenue curves are typical ones of a monopolist supplier. Since $S_A$ is a straight line, it is easy to prove that $MR_A$ has a slope that is twice the slope of $S_A$.\(^{11}\) The same relationship holds for $MR_B$ and $S_B$.

Second, to maximize revenue, Chinese government need to set the amount of $A$-Shares and $B$-Shares such that marginal revenues of $A$- and $B$-Shares are equal to each other. Under the assumption that $\overline{OO'}$ is the marginal revenue of the government in equilibrium, $A$- and $B$-Share prices should be $\overline{OP_A}$ and $\overline{OP_B}$ in equilibrium. Next we calculate the difference between $P_A$ and $P_B$ in this case. From the relationship between $MR_A$ and $S_A$, we know that point $J$ must be the middle point of the interval $O'L$. Since line $VL$ is parallel to line $AO'$, point $V$ must be the middle point of interval $AL$. Further, we know that point $P_A$ should be the middle point of $O'A$ because line $P_AV$ is parallel to line $O'L$. Similarly, point $P_B$ must be the middle point of $BO'$. Therefore, the difference between $\overline{O'P_A}$ and $\overline{O'P_B}$ is half the difference between $\overline{O'A}$

\(^{11}\)Here is the proof. At any point $V(x_1, y_1)$ on $S_A$, the government's revenue $R_g$ is equal to $x_1 \cdot (\delta - \kappa_S \cdot x_1)$, where $\kappa_S$ is the slope of $S_A$ and $\delta$ is the length of $OA$. The derivative of $R_g$ with regard to $x_1$ is $\delta - 2\kappa_S \cdot x_1$, and this is the marginal revenue from issuing $A$-Shares at $x_1$. 

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and $O'B$, or say the difference between $A$- and $B$-Share prices should be half of the length of interval $BA$. Since the analysis above holds as point $O'$ moves along the open interval $BO$, we know that the price difference between $A$-Shares and $B$-Shares is always half $BA$.

The analysis above does not depend on the slopes of $S_A$ and $S_B$, and this illustrates why $A$-Share prices should be higher than $B$-Share prices regardless of the number of investors and the risk aversion coefficients. Although we assume that domestic and foreign investors have the same risk aversion coefficients in the setup, the relaxation of such an assumption does not affect the price difference between $A$-Shares and $B$-Shares in equilibrium since the risk aversion coefficients only affect the slopes of demand curves $S_A$ and $S_B$, but not the length of interval $BA$.

In addition, Figure 1.2 explains the interaction between investors' demand elasticities and the government's share supply. With investors' demand functions fixed, the higher prices of $A$-Shares than $B$-Shares is a natural result of the following two factors: the government is a revenue maximizer, and the government can effectively restrict the set of shares accessible to domestic investors. If the government could not prohibit domestic investors from investing abroad or purchasing $B$-Shares, the price differences between $A$- and $B$-Shares would be different in equilibrium.

Figure 1.2 also gives a graphical presentation of the relationship between the size of $A$-Share market and the size of $B$-Share market. If the total amount of capital to
be raised from stock markets is less than \( OB \times BW \), then the amount of shares issued by the government is less than \( BW \), and the government does not issue any B-Shares. On the other hand, if the need for capital exceeds \( OB \times BW \), the government needs to issue more shares than \( BW \), and it is necessary to issue B-Shares in addition to A-Shares. The size of A-Share market should be larger than the size of B-Share market as long as the amount of shares issued to the public is less than twice \( ZX \), assuming \( MR_A \) and \( MR_B \) do cross at point \( X \). It is possible that \( MR_A \) and \( MR_B \) do not cross at all\(^{12} \), and in this case the size of A-Share market is always larger than the size of B-Share market regardless of the amount of capital to be raised.

Meanwhile, because of the fact that the analysis above is based on a static model, caution is needed when applying the results above to explain the dynamic development of the Chinese stock markets. Specifically, in the attempt to explain why the Chinese government did not issue B-Shares until 1992, the shift of the demand curve over time needs to be taken into consideration to get rigorous results. Assuming the shares issued before 1992 was equal to the length of the interval \( BW \) as shown in Figure 1.2, the domestic investors’ demand curve that the government faced after 1992 should be different from \( S_A \). Instead, the government should face a demand curve that has the same slope as \( S_A \) but intersects the Price axis at point \( T \) rather than point \( A \). This shift of demand curve would not change the conclusion that A-Share

\(^{12}\)The slope of \( MR_A \) and \( MR_B \) depends on the number of investors in each market as well as investors’ risk aversion coefficients, in additional to the covariance between domestic and foreign assets. Theoretically, there exist situations where \( MR_A \) and \( MR_B \) do not cross.
prices should be higher than \textit{B-Share} prices, though, for \( T \) must be higher than \( B \).

To keep analysis simple, we are implicitly assuming that the domestic investors did not expect to have a second share issuance after 1992. To make the analysis more realistic, we should consider a multiple period model with a monopolistic supplier in the stock market, and employ game theory in the set up of the interplay of the government’s share issuance strategy and investors’ investment decisions. Such an analysis has the potential to explain further details in the Chinese stock markets, such as why the government has to announce the quota of new shares for each year, and why stock prices fluctuate wildly whenever the government changes its policy in setting the quota of new shares. However, a multiple period model is a direction for future research, and it is not expected to change the claim that \textit{A-Share} prices should be higher \textit{B-Share} prices, nor the claim that \textit{A-shares} should be issued first when the amount of capital needed is below a certain point.

In the following, we are going to apply the analysis in our simplified approach on some other stock markets outside China.

1.5.2 Implications Beyond China: The Case of Finland

Finland (Heitala (1989)) and Thailand (Bailey and Jagtiani (1994)) are similar to China in that domestic investors face legal barriers to investment abroad. In these countries, however, \textit{B-Share} prices are higher than \textit{A-Share} prices. In the following,
we use the example of Finland to show how the implications of our model differ from those of related studies.

The case of Finland is very close to the case in China, except for one key difference: Finnish firms do not have as much monopolistic power as the Chinese government. In China, the government has double roles: as regulator and as stock supplier. The stock supplier can choose the structure of ownership restrictions to maximize revenue. In Finland, however, the government is not the one selling shares to investors. Consequently, the stock suppliers in Finland, namely Finnish firms, face more constraints than the stock supplier in China. In the following, we show that this explains why 

\textit{B-Share} prices are higher than \textit{A-Share} prices in Finland.

Different from the ownership restrictions in China, Finnish investors can invest in \textit{B-Shares} in addition to \textit{A-Shares}\textsuperscript{13}. In addition, Finnish laws impose limits on foreign ownership restrictions. Specifically, there is a "20%" rule in Finland as described in Heitala (1989)\textsuperscript{14}. Based on such a setting in Finland, Figure 1.3 shows how our analysis may offer an explanation of the situation in Finland. The solid lines, $S_A$ and $S_B$, represent domestic and foreign demand curves respectively. Meanwhile, the dotted line $R_s$ is a certain percentage of $S_A$, and represents foreign ownership restrictions imposed by Finnish laws. First, as shown earlier in our analysis, a monopolistic supplier like the Chinese government prefers to sell shares to domestic investors at

\textsuperscript{13}To be consistent with the terminology in this chapter, we denote restricted shares in Finland as \textit{A-Shares}, and unrestricted shares as \textit{B-Shares}.

\textsuperscript{14}Many Finnish firms cannot issue more than 20% of their outstanding shares to foreign investors.
higher prices than to foreign investors when domestic investors cannot invest abroad. In Finland, however, a firm cannot prohibit domestic investors from purchasing B-Share, and so A-Share prices cannot be higher than B-Share prices. A firm can have two choices at most: selling shares at the same price, or selling B-Shares at higher prices than A-Shares. Under such a setting, a Finnish firm prefers selling all shares at the same prices rather than selling B-Shares at higher prices. This explains why insurance and foreign capital firms in Finland, which are exempt from the 20% rule, choose not to impose ownership restrictions at all.

Moreover, even for a firm facing the foreign ownership restriction $R_S$, Figure 1.3 shows that the restriction is not binding as long as the amount of foreign shares to be issued is smaller than $\overline{OG}$: we note that $X$ is the intersection of $S_B$ and $R_S$. As the amount of shares to be issued takes on larger values, the ownership restriction becomes binding. For example, when the amount of outstanding A-Shares is $\overline{OI}$, outstanding B-Shares can only be $\overline{OH}$ owing to the restriction $R_S$. Consequently, the ownership restriction in Finland results in a higher price of B-Shares, $P_B$, than the price of A-Shares, $P_A$.

Since the amount of Finnish shares in the early stage of the Finnish market should be smaller than in later stages, Figure 1.3 helps to explain why there were no higher prices of B-Shares than A-Shares in Finland before 1983, and why more and more B-Share prices became higher than their A-Share counterparts afterwards. As mentioned before, this analysis is based on a simplification of the real situation.
The analysis above gives different implications from literature. Observing higher $B$- than $A$-Share prices in 1984 and 1985, Heitala (1989) states that domestic investors may require a higher rate of return on domestic shares than foreign investors, because domestic investors are prohibited from investing abroad and are unable to diversify away the specific country risk as can foreign investors. This implies that the lack of opportunities to invest abroad is the reason why domestic investors are paying lower prices. The inference from our model, however, is different. First, the inaccessibility to foreign shares are shown earlier in our model to be the reason why domestic investors are willing to pay a higher price for the first infinitely small amount of domestic shares than foreign investors. This is why $OA$ is higher than $OB$ in Figure 1.3. Intuitively, a risk-averse domestic investor needs little risk premium for the first infinitely small amount of domestic shares. A risk-averse foreign investor, however, needs substantial risk premium even for the first tiny amount of domestic shares, for he needs compensation for the portion of domestic risk that covaries with the risk of foreign assets. Second, if Finnish firms faced no legal restrictions and could restrict domestic investors from buying $B$-Shares, domestic investors would have ended up paying higher prices than foreign investors. Therefore, the high $B$-Share prices in Finland lies in the fact that Finnish firms does not have as much freedom as the Chinese government in marker price discrimination.
In his conclusion, Heitala (1989) states that according to his model B-Share prices are higher when foreign investors require a lower rate of return than domestic investors. At end of his section II, *An Equilibrium Asset Pricing Model in the Finnish Stock Market*, he says, "By coincidence, for some stocks the two risk premiums may be equal, and these stocks are held in equilibrium by both investor groups. The normal situation is, however, that the equilibrium price of a stock will be determined solely by the demand from one investor group and the stock will appear overpriced to the other investor group.". Following this logic, it is natural that his model does not explain why *NO* B-Share prices were higher than *A-Share* prices in Finland before 1983. Further, his study gives no explanation why all insurance firms and other Finnish firms established by foreign companies, who are not subject to the "20%" rule in Finland, choose to make all their shares accessible to foreign investors rather than imposing ownership restrictions on them.

In summary, the analysis above demonstrates that our model can offer explanations to situations in some other countries, which are different from what have been offered in some previous studies.

### 1.6 Extension

The model we have analyzed above is a standard one with no market imperfections other than the existence of a government with monopolistic power. The main advan-
tage of the model is its simplicity and ability to explain several notable phenomena in China, such as higher prices of A-Shares versus B-Shares and the development path of A-Share versus B-Share markets. To address additional real world issues, such as liquidity, we can extend the base model presented earlier in this chapter to analyze how the pricing of A- and B-Shares will be influenced.

1.6.1 Liquidity

It is argued in previous papers, such as Domowitz, Glen, and Madhavan (1997), that liquidity may play an important role in the pricing of A- and B-Shares. Less actively traded shares tend to have a larger spread between bid and ask prices, and hence share holders incur a higher transaction cost, in our case, on B-Shares. Therefore, investors demand a larger discount in the market price for shares with lower liquidity. In China, there is a serious thin trading problem in the B-Share market, but not in the A-Share market. This create a substantial difference in liquidity between A-Shares and B-Shares, and the investigation into liquidity should help to explain the difference in A- versus B-Share prices.

For simplicity, we assume that there are two market makers called A and B serving A-Share market and B-Share market respectively. An investor has to sell his shares to a market maker at end of the period, and each market maker charges a firm-specific percentage of each firm's final payoff as the transaction cost. This transaction
cost is called liquidity cost in this extension, and it is to be estimated by each firm’s bid-ask spreads, in addition to other related data items, in empirical studies. This setup is similar to the liquidity model in Domowitz, Glen, and Madhavan (1997), and we add two market makers here so as to make our story self-contained.

Set \( \Gamma_A = \text{Diag}[1 - \gamma_1^a, 1 - \gamma_2^a, ..., 1 - \gamma_{m_d}^a] \), which is a \( m_d \) by \( m_d \) diagonal matrix, and \( \gamma_i^a \) is the liquidity cost charged by Market Maker A for firm \( i = 1, ..., m_d \). Liquidity costs are measured in terms of percentages of final payoffs. By solving domestic investors’ problems, we have

\[
\bar{P}_A = \frac{\Gamma_A \bar{\mu}_D - a \Gamma_A \Omega_D \Gamma_A \bar{S}_A / n_a}{1 + r}
\]  

(1.39)

Similarly, solving foreign investors’ problems gives

\[
\bar{P}_B = \frac{1}{1 + r} \left[ \Gamma_B \bar{\mu}_D - a (\Gamma_B \Omega_D \Gamma_B - \Gamma_B \Omega_D F \Omega_F^{-1} \Omega_D' \Gamma_B) \bar{S}_B n_b - \Gamma_B \Omega_D F \Omega_F^{-1} (\bar{\mu}_F - (1 + r) \bar{P}_F) \right]
\]  

(1.40)

where \( \Gamma_B = \text{Diag}[1 - \gamma_1^b, 1 - \gamma_2^b, ..., 1 - \gamma_{m_b}^b] \), and \( \gamma_j^b \) is the liquidity cost charged by Market Maker B for firm \( j = 1, ..., m_b \). Solving the government’s problem gives

\[
a \Gamma_A \Omega_D \Gamma_A \bar{S}_A / n_a = (\Gamma_A - \Gamma_B) \bar{\mu}_D / 2
\]  

(1.41)

\[
+ a (\Gamma_B \Omega_D \Gamma_B - \Gamma_B \Omega_D F \Omega_F^{-1} \Omega_D' \Gamma_B) \bar{S}_B / n_b
\]  

\[
+ \frac{1}{2} \Gamma_B \Omega_D F \Omega_F^{-1} [\bar{\mu}_F - (1 + r) \bar{P}_F]
\]

Substituting (1.41) into (1.40) and (1.39) shows a price difference to be:

\[
P_A - P_B = \frac{\Gamma_A - \Gamma_B}{2(1 + r)} \bar{\mu}_D + \frac{1}{2(1 + r)} \Gamma_B \Omega_D F \Omega_F^{-1} [\bar{\mu}_F - (1 + r) \bar{P}_F]
\]  

(1.42)

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Because $\bar{\mu}_D$ is positive and larger than $\Omega_{DF} \Omega_F^{-1} [\bar{\mu}_F - (1 + r) \bar{P}_F]$, this reveals that a much higher liquidity of A-Shares versus B-Shares in China can contribute to the explanation of a higher level of A-Share prices in equilibrium. On the other hand, if B-Share liquidity were higher than A-Share liquidity, as in some other countries, the impact of liquidity on price differences would be the opposite.

Domowitz, Glen, and Madhavan (1997) also empirically investigate the role of liquidity in their study. However, rather than use a unified model such as ours, they give two alternative models. One is a liquidity model, and the other is a differential demand model. In their tests, they reject the liquidity model, and accept the differential demand model. In our empirical study in Chapter III of this thesis, *Equity Pricing in China: Empirical Tests*, we find empirical support to the liquidity factor, in addition to other factors in our base model. The rejection of their liquidity model in the empirical tests by Domowitz, Glen, and Madhavan (1997) may result from the following factors: the improper use of panel analysis with fixed individual effects in their tests as discussed in Chapter III, their small sample size, and/or a possible lack of significant differences between A- and B-Share liquidity in their sample of Mexican firms.
1.7 Discussion

In this section, we first describe some possible extensions to our model, and then discuss some alternative hypotheses and the empirical implications.

1.7.1 Further Extension

The model can be further developed into an intertemporal model with social welfare analysis. By doing so, the interest rate can be endogenized, and the social welfare analysis can show that the social welfare of the domestic country may be decreased upon integration. This might offer a more general explanation for why the government wants to ban domestic investors from investing abroad, and why the government want to protect certain domestic industries from foreign investment.

One other extension to be considered is the marginal impact of the foreign capital raised from the B-Share market on the real foreign exchange rate. Assuming that the amount of foreign capital raised from the B-Share market is large enough to significantly influence the effective foreign exchange rate of RMB versus USD in the free money market, the foreign capital raised by issuing B-Shares may mean more than just its market value based on the spot exchange rate. This may offer more implications on the relative prices and supplies of A- and B-Shares in equilibrium.
1.7.2 Alternative Hypotheses

Some alternative hypotheses may also contribute to the explanation of the differential pricing in China. The following is a list of such hypothesis, which are not necessarily in contradiction with our approach. In fact, some of them may be potential complements to our model\textsuperscript{15}.

1. INFORMATION EFFECT

In Merton (1987), it is shown that incomplete information may result in a higher discount of share prices. The investors tend to invest in only these firms that they know well, and hence the firms with a higher level of publicity enjoy higher prices than those firms with a lower level of publicity. Following this logic, Chinese investors may be willing to pay a higher price for domestic shares than foreign investors because of being more familiar with domestic firms. Moreover, a Chinese firm with better publicity abroad may have a lower price difference between its \textit{A-} and \textit{B-Shares}. In the literature on price differences in other countries, several papers have tried to employ the information factor in their modeling and empirical testing of the \textit{A-} and \textit{B-Share} price differences, such as

\textsuperscript{15}Some people may be interested in the potential role of corporate control in the pricing of \textit{A-} and \textit{B-Shares}. However, the issue of corporate control is not discussed here, for in most cases neither \textit{A-Shares} nor \textit{B-Shares} could reach such a point to outnumber the shares kept by the Chinese government. This implies that there is no need to make domestic or foreign investors to evaluate the benefit of corporate control when investing in Chinese stock markets.
Beiley and Jagtiani (1994) and Domowitz, Glen, and Madhavan (1997).

2. OPTIMISTIC DOMESTIC INVESTORS

Many people are concerned about whether the Chinese investors are overoptimistic about domestic firms' payoffs. Or say, domestic and foreign investors may have different beliefs about the same firms' expected payoffs. Mathematically, if $E_d(\pi_d) > E_f(\pi_d)$, then the price of A-Shares relative to that of B-Shares would be higher because of the difference in perceived values of $\mu_d$.

3. AGENCY PROBLEM

Agency problems can arise from the unbalanced compensation structure for investment managers. It is common practice, especially in China, for managers to receive incentive fees based on performance. That is, For fund managers who are making investment decisions for institutions or other people, they may gain more from their funds' $1$ profit relative to their loss from their funds' $1$ loss. Such a structure can extort the price of risk owing to the differing interests between the principal fund investors and the fund managers. Even risk-seeking behavior may be possible when short sales are not allowed. In China, the majority of the A-Shares are held by state-owned institutions or private groups who are managing money for other people. Therefore, serious agency problem exists in A-Share market. In addition, short sales are not allowed in Chinese stock markets, which further aggravates the distortion effect on asset pricing by agency problem.
1.7.3 Empirical Implications

Our model has two major testable implications. First, from (1.24) we can see that a firm's $A-minus-B$ share price difference is positively correlated with its foreign beta with a well-defined foreign market portfolio being the benchmark. Consequently, we can test whether the cross-section price differences are significantly correlated with firms' foreign betas. If we consider the possibility of time-varying betas, it is also desirable to test the relationship between the time-series price differences and the firms' corresponding time-varying betas.

Second, from (1.25) or (1.26), we can infer some testable implications about the relationship between the number of outstanding $A$- and $B$-Shares. For example, the firms with a positive number of outstanding $B$-Shares and zero $A$-Shares should have a zero or negative beta with the foreign market portfolio being the benchmark. Hence, we can test whether the firms with no outstanding $A$-Shares have lower foreign betas than the firms that have not only outstanding $B$-Shares but also outstanding $A$-Shares.

In addition to the two major implications above, there are also some other implications that may be testable, such as the relationship between the difference of share prices and the difference of outstanding shares. However, to test these implications, one has to construct a non-linear regression, while there may not be any additional statistical power from such tests. Therefore, it is not so desirable to test
these additional empirical implications.

Now we move on to discuss the test of liquidity effect. The liquidity can be measured with bid-ask spread. In addition, the trading volume can also be a meaningful indicator of the liquidity, especially for large investors. Bid and ask prices at a certain point of time alone cannot tell how large a discount an investor has to suffer when he must sell a large volume of shares. Therefore, the range of supporting trading volume should also be considered in the measure of liquidity, which is important for accommodating market pressure. As derived in our analysis, the differences between A- and B-Share liquidity should be positively correlated with price ratios. The higher the gap between B- versus A-Share bid-ask spread, the higher the A- to B-Share price ratios. Similarly, the trading volume should play a similar role in price differences.

Other than the testable implications of our model, it is also worthwhile to conduct some tests of alternative hypotheses related to Chinese stock markets. Here is a list of examples.

- Test of information asymmetry. We can use some proxies for publicity, such as size and geographic location, to test the hypothesis of information asymmetry. The higher a firm’s publicity among foreign investors, the higher the B-Share price. There are some examples of this type of test techniques in existing literature, such as Beiley and Jagtiani (1994) and Domowitz, Glen, and Madhavan (1997).
• Test of differential beliefs. This may be carried out by analyzing the impact on prices by payoff-related information, such as earnings announcements.

• Test of agency problems. This can be done through tests of asset pricing models, such as the risk-return relationships. In addition, some event studies can also provide significant power in testing the agency problems.

• Test of exchange rate risk. Owing to the governmental control on the convertibility of the Chinese currency, RMB, a special measure needs to be constructed so as to proxy for the risk of exchange rate risk. Under the plausible assumption that RMB is more closely correlated with other Asian currencies than US Dollars, we can proxy the risk of holding RMB with the difference between the change of RMB versus USD and the change of other Asian currencies versus USD. If such a proxy is significantly correlated with the $A-\text{minus-}B$ share price differences in the right direction, then the exchange rate risk is priced in the Chinese stock market and can contribute to the explanation why $A$-Share prices are higher than $B$-Share prices.

1.8 Conclusion

With a general equilibrium model, we have analyzed the government’s incentive to discriminate between domestic and foreign investors, resulting in higher prices of $A$-Shares than $B$-Shares. Contrary to common perception, the number of investors and
the coefficient of risk aversion do not affect the price differences between \textit{A-Shares} and \textit{B-Shares}. This is because of the role of the monopolistic government. We have also offered an explanation why the size of the \textit{A-Share} market is larger than the \textit{B-Share} market in China, and why the \textit{A-Share} market was established years before the \textit{B-Share} market. Although our analysis is only based on a simple one-period world, its implications may extend to a multiperiod case.

Further, our study helps to analyze some unexplained issues in some other countries such as Finland, with implications that are different from previous studies.

Some empirical implications have also been derived from our model, such as the relationship between foreign betas and price differences, as well as relative share supplies. We have also discussed some alternative hypotheses and corresponding tests.

There are further possible extensions of our model. First, it may be possible to integrate the agency problem from unbalanced compensation with the explanation for price differences between \textit{A-Shares} and \textit{B-Shares} in this chapter\textsuperscript{16}. Second, the model may be applied to study the interplay between the government and investors in a multi-period framework where investors have rational expectations of future stock

\textsuperscript{16}See Chapter II titled \textit{Unbalanced Compensation and Asset Prices: An Agency Asset Pricing Model from China.}
issuances\textsuperscript{17}.

Bibliography


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Table 1.1: Ownership Restrictions in Different Countries

This table shows different ownership restrictions of a number of countries that have been studied in the literature.

<table>
<thead>
<tr>
<th>Paper</th>
<th>Country</th>
<th>Domestic Investors</th>
<th>Foreign Investors</th>
<th>Endogenize Supply</th>
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<td></td>
<td>Domestic Shares</td>
<td>Foreign Shares</td>
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<td>U</td>
<td>U</td>
<td>R</td>
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<td>(1995, RFS)</td>
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<td>R</td>
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<td>Gordon and Li (1999, 2001)</td>
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<td>Su (1999), and others</td>
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Figure 1.1: The Government's Optimal Supply Schedule

For any fixed amount of capital that the government must raise from Chinese stock markets, this figure gives the government's optimal supply of A- and B-Shares as a monopolistic supplier. The graph are based on numerical results calculated with the formulas in this chapter by setting the parameters as follows: $a = 0.5$, $r = 0.05$, $\mu_f = 1000$, $\sigma_f = 0.35\mu_f$, $P_f = 743.16$, $\mu_d = 100$, $\sigma_d = 0.35\mu_d$, $n_a = 10$, $n_b = 5$, and $\rho = 0.5$. These numerical results only serve as an example to show how the government's optimal supply schedule looks like.
Figure 1.2: The Case of China
Figure 1.3: The Case of Finland

[Diagram showing supply and demand curves with points labeled X, Z, U, J, K, PR, PB, PA, RB, SA, SB, D, E, F, G, H]
Chapter 2

Unbalanced Management

Compensation and Equity Prices:
An Agency Asset Pricing Model
for China

2.1 Introduction

The transitional economy in China poses many challenges to economic theory, and one of the most pressing tasks is to offer explanations to puzzles in Chinese stock markets. Peng, et al (1998) show that the consensus in the A-Share market, which
is open to Chinese investors only, is that stock prices are higher than their intrinsic values. Such an overpricing anomaly is hard to justify with traditional asset pricing models. Moreover, it is also a puzzle in China why investors, including the largest investment companies, are willing to take extremely risky positions in their investment. For instance, in 1997 the largest securities company in China, Shenyin Wan'guo Securities Company (SWSC), invested over 60% of its equity value in Lujiazui, a single firm listed in the Shanghai Stock Exchange. Because of such puzzles, many practitioners and researchers in China complain about mainstream asset pricing models, and doubt whether the current financial theory can explain the pricing behaviour in Chinese stock markets. Nevertheless, there have been very few academic studies in the finance literature that rationalize these anomalies in China, especially the overpricing of Chinese stocks. In this chapter, we argue that traditional financial theory can indeed offer an explanation for the situation in China. We accomplish this by adding two Chinese factors into asset pricing: Unbalanced Management Compensation (UMC) and a no short-sales constraint.

UMC refers to a situation where a manager gets more financial benefit from one unit of profit than the penalty from one unit of loss, and the no short-sales constraint refers to regulations that prohibit short sales in Chinese stock markets. UMC causes a misalignment between the interests of fund managers and fund owners, and hence results in a distortion in asset pricing. This is the agency problem to be studied in this chapter. As pointed out in Allen (2001), relative to the huge literature on agency
problems in the area of corporate finance, only very a few researchers have studied how agency-based asset pricing models can explain pricing anomalies. Some of the existing contributions in this area are Brennan (2000), Cuoco and Kaniel (2000), and Arora and Ou-Yang (2000). There has been even less investigation of the link between agency-based asset pricing models and bubbles. Notable exceptions are Allen (2001) and Allen and Gale (2000).

In this chapter, we develop a static one-period model with UMC and a no short-sales constraint. We call this model the Agency Capital Asset Pricing Model (ACAPM), and use it to justify the existence of bubbles in Chinese stock markets in a rational equilibrium. In addition to managers with UMC, managers with Balanced Management Compensation (BMC) are also included in the model. BMC managers can also represent individual investors who directly invest in the stock markets. With fixed supply of shares of a single risky asset, we derive share prices in a partial equilibrium and study the link between UMC and asset pricing.

To facilitate our discussion, we define two forms of bubbles. The strong form bubble is defined by a negative Sharpe ratio. In a weak form bubble, the Sharpe ratio is positive, but smaller than what it would be in a world without UMC. The existence of UMC gives rise to either a strong form of bubbles or a weak form of bubbles, depending on the number of UMC managers and the parameters in their

\[ Our\ model\ is\ a\ static\ single-period\ one,\ and\ so\ the\ definitions\ here\ focus\ on\ the\ overpricing\ property\ of\ bubbles.\]
compensation contracts.

The no short-sales constraint plays an important role in the formation of the strong form of bubbles, though it is negligible in the weak form of bubbles. Without the no short sales constraint, the strong form of bubbles cannot exist, for even a UMC manager also prefers to short sale a stock with a negative Sharpe ratio rather than purchase it.

An extension of our model to multiple assets gives implications for fund managers’ portfolio choices. The results show that a UMC manager chooses to diversify in a market with a weak form of bubbles. However, when a strong form of bubbles exists, a UMC manager prefers to invest in one single asset rather than holding a diversified portfolio. Meanwhile, a UMC manager may still prefer a lesser amount of absolute risk although he chooses not to diversify. This seemingly contradictory result comes from the structure of UMC, which forces UMC managers to care about not only the total risk of his holdings, but also the risk decomposition of his holdings.

We also investigate other characteristics of ACAPM, such as how aggregate utilities of UMC and BMC managers change as the compensation structure varies. In addition, we apply our analysis to North American stock markets, and offer an explanation to a number of issues such as the equity premium puzzle and the conflicting and uneven evidence on the risk-return relationship in the literature.

The papers by Cuoco and Kaniel (2000) and Allen and Gale (2000) are the closest
Cuoco and Kaniel (2000) adopt a different form of asymmetric compensation, which is based on index-adjusted compensation fees, to study the pricing differences between index and non-index stocks. They do not link the agency problem from compensation with bubbles. Allen and Gale (2000) use the limited liability in bank loans, which gives rise to an agency problem similar to the one from UMC, to explain the existence of bubbles. Allen and Gale (2000) assume a risk-neutral world with one asset, and hence do not analyze either managers' portfolio choices or the interaction between a manager's personal risk aversion and the risk-distorting effect of his or her compensation contract. A more detailed comparison between our work and these studies is given in next section.

Before we move on to the literature review in next section, we show here why UMC is a reasonable assumption for China. We show that the claim that UMC is common in China is supported by both academic literature and public information from Chinese stock markets. Please note that UMC managers in our model is a simplification of the diverse investors in China with de facto UMC, including managers of SOEs, corrupted officials, as well as managers of investment companies and money funds.

First, the literature on the Soft Budget Constraint (SBC) indicates the existence of UMC in China. For example, Lin and Tan (1999) states “In a socialist economy, when a state-owned enterprise incurs losses, the government often provides it with additional funding, cuts its taxes, and offers other compensations. Coincidentally, the managers of an SOE (State-Owned Enterprise) also expect to receive financial
assistance from the State. Such a phenomenon is called the soft budget constraint (SBC)." This gives one account of SBC in China. Blayney (1999) gives another account, "Misappropriation and wasting of state assets has become an all-too-common problem in China. Too often, Chinese factory managers and local government officials, by a variety of stratagems, have been able to exploit loopholes in China's asset appraisal regime to transfer state assets to themselves or entities under their control." In general, a SOE manager can steal a larger portion of SOE assets in positive states than in negative states, and this explains why UMC is even worse than what the government allows.

In addition to the growing literature on SBC, there are also a few papers on compensation contracts of Chinese managers, namely Shirley and Xu (2002) and Xu (2001). Although the focus of these studies is on the impact of performance contracts on firms' performances, Shirley and Xu (2002) and Xu (2001) provide information showing that performance contracts in China tend to be based on profits, but not on losses. Further, they also show that the management compensation in SOEs tends to be risk-free rate based rather than index-adjusted. Also, they find few stock options in performance contracts, although stock options are very popular in North America. This gives a reason why UMC is more serious in China than in North America, for stock options with zero or very low exercise prices are essentially balanced compensation contracts.

Additional evidence for the existence of significant stock investment by SOE man-
agers in China comes from a crackdown on such illegal and improper investments in 1997. The official announcement by the government shows how serious a problem UMC is in Chinese stock markets. We quote part of this announcement here:

> Recently, there has been a sustained flow of capital from state-owned commercial banks to stock markets through a variety of channels. Some SOEs and listed companies invest in stock markets with bank loans. ... Some SOEs invest in stock markets with capital allocated for further corporate development and expansion. Such a situation not only boosts stock speculations in stock markets, but also puts the state-owned capital at high risk and jeopardizes the security of state-owned assets. The illegal trading activities by SOEs and listed firms must be prohibited so as to maintain orders in stock markets.

The magnitude of the impact of UMC on asset pricing also depends on the weight of institutional investors in stock markets. A researcher in the Shanghai Stock Exchange (SHSE), Honghui Sun (1998), finds strong evidence showing that the majority of investment in stock markets is controlled by institutional investors. In short, UMC is widespread in China, and managers with unbalanced compensation play a major role in asset pricing because they control the majority of the capital invested in stock markets.

The rest of this chapter proceeds as follows. Section 2.2 reviews the related litera-
ture, and section 2.3 develops the model: ACAPM. Section 2.4 characterizes ACAPM, and section 2.5 gives numerical analysis. After the discussion on the formation of bubbles in section 2.6, section 2.7 extends our analysis to North American stock markets, including the provision of a possible explanation for the equity premium puzzle with the unbalanced capital gains tax. Section 2.8 concludes. Appendices are provided on the assumptions concerning managers' personal investments, an extension of our model to multiple assets, and the effect of index-adjusted compensation in North America. The appendices also show the proofs.

2.2 Literature Review

This chapter is related to several fields, including agency problems, management compensation, fund performance, bubbles and soft budget constraints. In the following, we review the related literature in different groups.

2.2.1 Agency, Incentive Compensation, and Managerial Risk Choices

There has been a rich literature on principal-agent conflicts and moral hazard problems resulted from limited liability and/or unbalanced compensation structure, such as Jensen and Meckling (1976), Myers (1977), Fama (1980), Jensen and Murphy (1988
and 1990), and Garen (1994). For example, Jensen and Murphy (1990) emphasize that it is how managers are paid that matters most, not how much managers are paid. Jensen and Murphy (1988) also discuss the understanding of the internal incentive structures and call for viable economic explanations. There are also a number of papers discussing optimal contracting and the effect of incentive fees on managerial risk choices, such as Carpenter (2000), Dybvig, Farnsworth, and Carpenter (2001), Ou-yang (2000), Brander and Lewis (1986), and Nohel and Todd (2000). However, the existing literature limits itself to the field of corporate finance, and few have studied the effect of management compensation in the investment industry on asset pricing. Exceptions are Brennan (2000), Cuoco and Kaniel (2000), Allen (2001), and Arora and Ou-Yang (2001). Brennan (2000) studies the effect of symmetric incentive fees based on a benchmark portfolio, and hence focuses his analysis on the pricing differences between listed and non-listed stocks as well as related issues on portfolio choices. Arora and Ou-Yang (2001) study the impact of fund management compensation on asset pricing, but they limit their model to linear contracts which therefore excludes the case of unbalanced management compensation. Ou-Yang (2000) studies the contracting problem between investors and portfolio managers with exogenous equilibrium prices.

Cuoco and Kaniel (2000) and Allen and Gale (2000) are the closest to our work. In his presidential address, Allen (2001) points out the lack of research in the link between agency problems in the investment industry and asset pricing, and calls for
more work in this area. Although Allen and Gale (2000) do not discuss management compensation in the investment industry, their analysis of the credit risk is similar to our analysis of the unbalanced management compensation, and hence has an inherent link with our work. A close comparison between Allen and Gale (2000) and our work is to be discussed in details in Section 2.2.3.

Cuoco and Kaniel (2000) offers the only model that directly deals with pricing effects of asymmetric incentive fees, which is comparable to UMC in this chapter. However, their work limits itself to the pricing differences between index versus non-index stocks. Like our work, Cuoco and Kaniel (2000) study the effect of asymmetric management compensation on asset pricing. The key difference between Cuoco and Kaniel (2000) and our work is the structure of compensation contracts, and hence the major issues to explain. Cuoco and Kaniel (2000) assume an index-adjusted performance fee, and focus on the difference in the pricing of index versus non-index stocks. A key limitation of their study is that they say little about the formation of bubbles, or overpricing at the market level. In our model, the compensation contract is based on a manager's riskfree-rate-adjusted performance, not his index-adjusted performance. Such an assumption is closer to the real situation in Chinese stock markets, and can justify the existence of the strong form of bubbles in a rational equilibrium, which is important for explaining puzzles in China.

The techniques employed in Cuoco and Kaniel (2000) are also different from ours. Cuoco and Kaniel (2000) develop a continuous-time dynamic model to examine the
optimal investment by fund managers, while we carry out an analysis based on a static one-period mean-variance model. Without going through the amount of mathematics required of a continuous-time model, we are nonetheless able to explain key issues of concern and infer major implications of interest. An advantage of employing a simple model as in our work is the benefit of concise results and clear inferences. For example, simple functional analysis alone can show key economic implications on asset pricing in our model, while Cuoco and Kaniel (2000) must resort to numerical analysis to reach conclusions of similar nature.

Other than Cuoco and Kaniel (2000), few papers on asset pricing deal with the asymmetric nature of management compensation. Brennan (2000) studies the agency problem caused by symmetric compensation based on index adjusted performance, and finds supporting evidence using data from the NYSE. He urges two types of further work: modeling manager’s dynamic strategy and endogenizing the optimal compensation contract. Cuoco and Kaniel (2001) is the work aimed towards the first direction, while Carpenter (2000), Dybvig, Farnsworth, and Carpenter (2001) and Ou-yang (2001) are the work aimed towards the second direction. Our work is a study based on UMC which can link the agency problem with bubbles in China as well as other countries in a similar economic situation.

There do exist a number of other papers which are close to our analysis of the risk incentive of managers’ decision making, such as Brander and Lewis (1986) and Nohel and Tod (2000). These papers, though, do not study the effect of such principal-agent
problems in the investment industry on stock prices. In Brander and Lewis (1986), a
manager with limited liabilities aims to raise the firm's profits in good states and lower
the firm's profits in poor states, and make the firm's payoff riskier so as to exploit his
limited liability. Nohel and Tod (2000) is close to ours in the analysis of a manager's
choice among risky investments. In a static model with investments' future payoffs
following a uniform distribution, Nohel and Tod (2000) study the relationship between
a manager's risk-taking behaviour and different forms of compensation: fixed wage,
stock option, and free stocks. They show that a manager takes excessive risk when
the bonus for profits outweighs the penalty for losses. In this chapter, we not only
show that a manager will exhibit risk-seeking behaviour when his compensation is
sufficiently unbalanced, but also demonstrate the effect of such risk-taking behaviour
on asset prices. In addition, to infer more reliable empirical implications, we use a
normal distribution rather than the uniform distribution in Nohel and Tod (2000).

Lie (2000)'s work is also based on the existence of the type of problem we are
studying, but his work is limited to a firm's internal mechanism. Lie (2000) proposes
that disbursement of excess cash can mitigate the agency problem. In a dynamic
setting, Carpenter (2000) studies the effect of call options in managerial compensation
on managers' portfolio choices, and infers that incentive compensation "does not
strictly lead to risk-seeking". Carpenter (2000) also takes the price processes as
given, and hence does not study the link between managerial compensation and asset
pricing.
Heinkel and Stoughton (1994) study the problem of motivating managers to work harder in a multiple period setting, and find that the possibility of multiple period contracting can induce a manager to work to the mutual benefit of both the principal and the agent. Dybvig, Farnsworth, and Carpenter (2001) assume prices as given and study the optimal compensation contract. They show that a performance-based component should be included in the optimal contract, and such a component is symmetric in the first-best case, though there is no indication such a component should still be symmetric in the third-best case where agents truthfully reveal their signals. To my understanding, even these papers are not against the existence of indirect asymmetric incentive fees in the real world. For example, the multiple period contracting might be interpreted as one indirect form of incentive fee.

There is also empirical evidence showing that the structure of management compensation does matter in reality. For example, using data of 153 firms and a sample period of 1979-1980, Mehran (1995) finds supporting evidence of incentive compensation, which also suggests that the form rather than the level of compensation is what motivates managers to increase firm value.

2.2.2 SBC in Transitional Economies

Recently, there has been a growing literature in the area of Soft Budget Constraint (SBC), which is a typical problem in transitional economies such as China. "The
challenges of the market economy in China for economic theory touch on private versus public ownership of assets and ... individualism versus the collective good ...” says Chow (1997), who advised China in the 1980’s and 1990’s. This points out the need for new development in theory to solve problems in transitional economies, especially the half born market economy in China.

Under such a background, SBC in State-Owned Enterprises (SOEs) rises in the literature as a base for the development of some new theories. SBC normally refers to the governmental subsidy offered to SOEs when they are losing money, as well as the lack of punishment on the managers when SOEs are not performing well. Meanwhile, when SOEs do perform well, managers can legally claim a portion of the profits as bonus, and even take out more in other forms such as perks.

Kornai (1980) is among the first who study the SBC problem in central-planned economies. As more and more socialist economies change to market economies, the SBC problem has attracted the attention of more and more researchers, such as Chow (1997), Jefferson (1998), Lin and Tan (1998), Lin, Cai and Li (1999), and Maskin (1999). The literature has also discussed possible ways to solve the SBC problem. In our work, the focus is to measure the impact of such a problem on the pricing behaviour in Chinese Stock Markets.
2.2.3 Bubbles

In the existing literature on bubbles, there is a lack of models that use standard assumptions to rationalize bubbles, as described by Franklin Allen (2001):

"How can asset prices get so high? The standard asset-pricing paradigm has little to say about this. ... within the paradigm, bubbles can only arise in exceptional circumstances. However, there are many theories of bubbles with assumptions that lie outside the paradigm."

This chapter is our approach to justify the existence of bubbles in a rational equilibrium, with assumptions lying inside the paradigm.

Allen (2001) emphasizes the impact of agency problem in financial institutions on the equilibrium price level in the market. He urges research in this direction, which has been largely neglected by the literature despite its importance. As Allen (2001) points out, previous attempts to explain anomalies such as bubbles have assumed market incompleteness, transaction costs, and other kinds of frictions or even irrational behaviours. Our work employs the standard paradigm and account for the existence of UMC in China. There is no need for any frictions.

Among papers on bubbles, the model by Allen and Gale (2000) is the closest to ours. Like our study, Allen and Gale (2000) also point out the inherent relationship between an agency problem and asset pricing. In their model, they use credit risk
of investors, which has a similar effect on asset pricing as UMC in our model, to explain the formation of bubbles. While the apparent difference between their work and ours is the source of the agency problem, which is the credit risk in their model and the UMC in ours, the more distinctive difference lies in the following. Allen and Gale (2000) assume a risk-neutral world with a single asset that has a future payoff following an unspecified distribution on an interval, which takes the form of a uniform distribution in their numerical analysis. Hence, the model by Allen and Gale (2000) lacks implications for risk analysis, such as how the risk-aversion of an agent interacts with his risk-distorting incentive contract. In our model, we assume risk-averse individuals and a Gaussian distribution of the risky asset's future payoffs. This enables us to derive richer implications, such as why and when a risk-averse manager makes risk-seeking investment decisions for the fund under his management. In addition, we analyze UMC managers' portfolio choices in our extension to a two-asset model. Further, our model has assumptions closer to the reality in China, and hence explains the situation in Chinese stock markets better. Our model also offers a richer set of testable implications to be carried out in empirical analyses.

Other than Allen and Gale (2001), there are also a number of other studies on bubbles that are related to our work. For example, Abreu and Brunnermeier (2001) show that bubbles can exist despite the presence of rational arbitrageurs as long as there is a synchronization problem, which means the arbitrageurs are unable to coordinate their selling strategies in a timely manner. This synchronization problem
is one form of market inefficiency. In our model, no such inefficiency of information flow is required of the stock market. Tirole (1982) concludes that no speculation can exist in rational equilibrium under his setting, and bubbles rely on the myopia of traders. Our work shows that bubbles can exist in a rational equilibrium without any myopic traders, and the key difference between our model and Tirole (1982) is the existence of UMC.

2.2.4 Chinese Stock Markets

There has been growing interest in the young but rapidly expanding Chinese stock markets. Among others, the A- and B-Share price difference is one of the major topics that have attracted many researchers. The arguments for higher A-Share prices than B-Share prices vary among different studies, such as liquidity, information asymmetry, deadweight costs, and monopolist government. We hypothesize that UMC is more unbalanced for Chinese managers than for North American managers. The link to A- and B-Share price differences come from the fact that Chinese managers cannot purchase B-Shares. This naturally provides another angle to explain the higher

2As defined in Chapter I, Ownership Restrictions and Market Segmentation, Chinese A-Shares and B-Shares are the identical shares issued by the same Chinese firms to domestic and foreign investors respectively.

3Owing to a policy change in 2001, Chinese investors are now allowed to invest in B-Share markets subject to certain restrictions. Ever since the change, the B-Share markets have been going up a lot, and there are much smaller gaps left between A-Share and B-Share prices.
prices of *A-Shares* than *B-Shares*.

Compared with our Chapter I, another chapter titled *Market Segmentation and Ownership Restrictions*, this chapter serves more as an integral complement rather than a completely different explanation. As discussed above, this chapter helps to explain why *A-Share* prices are higher than *B-Share* prices in China by adding UMC as a pricing factor. In Chapter I, we focus on the impact of the monopolist government on asset pricing. An implicit assumption of Chapter I is that UMC does not exist in Chinese investment industry. In this chapter, we acknowledge the existence of UMC and its dramatic impact on stock prices. Meanwhile, we leave aside the government's share issuance decision in this chapter, and fix the supply so as to focus our attention on the link between UMC and asset pricing. If, rather than a partial equilibrium, a general equilibrium with endogenous supply had been used to carry out our analysis in this chapter, this chapter would have been considered as an extension of Chapter I. Therefore, the two chapters are in fact sister chapters which complement each other's analysis, not two mutually excluding theories that compete with each other.

Another aspect of the Chinese stock markets has been developed by Tian (2000) who shows that the state-ownership has a U-Shape relationship with listed firms' accounting performances. This indicates a stricter control and monitoring of state-owned assets when there is a larger state-ownership. Similarly, Xu and Wang (1997) provide empirical evidence that the state-ownership is adversely related to a firm's performance. They use the firms listed on Chinese Stock Markets as the sample,
and study the relationship between concentration of state-ownership and the firm's economic performance. This is consistent with the belief that the more concentration of state-ownership a firm has, the more likely it receives more subsidies from the government.

Gao and Peng (1998a and 1998b) show that the consensus opinion of Chinese investors is that stock prices are too high relative to their intrinsic values. It is not so convincing to explain this by simply claiming that Chinese investors are born to be gamblers. In fact, Kachelmeier and Shehata (1992) conduct an interesting study and find no differences between the risk preferences of Chinese individuals and those of North American individuals. This study speaks for the advantage of our model from another angle.

2.3 Agency Capital Asset Pricing Model (ACAPM)

2.3.1 Setup

We use a static one-period model to study the impact of UMC on asset pricing in China. There are $n_U$ UMC managers and $n_B$ BMC managers in the market, where the supply of a single risky asset is fixed. Here BMC refers to Balanced Management Compensation, where a manager gets the same bonus out of $1$ profit as the penalty out of $1$ loss. The payoff of the risky asset at the end of the period, $\pi$, follows a
normal distribution, \( N(\mu, \sigma) \). To keep the model as parsimonious as possible, we assume a single risky asset throughout the main text, and leave an extension to the case of multiple assets in Appendix A.2. All managers are risk averse individuals with a standard CARA utility function, \(-exp(-a\tilde{w})\), where \(a\) is a positive constant and \(\tilde{w}\) stands for the end-of-period wealth.

Each UMC manager has an identical contract, and we denote Manager \(k\) as the representative UMC manager. The size of Fund \(K\) is \(W_K\). Manager \(k\) receives a fixed amount of basic salary \(\delta_k\), plus a bonus of \$c_g\ from fund \(K\)'s \$1 profit, and minus a penalty of \$c_l\ for fund \(K\)'s \$1 loss. Here the profit and loss are riskfree rate adjusted performance, where the riskfree rate is \(r\). For any \(x \in \mathbb{R}\), let \(x^+ = MAX\{x, 0\}\) and \(x^- = MIN\{x, 0\}\), and write manager \(k\)'s compensation contract as
\[
\tilde{w}_k = \delta_k + c_g D_k(\tilde{\pi} - RP)^+ + c_l D_k(\tilde{\pi} - RP)^-,
\]
where \(R = 1 + r\), and \(D_k\) is Fund \(K\)'s investment in the risky asset. Same as any other individual, manager \(k\)'s objective function is to maximize his personal utility at the end of the period, and his reserve utility is assumed to be satisfied by \(\delta_k\) alone. In general, we assume that \(c_g \geq c_l\) in this chapter unless otherwise specified.

Meanwhile, each BMC manager also has an identical contract. We denote Manager \(q\) as the representative BMC manager, who controls fund \(Q\). The size of Fund \(Q\) is \(W_Q\). Manager \(q\) gets a fixed amount of wage \(\delta_q\), plus a fixed portion of Fund \(Q\)'s riskfree-rate-adjusted performance. This fixed portion is set to be \(c_0\). Denoting Fund \(Q\)'s investment in the risky asset as \(D_q\), we write manager \(q\)'s compensation
contract as follows: \( \bar{w}_q = \delta_q + c_0 D_q (\bar{\pi} - RP) \). Manager q’s objective function is also to maximize his personal utility at the end of the period, and his reserve utility is assumed to be satisfied by \( \delta_q \).

Under this setting, managers with balanced compensation behave like investors who are investing with their own wealth, and so without loss of generality, we have only institutional investors in our model: the role of individual investors is redundant, being subsumed by the role of BMC managers. Fund managers can invest in both the riskless asset and the risky asset. In addition, we do not consider fund managers’ personal investment in the stock market. This assumption is consistent with regulations in China, and more importantly, our model does not lose any generality because of this assumption, for as we shall show in Appendix A.1, fund managers will not make any such investment anyway even if they are allowed to do so.

The total claims on the single risky asset is normalized to one share. This share is infinitely divisible, and a portion of it is sold out as negotiable shares in the market. To be consistent with the standard terminology, we still use the plural shares when referring to the amount of demand and/or supply.

Short sales are not allowed in our model, as is the real situation in Chinese stock markets. As usual, there is only one price for the risky asset since we are not studying B-Shares, Chinese shares accessible to foreign investors only, in this chapter.
2.3.2 Managers with Balanced Compensation

At the beginning of the period, manager q, a representative BMC manager, solves the following problem:

\[
\max_{D_q} E\{U_q(\tilde{w}_q)\} = E\{-\exp(-aw_q)\} \tag{2.1}
\]

s.t.

\[
W_Q = D_qP + C_q \tag{2.2}
\]

\[
\tilde{w}_q = \delta_q + c_0D_q(\tilde{\pi} - RP) \tag{2.3}
\]

\[
D_q \geq 0 \tag{2.4}
\]

where equation (2.2) is the budget constraint, equation (2.3) is the compensation contract for manager k, and equation (2.4) is the no short-sale constraint.

Equations (2.1-2.4) form a mean-variance maximization problem where the objective function is

\[
\max_{D_q} a c_0D_q(\mu - RP) - \frac{1}{2}a^2c_0^2D_q^2\sigma^2 \tag{2.5}
\]

Taking first order conditions, we get manager q's demand for the risky asset

\[
D_q = \text{MAX} \left\{ \frac{\mu - RP}{c_0a\sigma^2}, 0 \right\} = \frac{(\mu - RP)^+}{c_0a\sigma^2}. \tag{2.6}
\]

Note that \(D_q\) must be no less than 0 because of the no short-sale constraint.

Now we discuss whether manager q's contract can put his interests in alignment with fund q's owners. If fund q was a private fund owned by a single person who had
the same risk attitude as manager q, then the owner would purchase \((a\sigma^2)^{-1}(\mu-RP)^+\) rather than \((c_0a\sigma^2)^{-1}(\mu-RP)^+\), and so it seems that manager q would behave in a less risk averse manner than what the fund owners desire. However, this argument is not necessarily true because fund q may be owned by many investors. If fund q has \(n\) identical owners with same risk attitudes as manager q, the investment decision of manager k is exactly as what the \(n\) owners desire if \(c_0 = 1/(n+1)\).\(^4\) When \(n\) is large, it is reasonable to assume that manager q's variable wealth from his compensation is roughly at the same scale as the average equity claim per fund q's owner. In such a situation, the compensation ratio \(c_0\) is about \(1/(n+1)\), and so manager q's investment decision is in alignment with the risk attitudes of fund q's owners. The argument above shows that BMC does not cause a serious agency problem between fund owners and their manager. Alternatively, assuming relative constant risk aversion would give the same result, but it is not discussed here since the analysis above suffices.

### 2.3.3 Managers with Unbalanced Compensation

Manager k, a representative UMC manager, solves

\[
\max_{D_k, c_k} E\{U_k(\Bar{w}_k)\} = E\{-exp(-a\Bar{w}_k)\}
\]

\(^4\)Investors need to consider k's free stock options, and \(c_0\) should be set at \(1/(1+n)\) rather than \(1/n\) to perfectly align k's interest with fund owners.
s.t.

\[ W_K = D_k P + C_k \quad (2.7) \]
\[ \tilde{w}_k = \delta_k + c_g D_k (\tilde{\pi} - RP)^+ + c_l D_k (\tilde{\pi} - RP)^- \quad (2.8) \]
\[ D_k \geq 0. \quad (2.9) \]

Equation (2.7) is the budget constraint, equation (2.8) is the compensation contract for manager k, and equation (2.9) is the no short-sale constraint.

To solve manager k’s maximization problem, we first derive Lemma 1:

**Lemma 1**  Manager k’s utility maximization problem is equivalent as the following:

\[
\max_{D_k \geq 0} \frac{-1}{h(\Delta - c_l a D_k \sigma)} + \frac{-1}{h(-\Delta + c_g a D_k \sigma)} \quad (2.10)
\]

where

\[ \Delta = \frac{\mu - RP}{\sigma} \quad (2.11) \]
\[ h(x) = \frac{f(x)}{1 - N(x)} \quad (2.12) \]

Here \( f(x) \) and \( N(x) \) are, respectively, the density function and distribution function of a standard normal variable. The function \( h(x) \) is increasing, convex, approaches \( x \) as \( x \to \infty \), and approaches 0 as \( x \to -\infty \).

The function \( h(x) \) is called hazard rate\(^5\), and \( \Delta \) is the Sharpe ratio. The Sharpe\(^5\) hazard rate is a frequently encountered term in reliability or survival theory. Its inverse, \( M(x) = (1 - N(x))/f(x) \), is the well-known Mill’s ratio in statistics.

\(^5\)Hazard rate is a frequently encountered term in reliability or survival theory. Its inverse, \( M(x) = (1 - N(x))/f(x) \), is the well-known Mill’s ratio in statistics.
ratio also provides a natural metric for the strength of bubbles: the lower the Sharpe ratio, the stronger the bubbles.

Taking the first order condition of the simplified maximization problem in Lemma 1, we obtain

**Lemma 2** Assuming $D_k > 0$, the first order condition of equation (2.10) is as follows:

$$B_g c_g = B_l c_l$$  

(2.13)

where

$$B_g = 1 - \Phi(-\Delta + c_g aD_k \sigma)$$  

(2.14)

$$B_l = 1 - \Phi(\Delta - c_l aD_k \sigma)$$  

(2.15)

$$\Phi(x) = \frac{x}{h(x)}$$  

(2.16)

where $h(x)$ is as defined in equation (2.12), and $\Delta$ is the Sharpe ratio.

In (2.13), $B_g$ represents the marginal base of incentive compensation in states of positive performance. $B_l$ is the counterpart of $B_g$ in states of negative performance. Equation (2.13) indicates that a larger $c_g$, the bonus rate for positive performance, than $c_l$, the penalty rate for negative performance, must be met with a proportionally smaller $B_g$ than $B_l$. Economically, the first order condition in Lemma 2 requires that the marginal bonus from holding more of the risky asset must be equal to the marginal penalty.
Equation (2.14) shows that $c_g$ is part of the expression of $B_g$, which fits intuition well since manager $k$'s bonus also depends on the number of shares purchased for Fund K, and hence on the bonus rate, $c_g$. The logic is similar for $B_l$ and $c_l$.

The transcendental equation (2.13) has no closed form solution. Therefore, we cannot get an explicit pricing function. However, we can derive an implicit pricing function from equation (2.13), and then study major issues of concern by characterizing this implicit pricing function.

2.3.4 Equilibrium

Putting together the demand of UMC and BMC managers, we solve the price in a partial equilibrium with fixed supply. The market clearing condition is

$$S = n_B D_q + n_U D_k$$  \hspace{1cm} (2.17)

At the beginning of the period, if the risky asset’s Sharpe ratio is negative, a BMC manager does not purchase any shares of the risky asset. Note that a manager can not take a short position owing to the no short-sale constraint. In this case, only UMC managers invest in the stock market, and the market clearing condition (2.17) reduces to $D_k = S/n_U$. Substituting $S = n_U D_k$ into (2.13), we have:

$$(1 - \Phi(\Delta - c_l aS\sigma/n_U))c_l = (1 - \Phi(-\Delta + c_g aS\sigma/n_U))c_g, \quad \Delta \leq 0. \hspace{1cm} (2.18)$$

On the other hand, if the risky asset’s Sharpe ratio is positive, the demand of
manager q is positive. Substituting (2.6) and (2.17) into (2.13), and canceling $D_k$ and $D_q$, then rearranging, we get:

$$(1 - \Phi((1 + \frac{c_l}{c_0} n_B) \Delta - c_l a S \sigma / n_U)) c_l = (1 - \Phi(-(1 + \frac{c_g}{c_0} n_B) \Delta + c_g a S \sigma / n_U)) c_g, \quad \Delta > 0. \quad (2.19)$$

Combining equation (2.19) and equation (2.18), we get an implicit pricing function for $P$ in the partial equilibrium:

$$[1 - \Phi(\Delta + \frac{c_l}{c_0} n_B \Delta + - c_l a S \sigma / n_U)] c_l = [1 - \Phi(-\Delta - \frac{c_g}{c_0} n_B \Delta + c_g a S \sigma / n_U)] c_g \quad (2.20)$$

If we relax the assumption that $c_l \leq c_g$ in the analysis above, the same results still hold as long as $D_k > 0$. However, if $D_k = 0$ because of a much larger value of $c_l$ than $c_g$, the model shall collapse to a situation with only BMC managers left in the market, and equation (2.20) should be replaced with the following pricing function:

$$P = \frac{\mu - c_0 a S \sigma^2 / n_B}{R} \quad (2.21)$$

### 2.4 Characterization of the ACAPM

Traditional CAPM determines the pricing of securities under a perfect market, where no agency problems exist. By contrast, we take into account the agency problem resulted from Unbalanced Management Compensation (UMC), which makes the investment decision of a fund manager different from the one fitting into the best interests of fund owners. In CAPM, a risky asset’s market price only depends on its risk,
or say the dispersion of its future payoffs. In this model, however, the market price depends on not only the dispersion of the risky asset's payoff, but also fund managers' compensation contracts. Using the implicit pricing function (2.20), we can extract an asset pricing model where the agency problem caused by UMC is fully taken account of. Such a model is named Agency Capital Asset Pricing Model (ACAPM) in this chapter.

2.4.1 UMC and Price

First, we study how UMC affects the market price in equilibrium. We define a measure, \( m = \frac{c_g}{c_t} \), to gauge the severity of UMC. It is clear from \( m \)'s definition that the more upward skewed manager \( q \)'s compensation is, the higher the value of \( m \) should be.

Although there is no explicit solution to the transcendental equation (2.20), we can study how market price varies as \( m \) changes by inspecting the implicit derivative function of \( P \) with regard to \( m \). Without loss of generality, we hold \( c_g \) as a constant and allow \( c_t \) to vary in the range of \((0, c_g] \) so as to study how market price reacts when \( m \) changes.

Taking derivatives of \( p \) with regard to \( m \), rearranging, get
Proposition 1 For $c_l \in (0, c_g]$, $\partial P / \partial m > 0$. Further,

$$P \rightarrow \frac{\mu - \frac{c_g c_0}{n c_0 + n c_0} a \sigma^2}{R} \text{ as } m \rightarrow 1$$

(2.22)

and

$$P \rightarrow \infty \text{ as } m \rightarrow \infty$$

(2.23)

Proposition 1 shows that the lower the penalty rate, the higher the market price. In addition, as long as the penalty rate, $c_l$, is small enough, $P$ can be much higher than its intrinsic value since $P \rightarrow +\infty$ as $m \rightarrow +\infty$. This offers an explanation to why A-Share prices in China are widely considered to be much higher than their intrinsic values, and why Chinese investors still invest in such an overpricing market.

BMC managers do not invest in the stock market when there is a strong form of bubbles, where $c_l$ is so low that the Sharpe ratio is negative.

In China, stock markets are widely considered to be a “policy market”, or “governmen­tal market”, partly owing to the fact Chinese stock markets often move up and down abruptly, and sometimes turbulently, as the government changes its policy. One reason to this phenomenon is the government’s power to change the intensity of its monitoring on the investment by SOE managers and government officials. These managers and officials are the de facto UMC managers in this model, and the monitoring on their investment in stock markets has significant impact on market prices. When the government loosens restrictions on the investment by these UMC managers, market prices shall go up. Or say, when $m$ and/or $n_U$ goes up, $p$ rises. This is
a scenario that rising bubbles can form in Chinese stock markets.

2.4.2 Risk and Price

In this subsection, we examine how market price $P$ varies as the dispersion of future payoffs, which is measured by $\sigma$ here, changes. To do so, we first take derivatives of $P$ with regard to $\sigma$, and then get the following proposition.

**Proposition 2** With all other parameters fixed, the relationship between $P$ and $\sigma$ in equilibrium, which corresponds the risk-return relationship in the market, is as follows

$$\frac{\partial P}{\partial \sigma} = \begin{cases} < 0, & \Delta > -aS\sigma c_\theta / n_U \\ \geq 0, & \Delta \leq -aS\sigma c_\theta / n_U \end{cases}$$

(2.24)

where $c_\theta$ is a weighted average of $c_\theta$ and $c_t$.

This proposition shows that the risk-return relationship depends on the market condition measured by the Sharpe ratio. When the Sharpe ratio is positive, the risk-return relationship is positive. This indicates that the stock market exhibits risk-averse behaviour even if there is a distortion in asset pricing from UMC, as long as such a distortion is not serious enough to cause a market return lower than risk-free rate. Therefore, a low $c_t$ relative to $c_\theta$ does not always cause a negative risk-return relationship.

When $c_t$ is so low that the Sharpe ratio is lower than $-aS\sigma c_\theta / n_U$, the risk return relationship becomes negative. This is why stock market may exhibit risk-seeking
behavior when UMC is severe.

When \( 0 > \Delta > -\alpha S\sigma c_d/n_U \), however, risk-return relationship is positive rather than negative, despite the existence of the strong form of bubbles. Such a situation lies in the fact that managers are themselves risk-averse individuals. The investment decision of a UMC manager is equivalent to a decision of investing in Asset II, whose end of period payoff is \( \tilde{\pi}_{II} = (\tilde{\pi} - RP)^+ + (c_t/c_g)(\tilde{\pi}_d - RP)^- \), with his personal wealth. With price fixed, an increase in \( \sigma \) has two effects on the distribution of \( \tilde{\pi}_{II} \). On one hand, it increases the expected payoff of Asset II, \( E\{\tilde{\pi}_{II}\} \). On the other hand, it also increases the dispersion of Asset II's payoff, \( \sigma_{II} = \sqrt{VAR(\tilde{\pi}_{II})} \). A UMC manager does not like the latter effect, and so he pays less for one unit of \( \tilde{\pi} \) when the first effect cannot outweigh the latter effect. This is how \( P \) may be decreasing with regard to \( \sigma \) even when a strong form of bubbles exists.

\footnote{Mathematically, there can be a situation when the increase in \( \sigma \) does not increase \( E\{\tilde{\pi}_{II}\} \). That is, if \( RP - \mu \) is so high relative to \( \sigma \) that \( E\{c_g(\tilde{\pi} - RP)^+\} \) is smaller than \( -E\{c_t(\tilde{\pi} - RP)^-\} \), a small increase in \( \sigma \) has a negative, rather than positive, effect on the expectation of \( \tilde{\pi}_{II} \). However, such a situation is not feasible in this model, for it requires the expectation of \( \tilde{\pi}_{II} \) to be negative in the first place, which cannot exist in equilibrium: a UMC manager is a risk averse individual as well, and so does not buy a risky asset with a negative mean of payoff in such a situation.}
2.4.3 Price and Demand

When the risk preference in the market is distorted by UMC, one may wonder how price-demand relationship changes. Moreover, an analysis of the price-demand relationship is also helpful for linking this model with the one in Chapter I, Market Segmentation and Ownership Restrictions.

The relationship between $P$ and $S$ is as follows:

**Proposition 3** The more shares in the market, the lower the market price. That is,

\[
0 > \frac{\partial P}{\partial S} = \begin{cases} 
\frac{-ac_0 \sigma^2}{\beta w U}, & \Delta > 0; \\
\frac{ac_0 \sigma^2}{\beta w U}, & \Delta \leq 0.
\end{cases}
\]  

(2.25)

where $c_0$ is a weighted average of $c_g$ and $c_l$, and $c_\eta$ is a weighted average of $c_l/(1 + \frac{c_g N B}{c_0 N_U})$ and $c_g/(1 + \frac{c_g N B}{c_0 N_U})$.

Noting that $c_\eta$ and $c_0$ are positive, it is easy to prove that the derivative of $P$ with regard to $S$ is always negative. The negative sign of $\frac{\partial P}{\partial S}$ fits intuition well, for a lower $c_l$ than $c_g$ can only change the slope of Price-Supply relationship, but not the sign of it.

2.4.4 Fundamental Value and Market Value

In a perfect market where a firm’s market value is equal to its true value, a change in the firm’s fundamental value should cause a same change in its market value.
However, in a market with UMC, it is obvious that a firm’s market value is higher than its true value, and it is interesting to know how the market value reacts when the firm’s fundamental value changes. In our model, a shock to \( \mu \) is a change in the asset’s fundamental value, and we examine in the following how the market price varies as the value of \( \mu \) changes.

**Proposition 4** *The market value is linear with regard to \( \mu \), the risky asset’s expected future payoff, and the coefficient is \( 1/R \). That is,*

\[
\frac{\partial P_A}{\partial \mu_d} = \frac{1}{R} \tag{2.26}
\]

This shows that the overpricing in a market with UMC managers only comes from the misvaluation of the risk component of the risky asset’s future payoffs.

Caution is needed in empirical tests. Although the market value changes the same amount when there is a shock to the risky asset’s fundamental value, the percentage change of the market price is not the same as the percentage change of the fundamental value. Since the market price is higher than the fundamental value in our model, the denominator is higher when calculating returns. This has an implication for the comparison between *A-Share* and *B-Share* markets: when there is news about a shock to a firm’s cash flow, the abnormal return in *A-Share* market should have a smaller magnitude than in *B-Share* market. However, if the news also affects the dispersion of future payoffs, it may cause a larger change in *A-Share* returns than in *B-Share* returns. This is consistent with evidence in the literature.
2.5 Numerical Analysis

In this section, we conduct a numerical analysis of ACAPM for better understanding of the results in the model. To study the relationship between market price and the two pricing factors — risk and UMC, we first calculate the market price in equilibrium as $c_l$ and $\sigma$ take on different values in corresponding ranges. Then, to compare the market shares of UMC versus BMC managers in different situations, we also calculate the demand of representative manager $q$ and $k$ as $c_l$ and $\sigma$ vary. Last, we also calculate the utility of representative manager $q$ and $k$ for all combinations of $(c_l, \sigma)$, and then study how the utility of different managers is affected by UMC as well as the total risk of the asset.

In this numerical analysis, we set parameters as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, $c_0 = c_g = 0.05$, $\delta_q = \delta_k = 1$. We then change $c_l$ from 0.001 to 0.1 by a step of 0.001, and $\sigma$ from 50 to 350 by a step of 3. The range of penalty rate, $c_l$, includes not only values lower than $c_g$, but also values higher than $c_g$, which enables us to study different effects of UMC on asset pricing as the compensation is skewed in opposite directions. When $c_l = 0.05$, it is equivalent to a market with BMC managers only. $n_B = n_U$ means that the managers in the market are equally divided into the two categories, and we will change this equality later in this chapter to study the impact of the proportion of UMC managers on asset pricing. The riskfree rate, $r$, is set to be 10%, which is close to the interest rate in China in
2.5.1 Analysis of Market Price and Compensation Ratios

Using the implicit pricing function, we calculate the market price in equilibrium for different combinations of \((c_l, \sigma)\), and present the results in Figure I. Figure I shows that the market price increases as the penalty rate, \(c_l\), decreases, as documented in Proposition 1. Meanwhile, the relationship between market price and the dispersion of the risky asset’s future payoff depends on the value of \(c_l\). When \(c_l\) is high, price and risk have a negative relationship, similar to the case in a standard CAPM. However, as \(c_l\) becomes smaller and smaller, the price-risk curves start to bend upward. When \(c_l\) is sufficiently small, price and risk have a positive relationship. The diagram shows that the risky asset’s price can be higher than the present value of its future payoff discounted at the riskfree rate, which is 1000 in this analysis. This verifies the existence of the strong form of bubbles in a rational equilibrium when \(c_l\) is sufficiently small.

Figure IA provides cross-sectional views of Figure I by fixing \(\sigma\) at 50, 200, and 350 respectively. These price-penalty rate curves show that the market price is increasing w.r.t. \(m = c_g/c_l\), or say decreasing w.r.t. \(c_l\). The sign of such a relationship is independent of \(\sigma\). The value of \(\sigma\), however, does affect how fast \(P\) decreases w.r.t. \(c_l\). The higher the value of \(\sigma\), the faster \(P\) increases as \(c_l\) decreases.
Figure IB gives four price-risk curves by fixing $c_l$ at 0.001, 0.03, 0.05, and 0.1. This enables us to study the shape of price-risk curves as $c_l$ takes on different values. When $c_l = 0.5$, the model reduces to a world where all managers have balanced compensation, and the market price is decreasing w.r.t. $\sigma$, same as in a traditional CAPM. However, when $c_l = 0.001 \ll 0.05$, the market price is strictly increasing with regard to the dispersion of the risky asset’s future payoff, $\sigma$. This indicates risk-seeking investment behaviour in the market. Moreover, the market price can be higher than $\mu/R$ even when $c_l$ is just moderately lower than $c_g$, as shown in the price-risk curve at $c_l = 0.03$. This is interesting, for it indicates that a small gap between $c_g$ and $c_l$ in the real world can make a big difference in asset pricing. The relationship between risk and market price, however, is not so clear at $c_l = 0.03$, and a close view is provided later in Figure IC.

In Figure IB, the price-risk curve at $c_l = 0.1$ shows that, when the penalty rate is higher than the bonus rate, market price is even lower than what it would be in a traditional CAPM, for the stringent penalty drives UMC managers to make more risk-averse decisions than BMC managers. This may help to show why unbalanced capital gains taxes can result in high risk premium. For a fixed level of risk, it is clear that a higher $c_l$ would result in a lower price, and hence a higher return. This is why the risk premium in a world with unbalanced capital gains taxes can be higher than in a traditional asset pricing model. Such an argument may offer an explanation to the equity premium puzzle, which is claimed by many to be the #1 anomaly in asset
Figure IC is simply a close view of the price-risk curve at $c_l = 0.03$. With $\sigma$ in the range $(50,350)$, $P$ reaches its maximum value of 1023.9687 at $\sigma = 260$. Noting that the price is higher than 1000 throughout the region, this graph demonstrates a scenario where the market price can be decreasing with regard to the dispersion of the risky asset’s future payoffs, even in a market with the strong form of bubbles. From the analysis in Proposition 2, we know that a UMC manager prefers more risk when $\sigma$ is less than 260 because of the distortion effect of the unbalanced compensation. As $\sigma$ exceeds 260, though, any additional increase in $\sigma$ cannot bring a large enough increase in the expectation of $\tilde{\pi}_{II} = (\tilde{\pi} - 0.1P)^+ + 0.03(\tilde{\pi} - R\tilde{P})^- / 0.05$ to compensate its impact on the dispersion of $\tilde{\pi}_{II}$ . Therefore, the market price would fall. In short, the price-risk curve bends downward in the range $\sigma \geq 260$ just because UMC managers are also risk-averse individuals themselves.

Figure IC is also interesting for analyzing a UMC manager’s choice of diversification when there are multiple risky assets available in the market. This is to be discussed further in Appendix A.2.
2.5.2 Analysis of Market Price and the Number of UMC Managers

The number of UMC managers also affects the level of market price in equilibrium, which can help explain the formation of bubbles, as well as price differences between Chinese A-Shares and B-Shares later in this chapter. In addition to the setting where \( n_U = n_B = 25 \), we also calculate the market price in a different setting where \( n_U = 10 \) and \( n_B = 40 \). Then, we calculate the price difference between two settings, \( P_{\text{diff}} = P_{n_U=25} - P_{n_U=10} \). Here \( P_{n_U=25} \) is the market price with 25 UMC managers, and \( P_{n_U=10} \) is the market price with 10 UMC managers. Figure II show the results. When \( c_l < c_g \), the more UMC managers, the higher the market price. When \( c_l > c_g \), the price difference is the other way around.

Figure IIA shows a cross-sectional view at \( \sigma = 200 \). It offers a closer view, clearly showing that \( P_{\text{diff}} > 0 \) when \( c_g > c_l \), and \( P_{\text{diff}} < 0 \) when \( c_g < c_l \).

2.5.3 Analysis of Demand

To compare the market share of each type of managers, we calculate manager k and q’s demand for the risky asset in equilibrium. Figure III show the results, and the parameters are the same as in Figure I. When \( c_l = 0.05 = c_g \), the demand of manager k is the same as the demand of manager q. When \( c_l < 0.05 = c_g \), manager k purchases more of the risky asset than manager q. When \( c_l \) is so small that the market price
is higher than or equal to 1000, the demand of manager q is 0. Because of the no short-sale constraint, the demand of a manager cannot be negative even if \( c_l \) further decreases, and hence the demand of manager k stays at 0.02.

On the other hand, when \( c_l > 0.5 \), manager k purchases less of the risky asset than manager q, for manager k faces a harsher penalty than manager q, and becomes more risk-averse. Figure IIIA is a cross-sectional view of Figure III at \( \sigma = 200 \), and gives a clear view of the relationship between \( D_q \) and \( D_k \).

2.5.4 Analysis of Managers' Utility

It is interesting to know how a manager's utility is affected by the compensation structure at a macro level, such as whether a manager's utility in a UMC world is higher than in a traditional setting without any UMC. To investigate this, we study how the utility of different managers changes as the compensation contracts of UMC managers vary. Figure IV shows the results of our calculation, and Figure IVA is a cross-sectional view at \( \sigma = 200 \). Manager k, a representative UMC manager, does not necessarily have a higher utility level as the penalty rate, \( c_l \), decreases. This implies that UMC is not only harmful to the benefits of BMC managers and fund owners, but also harmful to UMC managers themselves at an aggregate level when \( c_l \) is too low. There are two effects of low \( c_l \). On one hand, a very small \( c_l \) gives an individual manager protection against poor states; on the other hand, he also suffers from a
higher market price in equilibrium because of the higher demand from other UMC managers.

This analysis shows that UMC can cause a typical Pareto inefficiency because of a market failure from externalities. We suggest that the Chinese government may mitigate this problem by giving SOE managers stock options with an exercise price of 0. This can reduce the ratio of $c_g/c_l$, even if it is impossible to keep SOE managers from grabbing a larger portion of profits in positive states\(^7\).

### 2.6 Bubbles

In literature, there are two different types of definitions of bubbles. One type refers to the rising of stock prices without any fundamental justifiability and the eventual market crash, and the other type only refers to higher stock prices than intrinsic values. The first type mainly describes dynamic properties of bubbles, and the second type only gives static properties. For simplicity, we adopt the second type of definition in this chapter, and it is easy to justify the rise and fall of prices once the overpricing is explained.

ACAPM helps to rationalize the existence of bubbles in China, as well as other countries with unbalanced compensation. It is shown earlier that the second type of bubbles can exist in a rational equilibrium. For the first type of bubbles, which

\(^7\)Stock options are rare in State-Owned Enterprises.
requires rising prices in addition to the high market price level, we can rationalize it based on results in this chapter. The analysis in last section show that market price can rise without any change of the risky asset's future payoffs. First, if $m$ becomes higher, which means management compensation becomes more upward skewed, the price will rise, ceteris paribus. In addition, if $n_U$ becomes larger relative to $n_B$, which means more funds in the market are managed by managers with unbalanced compensation, the price will also rise. Therefore, rising bubbles can be easily rationalized as long as the de facto compensation contract and/or the number of UMC managers do vary over time. Similarly, it is also easy to justify the burst of bubbles. A convenient example is a crash down on UMC by the government, which can cause bubbles to burst as long as the government does push it hard enough.

2.7 North American Stock Markets

Although the analysis above aims at an explanation to the situation in China, it can also be applied in North American stock markets to investigate certain issues, such as the equity premium puzzle and the pricing of a firm's idiosyncratic risk. In the following, we discuss some of these issues.
2.7.1 Capital Gains Taxes and the Equity Premium Puzzle

As we have already seen, the unbalanced management compensation in China can cause a distortion in asset pricing. Similarly, the asymmetric treatment of capital gains and losses in the U.S. can also result in a distortion in asset pricing, though the effect is the other way around. The distortion of pricing caused by unbalanced capital gains taxes may offer an explanation to the well-known equity premium puzzle in American stock markets.

Mehra and Prescott (1985) find that the risk premium in the U.S. stock markets is too high to be justified with a reasonable risk coefficient, which is the so-called Risk Premium Puzzle or Equity Premium Puzzle (EPP) in the literature. Ever since then, many researchers in finance and economics have offered different theories to solve the puzzle. The literature on EPP largely divides into two groups. The first group belongs to the behavioural approach, which contains two subgroups. One subgroup employs a utility function different from the widely accepted expected utility theory, such as Mankiw and Zeldes (1991). The other subgroup uses other behavioural assumptions, such as myopic loss aversion in Benartzi and Thaler (1995). The second group of researchers mainly resort to market imperfections and/or frictions to explain EPP, such as information asymmetry. Despite the various explanations available, it seems that no theory has been widely accepted as satisfactory.

By studying the unbalanced treatment of capital gains and losses in taxation,
this chapter may offer an explanation to the high risk premium from a new angle. In the United States, taxes on capital gains and losses are not balanced. Whenever an investor makes a gain in the stock market, all or part of the gain must be included in his taxable income however large the capital gain is, and the exact tax rate depends on the investor’s holding period. On the contrary, when an investor suffers a loss, only up to $3,000 per year \(^8\) can be included in his taxable income. When a loss is larger than this upper limit of $3,000, the amount exceeding this limit can only be applied to past capital gains in the last three years, if any, and possible gains in the future. Such a tax structure is not balanced because of the following reasons.

First, there is a good possibility for an investor to finally end in net losses although the expected rate of return on his investment can be positive at the time of his investment. Meanwhile, the total loss is possibly to be much larger than $3,000 in a given year, especially for large investors who have significant influence on market prices. Clearly, such an investor has to suffer all his losses without an appropriate tax subsidy. However, in the case of net capital gains in the end, an investor has to give up a significant portion of his gains as taxes. Further, it is safe to assume that the richer people tend to be the elder, and hence may have a higher possibility of ending up in losses because they have a shorter life span left\(^9\).

\(^8\)For a married person, the amount is even less: up to $1,500 each year.

\(^9\)Assuming a standard market where the return follows a standard diffusion process, it is straightforward to see that the variance of \(\log(P_t/P_0)\) is linear with regard to the length of time, \(t\). Therefore, for \(t_2 > t_1\), the possibility for the \(P_{t_1} - P_0\) to be negative is larger than the possibility for \(P_{t_2} - P_0\)
Second, capital gains taxes are paid at end of each year, while the deduction in taxes from capital losses may be years from the dates of losses even if the investor is lucky enough to gain back all his losses in the end. Such a time lag creates a significant asymmetry in capital gains taxes because of the time value of capital, for the government makes no interest payments on tax credits. This gives another reason why capital gains taxes are unbalanced.

Third, some researchers have argued that the best method to deal with capital gains tax is never to realize capital gains. This argument requires a number of assumptions, such as no costs in extended period of short sales and the availability of perfect tax-exempt substitutes. If such assumptions do hold in reality, surely capital gains taxes would not matter at all. However, capital gains taxes do matter in the real world because of costs in short sales and other imperfections, as argued by some researchers such as Klein (2001).

In short, the discussion above shows that taxes levied on capital gains are much larger than tax subsidies to capital losses. Such an asymmetry in capital gains taxes is similar to a situation analyzed in the main model of this chapter where \( c_g < c_l \). Consequently, the equilibrium market prices should be lower than in a world without capital gains tax, ceteris paribus. Therefore, the risk premium in a model with capital to be negative, since the expected rate of return is positive and linear with regard to the length of time too. This is why the unbalanced capital gains tax has a more pronounced effect on people who have a shorter life span to invest.
gains taxes should be larger than that in a model without capital gains taxes. Since
the mean excess return in Mehra and Prescott (1985) is only about 6%, it does not
seem to be difficult to explain the EPP with asymmetric taxes on capital gains and
losses.

Klein (2001) studies the long-term return reversals with capital gains taxes. How­
ever, his model does not have any direct link to the explanation of the EPP because
capital gains taxes are assumed to be balanced in his model: capital losses can al­
ways be included in investors’ taxable income in Klein (2001). Such an assumption
is obviously not consistent with the real situation in the United States.

In the following, we use the analysis in the main text to study the impact of capital
gains taxes on asset pricing. For simplicity, we assume that an regular investor pays
a fixed tax rate, \( T_g \), on capital gains, and receives a fixed subsidy rate, \( T_l \), for capital
losses. Meanwhile, there are also some tax-exempt investors whose tax rate on capital
gains and losses is \( T_0 = 0 \). Denoting \( c_g = (1 - T_g) \) and \( c_l = (1 - T_l) \), we use investors
facing unbalanced capital gains taxes to replace UMC managers in the main model,
and the number of such investors is \( n_U \). Similarly, denoting \( c_0 = 1 - T_0 = 1 \), we use
tax-exempt investors to replace BMC managers in the main model, and the number
of such investors is \( n_B \). Noting that \( c_g \) is now lower than \( c_l \), we get the counterpart
of Proposition 1 as follows:

\[ \text{Proposition 5} \text{ For } T_g \in (T_l, 1), \text{ the higher the tax rate on capital gains, the higher} \]
the equity premium. That is,
\[ \frac{\partial P}{\partial T_g} < 0 \] \hspace{1cm} (2.27)

Further,
\[ P \rightarrow \frac{\mu - \frac{c_g}{n \sigma^2} + \frac{\nu }{n \sigma^2}}{R} \text{ as } T_g \rightarrow T_i \] \hspace{1cm} (2.28)

and
\[ P \rightarrow \max\{\frac{\mu - aS\sigma^2}{R} + \frac{n_B}{n_B}, 0\} \text{ as } T_g \rightarrow 1 \] \hspace{1cm} (2.29)

The \( n_u \) above represents the number of investors with balanced tax structure, such as these tax-exempt institutions. The effective tax rate for investors with balanced tax structure, \( c_0 \), should be equal to 1 in the case of tax-exempt investors. The tax-exempt investors could be non-profit organizations who do not need to pay taxes on capital gains, or individual investors who have huge tax credits.

Equations (2.28) and (2.29) also fit well into intuition. Equation (A.71) indicates that the pricing in the market is just the same as in a standard asset pricing model if there are no capital gains taxes. Meanwhile, equation (A.72) indicates that only tax-exempt investors would stay in the market if the government were to take away all capital gains.

Proposition 5 states that the equity risk premium is higher when \( T_g > T_i \), than when \( T_g = T_i \). Since the major players in the U.S. markets are not all tax-exempt, it is not surprising to see a higher equity risk premium in reality than what is derived from theoretical asset pricing models where unbalanced capital gains taxes do not exist.
A more rigorous analysis of the link between capital gains taxes and EPP requires a multiple-period or continuous-time setting, and asks for numerical analysis with key parameters estimated from data in the real world. This is what we are working on in an independent study.

2.7.2 Index-adjusted Management Compensation

In contrast to China, U.S. does not have significant problems related to Soft Budget Constraints. However, the U.S. does have different forms of asymmetry in fund managers' compensation, such as incentive fees based on index-adjusted performance. Such compensation structures in the U.S. also cause distortions in the valuation of firms' idiosyncratic risks, which is similar to the case in China, but the market risk of each firm is still priced in a similar manner as described in traditional CAPM. This gives a possible explanation to conflicting, ambiguous, and time-varying evidence on risk-return relationship in the literature. Appendix A.3 provides details.

2.7.3 Implications in Corporate Finance

The analysis in this chapter also has implications in management compensation in the area of corporate finance. In the main text of this chapter, we only consider the compensation for managers in the investment industry who can make investment decisions for investors, and then study its effect on asset pricing at a macro level. We
have not studied how a manager's compensation may affect the value of the individual firm under his management. By switching our analysis from the macro level to the micro level, we can infer further implications from UMC in the field of corporate finance.

To align the incentive of corporate managers with the interests of shareholders, it is necessary to give corporate managers large amount of stock options with very low exercising prices. Otherwise, if the exercising price is high, a manager may choose riskier projects than investors would like to see. The optimal exercising price of stock options depends on the range of risky projects available to corporate managers. If a corporate manager can choose from a wide range of risky projects, such as the CEOs of start-up and/or high-tech firms, exercising price of stock options should be very low. As shown in the numerical analysis of managers' utilities, awarding managers free stock options is an effective method that can benefit all parties involved.

Relative to cash compensation, such as salary, stock options are more costly to shareholders, for a manager must be offered a compensation package with a higher market value so as to trade off the large amount of risk that the manager has to undertake from the package. Although it is reasonable to believe that such extra cost is worthwhile when designing compensation contract for high ranking managers, it may be not so optimal for low-ranking managers and employees who has little power over the choice of risky projects. This indicates that the CEOs should be given free stock options, while the employees should be given stock options with an economically
meaningful exercising price.

In North America and Europe, stock options are widely used in the real world as an important form of compensation. By contrast, stock options is not a realistic choice in Chinese state-owned enterprises yet\(^{10}\). However, as discussed earlier in this chapter, there is widespread UMC resulted from the soft budget constraint problem in Chinese SOEs, and such a phenomenon in the investment industry seriously affect asset pricing in Chinese stock markets. Such UMC also still has implications on the current economic performance of Chinese firms. For those big enterprises with higher percentage of state ownership, the government must be monitoring their activities more closely, and hence the performance should be good because closer monitoring results in a lower level of UMC. Meanwhile, for those enterprises with little state ownership, the owners must be monitoring the managers even more closely, and so their economic performance should be even better. However, for enterprises with medium state ownership, the monitoring of the managers should be the worst, and hence the a higher level of UMC tends to prevail. Consequently, these firms are expected to have the poorest economic performance on average.

Another potential application in corporate finance is the relationship between unbalanced corporate tax and a firm’s optimal capital structure. Similar to the impact

\(^{10}\)Although a manager may receive a one-time free stock bonus at the time of IPO, stock options is not part of a regular compensation package. Further, listed firms compose only a small percentage of state-owned enterprises (SOEs), and a manager of a non-listed SOE do not have any stocks of the firm under his management.
of the unbalanced capital gains tax on an investor's valuation of risky assets and hence his portfolio choice, the so-believed unbalanced corporate tax also has an effect on a firm's valuation of its profits and interest expenses of debt. There is a large number of papers related to this area, and it is left to further study whether such a thought could result in some further development in the research on tax and capital structure.

2.8 Conclusion

In this chapter, we have developed a simple agency capital asset pricing model, which shows that UMC, together with the no short-sale constraint, can explain the overpricing anomaly in China, and hence rationalize the formation of bubbles. The unbalanced compensation gives managers incentives to underweight downside risk, and so creates a higher level of market price than in a world without UMC. Further, the risk-return relationship is negative when UMC is severe, which is in sharp contrast with the positive risk-return relationship in traditional capital asset pricing models.

In addition, a UMC manager may choose not to diversify even if he prefers a lesser amount of absolute risk. The answer to this lies in the transformation effect of the unbalanced compensation, which renders the amount of absolute risk alone insufficient to measure the value of the risk.

It is also shown that an excessively low penalty rate is not good even for UMC managers themselves, for the competition among UMC managers force themselves to
pay a high price for the same asset.

Similar to the analysis of the UMC, *unbalanced* capital gains tax is also shown to have a profound impact on market prices in equilibrium, and hence offer a new explanation to the equity premium puzzle.

In North American markets, the asymmetric compensation is based on index-adjusted performance, and only the risk attitudes towards idiosyncratic risk is distorted by such a compensation structure. Consequently, market prices in North America should be increasing with regard to idiosyncratic risk, but decreasing with regard to market risk.

In short, UMC has important implications on asset pricing, though such a relationship did not attract much attention from financial researchers until recently. Further research in this area, such as empirical tests and theoretical extensions on the link between asset pricing and optimal contracting and monitoring of UMC managers, can help us to expand our understanding in this area. Another direction of future research is the endogenization of the existence of UMC.
Bibliography


Figure 2.1: Agency Asset Pricing Model — The Case of One Asset

In this numerical analysis, we set $c_g = 0.05$, and increase $c_l$ from 0.001 to 0.1 by 0.001, and $\sigma$ from 50 to 350 by 3. Market price, $P$, is then solved in equilibrium for each combination of $(c_l, \sigma)$, with other parameters set as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, $c_0 = 0.05 = c_g$, $\delta_q = \delta_k = 1$. 

![Graph showing the relationship between market price (P), penalty rate (c_l), and standard deviation of payoff (\sigma).]
Figure 2.1: A: Price-Penalty Rate Curves — Cross-sectional Views

This figure is a set of cross-sectional views of Figure I by fixing $\sigma$ at 50, 250, and 350 respectively. Each price-penalty rate curve is obtained as the penalty rate, $c_t$, increases from 0.001 to 0.1 by 0.001. The bonus rate, $c_g$, is set to 0.05. Other parameters are set as follows. $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, $c_0 = 0.05$, $\delta_q = \delta_k = 1$. 
Figure 2.1: B: Price-Risk Curves — Cross-sectional Views

This figure shows the price-risk relationship in equilibrium with $c_I$ fixed at 0.001, 0.03, 0.05, and 0.1. For each fixed value of $c_I$, a price-risk curve is obtained as the standard deviation of the risky asset's payoff, $\sigma$, varies from 50 to 350. The bonus rate, $c_g$, is set to 0.05. Other parameters are set as follows. $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, $c_0 = 0.05$, $\delta_q = \delta_k = 1$. 

![Price-Risk Curves Diagram](image)
This figure represents the price-risk relationship in equilibrium with $c_I$ fixed at 0.03, which is a cross-sectional view of Figure I. This figure shows how the market price changes as the standard deviation of the risky asset’s payoff, $\sigma$, varies from 50 to 350. The change of slope before and after the maximum point at $Q = 1023.9687, 260$ has important implications about a UMC manager’s risk attitude. The bonus rate, $c_g$, is set to 0.05. Other parameters are set as follows: $a = 0.5, S = 0.5, \mu = 1100, r = 0.1, n_B = n_U = 25, c_0 = 0.05, \delta_q = \delta_k = 1$. 
This figure shows the change in market price when the number of UMC managers increases from 10 to 25, with the sum of UMC and BMC managers fixed at 50. Specifically, denoting $P_{n_U=25}$ as the market price with 25 UMC managers, and $P_{n_U=10}$ as the market price with 10 UMC managers, we write the price difference as $P_{\text{diff}} = P_{n_U=25} - P_{n_U=10}$.

In this numerical analysis, we set $c_g = 0.05$, and increase $c_l$ from 0.001 to 0.1 by 0.001, and $\sigma$ from 50 to 350 by 3. Market price, $P$, is then solved in equilibrium with $n_U$ fixed at 25 and 10 respectively. Other parameters are set as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $c_0 = 0.05 = c_g$, $n_B + n_U = 50$, $\delta_q = \delta_k = 1$. 

\[ \text{Price Difference (P_{\text{diff}})} \]
This figure shows the relationship between the price difference and penalty rate with $\sigma$ fixed at 200. The price difference, $P_{\text{diff}}$, is defined to be $P_{n_U=25} - P_{n_U=10}$, where $P_{n_U=25}$ is the market price with 25 UMC managers, and $P_{n_U=10}$ is the market price with 10 UMC managers.

The bonus rate, $c_g$, is set to 0.05. Other parameters are set as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B + n_U = 50$, $c_0 = 0.05 = c_g$, $\delta_q = \delta_k = 1$. 
This figure shows how the representative UMC manager $q$ and BMC manager $k$ change their demands under different market situations. We set $c_q = 0.05$, and allow $c_t$ and $\sigma$ to vary in the range of (0.001, 0.1) and (50, 350) respectively. The representative managers' demand, $D_q$ and $D_k$, is calculated in equilibrium with other parameters set as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, and $c_0 = 0.05$. 
Figure 2.3: A: Managers' Demand — A Cross-sectional View

This figure is a cross-sectional view of Figure III at $\sigma = 200$. It shows how the demands of representative UMC manager $q$ and BMC manager $k$ change with $\sigma$ taking a fixed value at 200. We set the bonus rate, $c_g$, to 0.05, and allow the values of $c_i$ to vary in the range of (0.001, 0.1). The representative managers' demand, $D_q$ and $D_k$, is then calculated in equilibrium with other parameters set as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, and $c_0 = 0.05$. 
Figure 2.4: Managers' Utilities

This figure shows how the utilities of representative UMC manager $q$ and BMC manager $k$ vary under different market situations. We set the bonus rate, $c_g$, to 0.05, and allow $c_q$ and $\sigma$ to vary in the range of $(0.001, 0.1)$ and $(50, 350)$ respectively. The representative managers' utilities in equilibrium, $U_q$ and $U_k$, are calculated with other parameters being set as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, $c_0 = 0.05$, and $\delta_q = \delta_k = 1$. 

\[ \begin{align*} 
-0.598 & \quad -0.599 & \quad -0.6 & \quad -0.601 & \quad -0.602 & \quad -0.603 & \quad -0.604 & \quad -0.605 & \quad -0.606 \\
100 & \quad 200 & \quad 300 & \quad 0.1 & \quad 0.075 & \quad 0.05 = C_g & \quad 0.025 
\end{align*} \]
Figure 2.4: A: Managers’ Utilities — A Cross-sectional View

This figure is a cross-sectional view of Figure IV at $\sigma = 200$. It shows how the utilities of representative UMC manager $q$ and BMC manager $k$ change under different market situations with $\sigma$ fixed at 200. We set the bonus rate, $c_g$, to 0.05, and allow the values of $c_l$ to vary in the range of (0.001, 0.1). The representative managers’ utilities in equilibrium, $U_q$ and $U_k$, are calculated with other parameters set as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, $c_0 = 0.05$, and $\delta_q = \delta_k = 1$.
Figure 2.5: UMC Manager’s Portfolio Choice

This figure presents a numerical analysis of a representative UMC manager’s (k’s) portfolio choice, and the purpose is to explain why manager k may choose not to diversify even when he prefers to have a lesser amount of absolute risk. First, with $\alpha_k$ fixed at 0.5, manager k maximizes his personal utility by choosing $D_p$. His solution is shown as “$D_p$ with $\alpha_k = .5$” in the top diagram. The equilibrium price in such a setting is as shown in the second diagram. Then, manager k is allowed to choose both $D_p$ and $\alpha_k$ rather than $D_p$ alone in his utility maximization, with market price set to be the same as in the second diagram for each value of $\sigma$. In such a situation, manager k’s optimal choices of $D_p$ and $\alpha_k$ are shown in the top and third diagram respectively. The bottom diagram shows the increase in manager k’s utility after he is allowed to choose $\alpha_k$ in his utility maximization, where $U_{\text{diff}} = U_{\alpha_k \in [0,1]} - U_{\alpha_k = .5}$. In this numerical analysis, we allow $\sigma$ to take values in [50,350] while setting $\sigma_m = \sqrt{0.99} \sigma$ and $\sigma_e = \sqrt{0.02} \sigma$. In addition, we set $c_g = c_0 = 0.05$, $c_l = 0.03$, $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$ and $\delta_q = \delta_k = 1$. 

\[0.0208 \quad 0.0206 \quad 0.0204 \quad 0.0202 \quad 0.02 \quad \text{Demand} \]

\[0.0208 \quad 0.0206 \quad 0.0204 \quad 0.0202 \quad 0.02 \quad \text{Demand} \]

\[0.0208 \quad 0.0206 \quad 0.0204 \quad 0.0202 \quad 0.02 \quad \text{Demand} \]

\[0.0208 \quad 0.0206 \quad 0.0204 \quad 0.0202 \quad 0.02 \quad \text{Demand} \]

\[0.0208 \quad 0.0206 \quad 0.0204 \quad 0.0202 \quad 0.02 \quad \text{Demand} \]

\[0.0208 \quad 0.0206 \quad 0.0204 \quad 0.0202 \quad 0.02 \quad \text{Demand} \]
Chapter 3

Equity Pricing in China: Empirical Tests

3.1 Introduction and Review of Literature

Chinese stock markets have been developing very quickly since their establishment at the beginning of last decade, and now the combined size of Chinese stock markets in Shanghai and Shenzhen ranks among the largest in the world. As the size of Chinese economy approaches a global rank of #5, the research on Chinese stock markets is attracting more and more attention from both international researchers and global investors. While the Chinese equity market offers a fertile landscape for the testing of many financial theories, it also raises a variety of challenges to modern financial
theories.

In this chapter, we review the existing empirical studies on Chinese stock markets. We begin with Su (1999) who uses the sample period of April 1994 to September 1996 to study the relationship between beta and returns, and who finds supporting evidence for his model on price differences between A-Shares and B-Shares. His work is limited by the partiality of his model, in addition to the short sample period (less than two and a half years).

Using latent variable analysis, Fung, Lee, and Leung (2000) show that A- and B-Shares issued by the same firm are segmented, and the fundamental forces that drive the movement of returns are different for the A- and B-Share markets. Further, they also show that the Shanghai Stock Exchange (SHSE) follows the Shenzhen Stock Exchange (SZSE) rather than the other way around. Their sample period is from May 1993 to June 1997, which is more than 1.5 years longer than the sample period in Su (1999), and their data come from the Taiwan Economic Journal and University of Hong Kong. Fung, Lee, and Leung (2000) focus on the empirical characteristics of Chinese stock markets only, and do not provide any model to explain the implication of segmentation of A- and B-Share markets or other characteristics tested in their study.

Chakravarty, Sarkar, and Wu (1998) use both asymmetric information and market segmentation to explain why the A- and B-Share prices differ. In their sample period
Chakravarty (1998), et al find empirical support for the asymmetric information hypothesis using data from Datastream. They develop a model based on information asymmetry and ownership restrictions, but do not endogenize the supply of shares to the market by a monopolistic government. Moreover, Chakravarty (1998), et al find that A-Share returns appear to lead B-Share return. As discussed later, this may be the result of the thin trading problem in the B-Share market. Chen, Lee, and Rui (2001) use the illiquidity of B-Shares as the major reason to explain price differences between A- and B-Shares, and test their hypothesis with data from 1992 to 1997. Chen (2001), et al find that B-Share prices tend to move more closely with market fundamentals than do A-Share prices, consistent with the implication from our model in *Stock Ownership Restrictions and Discriminatory Asset Pricing in the Chinese Equity Market* (Chapter I): in Chapter I, our model shows that a shock in a firm's cash flow tends to cause a larger change in B-Share returns than A-Share returns. As we shall show, such a result may also be driven by their failure to deal with the thin trading in B-Share market.

Chen (2001), et al argue against the asymmetric information hypothesis proposed by Sarkar, Chakravarty, and Wu (1998) to explain the price differences between A- and B-Shares. However, they do not provide any formal model, limiting the power of their tests. Moreover, they follow the empirical method by Domowitz, Glen, and Madhavan (1997) without paying attention to the potential distortion of firm characteristics in a panel regression with fixed effects. Hence, their conclusion about firm-characteristic
variables is dubious. In addition, in their tests of the liquidity hypothesis, they use the trading volume, not the bid-ask spread. As argued later in this chapter, a combination of the two proxies is necessary to give an accurate description of shares' liquidity.


Fernald and Rogers (1998) use data from Reuters, Bloomberg, and Internet Securities in their study of the sample period 1993-1997. In their theoretical analysis, Fernald and Rogers (1998) point out that domestic investors may demand a lower risk premium because of limited access to risky securities. However, they do not study how the monopolist supply by the government should affect the price differences in equilibrium. Fernald and Rogers (1998) find a negative but insignificant relationship between firms' international betas and their B- to A-Share price ratios. This result, although not so strong, is consistent with our model. Their lack of significance may come from the neglect of the thin trading problem in the B-Share market.

One of the most challenging barriers in conducting research on Chinese stock
markets is the difficulty in collecting reliable data and dealing with the complexity of the market structure and regulations in China. With tedious and arduous efforts, we have collected what we believe to be a reliable dataset that can be applied to consider a variety of empirical issues in Chinese stock markets. Hence, one of the contributions of this chapter is the application of more accurate and reliable data. For example, in contrast to the broad-based, cross validated data used in this chapter, the data of Su and Fleisher (1999) are from a single stock dealer's house of a provincial security company in Zhejiang. Chakravarty, Sarkar, and Wu (1998) and Tian (2000) do use broader based data from Datastream. However, occasional but significant inaccuracy of Datastream data is suggested by comparing the Datastream data with those from the Shanghai Stock Exchange, where the latter are considered to be more reliable. Moreover, the data from Datastream is not complete.

A further unique aspect of this chapter is that none of the studies of Chinese stock markets has previously dealt with thin-trading, a thorny issue in Chinese B-Share Markets. Since trading of B-Shares before 1999 was infrequent, a special procedure is needed when such data are used for empirical tests, as discussed in Campbell, Lo, and MacKinlay (1998). One of the most obvious problems of thin trading is the spurious auto-correlations which may drive some of the results in existing literature, such as Chakravarty, Sarkar, and Wu (1998) and Chen, Lee, and Rui (2001).

On the risk-return relationship, there is a large and conflicting literature. Using either a firm/portfolio's covariance with market volatility or its own total volatility as
the proxy for risk, Fama and French (1973), French, Schwert, and Stambaugh (1987) and Campbell and Hentschel (1992) find the relation between risk and expected return to be positive, while Turner, Startz, and Nelson (1989), Glosten, Jagannathan, and Runkle (1993), and Nelson (1991) find the relation to be negative. Bekaert and Wu (2000) give a summary of studies in this area, and point out that the coefficient linking volatility to returns is often statistically insignificant in the literature.

Based on application of the model from our Chapter II to the North American market, the ambiguity in the relationship between the total risk and expected return is not surprising. Appendix C of Chapter II shows that the assumption of UMC based on index-adjusted performance gives rise to an agency problem in North America different from the agency problem in China. Such an agency problem in North America causes firms with larger idiosyncratic risks to be priced higher, and firms with larger market risks to be priced lower. Since a firm’s total risk consists of both its market risk and idiosyncratic risk, the relationship between a firm’s total risk and return is not clear. This is consistent with the conflicting literature on the risk-return relationship which generally does not provide robust results, with outcomes depending on data selection, time periods, and methodology employed.

A closer look at the literature indicates more consistency to the results in Appendix C of our Chapter II. Campbell, et al (2001) find a noticeable increase in the firm-level volatility relative to the market-level volatility in the U.S. market, and there has been a rapid growth of pension funds and mutual funds in the past two decades.
as documented in Arora and Ou-Yang (2001) and Heinkel and Stoughton (1994). Considering that a larger portion of idiosyncratic risks in total risks and the increased impact of agency problem from fund management compensation can cause a shift in the risk-return relationship, it is consistent with our model to observe the shift from a positive risk-return relationship in Fama-MacBeth (1973) to the less positive and even negative relationship in recent studies such as Glosten, Jagannathan, and Runkle (1993). Later in our empirical tests, we conduct a comparison study using data from the U.S. in the sample period 1993-2000, which is the same as the time period of our Chinese data. Based on the evidence from the literature discussed above, we expect to find a less obscure relationship between firms’ returns and idiosyncratic risks than some previous studies based on U.S. data before the 1990s or 1980s.

In this chapter, we check whether there is a difference in the relationship between returns and idiosyncratic risk vs. market risk. This is the key that differentiates our model from the traditional asset pricing models in the U.S. Moreover, it also differentiates the de facto compensation structures in China and the U.S. The results in our tests of the risk-return relationships in China and the U.S. can serve as a natural comparison between markets with different types and degrees of agency problems from unbalanced compensation.

In addition, our model and tests also indicate that different countries can have different structures of agency problems, and hence the risk and return relationship can differ. Therefore, it suggests we should be more careful about interpreting tests of
asset pricing theories for the U.S. stock markets with international data. For example, Bekaert and Wu (2000) reject the leverage theory for the volatility asymmetry, which is developed in the U.S., with the Japanese data. Since the financial institutions in Japan are different from the U.S., we suggest a more cautious approach of applying their methodology in U.S. data before reaching conclusion.

In this study, we use panel data analysis with fixed time effects to test the cross-sectional relationship between risk and return. This method has improved efficiency over Fama-MacBeth (1973) and Ferson and Harvey (1999). This is shown both analytically and empirically in our study. Ferson and Harvey (1999) show that panel data analysis has improved efficiency over the Fama-MacBeth method because the estimates of coefficients are a variance weighted average rather than a simple weighted average. However, Ferson and Harvey (1999) do not consider the time effects in stock returns, which, in our opinion, must be a significant factor in stock price movements considering the substantial changes in macroeconomic variables from year to year. In fact, Fama-MacBeth (1973) do implicitly take the time effects into account, and hence their method has an edge over Ferson and Harvey (1999) in this sense.

In the tests of the relationship between price ratios and proxies for different variables, we use panel data analysis with fixed effects more carefully than some other papers in the literature. For example, in a panel data analysis with fixed firm effects, the coefficient of the independent variable size, as measured by market capitalization, is not really a measure for size; instead, such a coefficient is closer to a measure of
each firm's price changes over time. Consequently, it is natural to expect inaccurate inference about the size factor in such an analysis. This is to be discussed in detail later in this chapter.

The rest of this study proceeds as follows. After introducing the testable implications in Section 3.2, we describe our data in Section 3.3 and present our empirical methodology in Section 3.4. Section 3.5 provides the empirical evidence and tests of implications from Chapter I, Market Segmentation and Ownership Restrictions, and Section 3.6 gives the tests on Chapter II, Unbalanced Management Compensation and Asset Pricing. We conclude in Section 3.7.

3.2 Testable Implications

3.2.1 Implications from Chapter I

In this subsection, we discuss the key implications of Chapter I, which derives an optimal supply strategy for the government and explains why the prices of A-Shares should be higher than those of B-Shares in a general equilibrium. Later in this study, we will consider the implications from inclusion of other factors documented in existing literature, such as liquidity and regime-switching risk in Chinese foreign exchange rates.

In our model, the key results can be represented by equation (24) and (26) in
Chapter I:

\[
P_A - P_B = \frac{1}{1+r} \cdot \frac{1}{2} \cdot \beta_D F (\bar{\mu}_F - (1+r)\bar{P}_F)
\]

(3.1)

and

\[
S^*_a = \frac{(1 - \rho^2)}{n_b/n_a} S^*_b + \frac{\beta_f [\mu_f - (1 + r)P_f]}{2a\sigma_d^2/n_a}
\]

(3.2)

The first equation shows that equilibrium prices of A-Shares are higher than those of B-Shares as long as firms' International Betas, \(\beta_D F = \Omega_D F \Omega^{-1}_F\), are positive. It should be remembered that if there was no monopolist government, then there would be no guarantee that A-Share prices would be higher than B-Share prices.

In addition, equation (1) also implies that the price gaps are larger for those firms with high international betas, since the equity risk premium in the foreign market, which is equal to \(\bar{\mu}_F - (1+r)\bar{P}_F\), should be positive. Therefore, we can estimate the international betas of Chinese firms with both A- and B-Shares, and then see whether there is a positive relationship between international betas and the price gaps. Without the model, we cannot be sure whether such a positive relationship exists because of the trade off between the positive effect on prices of low international betas, and the negative price effect of the issuance of more B-Shares. In contrast, Su (1999), who claims higher price gaps for firms with higher international betas, does so without really obtaining such a clear-cut inference from his model.

In our model, the relevant covariance is the covariance between firms' liquidating payoffs, not returns. For convenience of empirical tests, we can standardize equation
(3.1) with share prices, and then test the relationship using A- to B-Share price ratios and international betas estimated with returns.

Equation (2) shows the relationship between the optimal supply of A-Shares and B-Shares in general equilibrium. As a reminder, this is a simplified scaler case for a single firm, which is in contrast to the vector case in the first equation. Such a simplification is based on the assumption that there is no cross-sectional correlation between listed Chinese firms, though the testable implication inferred from this equation is expected to remain meaningful under a more general variance-covariance matrix of Chinese firms. The testable implication of the second equation can be inferred by looking at the second term on the right-hand side. This second term has the same sign as $\beta_f$, for $\bar{\mu}_F - (1 + \tau)\bar{P}_F$ is positive.

We begin by dividing B-Share firms into two groups: Group I, all of which have outstanding A-Shares as well, and Group II, which have no outstanding A-Shares. Equation (2) suggests that Group I should have lower international betas than those of Group II. In fact, the equation tells us that Group I’s international betas should be negative or around 0. If the firms with only outstanding B-Shares were picked randomly rather than by the monopolist government, say because of capital needs for only foreign currency, there would be no implication that such a distinction would exist between the two groups.

In China, there does exist a number of B-Share firms with no outstanding A-
Shares, and many other B-Share firms with outstanding A-Shares. This offers a natural sample for us to test the implications of equation (2).

### 3.2.2 Implications from Chapter II

Contrary to the traditional CAPM, our Agency CAPM predicts that the relationship between risk and return depends on the balance of fund managers' compensation structure: see figure 3.1. When $c_2$, the measure of punishment for negative performance, is small enough relative to $c_1$, the risk and return relationship can be around 0 or even inversely correlated. This is in contrast with the always positive risk-return relationship as predicted by the traditional CAPM, which is equivalent to a special case of our Agency CAPM where $c_2 = c_1$.

We define a strong form of bubbles as the situation when prices are higher than the expected payoffs discounted at the riskfree rate. Further, we define a weak form of bubbles as the situation when the prices are higher than the expected payoffs discounted at risk-adjusted rates based on traditional CAPM. For the strong form, we check whether the positive relationship between risk and return can be rejected. For the weak form, we could check whether the risk-premium is significantly lower than in benchmark stock markets, such as the NYSE or LSE, assuming that the equity premium is the same in countries without riskfree-rate adjusted performance fees. In this chapter, only the strong form is tested, for the result turns out to be
significant and makes the test of the weak form unnecessary. We also conduct an event study which can capture the existence of bubbles driven by Unbalanced Management Compensation (UMC).

3.3 Data Description

Our data come from a number of sources: the Shanghai Stock Exchange, the Shenzhen Stock Exchange, Shenyin Wanguo Securities Company, Shanghai Jiao Tong University, Wan De Consulting, and Datastream. In addition, we also use CRSP and COMPUSTAT databases to retrieve U.S. data, such as the SP500 returns used in the comparison study on risk-return relationships. In addition, Datastream is used in retrieving part of the Chinese transaction data for comparison with our data from other resources. We also get the global market index, namely *Morgan Stanley All Country Free World Index*, from Datastream.

Our data on Chinese stock markets include transaction data of all firms listed in the Shanghai and Shenzhen Stock Exchanges, the distribution data, and the accounting data. The transaction data are daily, while the accounting data are annual. In China, firms do not give quarterly accounting reports, and the distribution data are annual as well.

The items in our Chinese transaction database include the following: daily open, high, low, close, ask, bid and volume. The items in our Chinese distribution database
include the following items: cash dividends, stock dividends, stock splits, rights issues (with a few seasoned equity offerings as well), transferred shares, announcement dates and ex-rights dates. The items of our Chinese accounting databases include the following: revenue, earnings (before and after tax), adjusted earnings after non-operational gains or losses, total assets, equity, debt (short-term and long-term), sales, cost of sales and administration, fixed assets, inventory, turnover ratios of assets, and accounts receivable. Together, this provides an extremely comprehensive set of information for conducting research.

Our sample period for Chinese data is from Jan 1, 1993 to Dec 31, 2000. We exclude the period before 1993 because of two reasons: the daily price limits before May 1992 and the small sample size before 1992. Specifically, before May 1992, A-Share prices could rise by a maximum of 10% each day. Consequently, there were dramatically reduced transactions in the Chinese stock markets, with either no transaction price or a maximum price under the limits for a typical SHSE firm in a typical day before May 1992. In such a situation, it is obvious that market prices recorded by the SHSE cannot reflect the true market value of the stocks, and it is meaningless to take recorded prices in this period as market clearing prices for tests of theories in Chapter II. In addition, the sample size is also very small for the period before 1992: there were only 8 A-Share firms listed in Shanghai Stock Exchange before 1992, and an even smaller number in B-Share market. In fact, the listing date of the first B-Share is 1992.
By contrast, stock prices from 1993 to 2000 face few binding hurdles in daily movements, and changes in stock indices also resemble much more of a random walk than a straightforward upward trend: see Figures 3.2, 3.3, and 3.4. The situation is similar in the Shenzhen Stock Exchange. However, since early 1993, both Chinese A- and B-Share markets have been expanding very quickly. By the end of 2000, there were 559 A-Series and 55 B-Series shares listed in the Shanghai Stock Exchange, and another 500 A-Series and 58 B-Series shares listed in the Shenzhen Stock Exchange.

Our guidelines on the usage of Chinese databases are as follows. First, use the data from Datastream whenever feasible. In other words, we use Datastream data except where these are proven to be inaccurate. The objective of this guideline is to keep our empirical tests comparable with other people’s work as much as possible. Second, when the data from different data sources conflict with each other, we use the latest ones. Such situations do arise in a few distribution data items, which is not unexpected considering the fact that several listed firms do report inaccurate numbers first and then make corrections later. Following a logic similar to the one adopted by CRSP in calculating returns for U.S. stocks, we use the transaction and distribution data collected from China to construct the Chinese database of returns in our study.

To check the robustness of our tests, we repeat our tests using filtered data. For each firm-year, we first calculate the deviation of daily returns relative to market index returns, and then standardize such index-adjusted excess returns with the standard deviation in each firm-year. These are called Standardized Abnormal Returns (SARs).
We exclude the maximum and minimum observations in each series of SARs, and then repeat the tests with the rest of the observations. We choose this procedure to check the robustness of our tests out of two considerations. First, the existing literature has shown that empirical results are often sensitive to the exclusion of outliers, such as a study that points out that most of the explanatory power of Fama-French three factors goes away when the 1% outliers are excluded from the tests. Second, though we have made our best efforts in obtaining the most accurate and complete data for our study, there is always a concern that there may exist incidental missing information or data errors. For example, if a stock split or rights issue is missing in the distribution data file, the return of the stock on the ex-distribution date would be seriously underestimated. In such a case, taking out the observation with the minimum SAR in the firm-year should help us to filter out outliers. Such a method is even more effective in China considering that a typical Chinese firm gives out only annual distributions. After obtaining the filtered data by excluding the annual maximum and minimum SARs, we repeat the major tests in this study to check the robustness of the results.

A serious issue in the transaction data of B-Shares is the thin trading problem. It is well-known that B-Shares suffer a lack of liquidity, especially so in 1990s. The thin trading in the B-Share market results in a failure to correctly record the true prices of listed firms at each point of time, which can be illustrated by examining the first-order autocorrelations of different stock indices. As in Jorion and Schwartz (1986) who use the auto-correlations of Canadian stock indices to demonstrate the
thin trading problem in the Canadian Stock Market, we calculate the first-order auto-correlations in Chinese B-Share markets from 1993 to 2000. The results are presented in empirical tests later in this chapter, and they clearly indicate strong auto-correlations in B-Share indices. We also calculated the auto-correlations with the two subperiods 1993-1996 and 1997-2000, and the results are very similar.

As suggested by the literature such as Scholes and Williams (1977), Dimson (1979), Fowler and Rorke (1983), and Heinkel and Kraus (1988), nonsynchronous trading in B-Share market can cause a serious errors-in-variable problem in empirical tests, especially the distortion in the estimation of market betas using the market model and OLS regressions. In this chapter, we use a method similar to Dimson (1979) to adjust our procedure for the thin trading problem in Chinese B-Share markets. The details are discussed immediately below in Section 3.4.1.

3.4 Empirical Methodology

3.4.1 Thin Trading

Using a procedure similar to the one proposed by Dimson (1979), we estimate a firm's international beta with the following regression:

\[ r_{i,t} = \alpha_i + \beta_{i,0}r_{m,t} + \beta_{i,-1}r_{m,t-1} + \beta_{i,1}r_{m,t+1} + \epsilon_{i,t} \]  

(3.3)
where $r_{i,t}$ is firm i’s excess return relative to riskfree rate at time t, $r_{m,t}$ is the market excess return at the same time period, and $r_{m,t-1}$ and $r_{m,t+1}$ are the market excess returns at time $t-1$ and $t+1$. The estimator of firm i’s international beta, $\beta_i$, is the sum of OLS estimators of $\beta_{i,0}$, $\beta_{i,t-1}$, and $\beta_{i,t+1}$. Further, we also check the robustness of our results with the following adjusted beta

$$\beta_{i,adj} = (\beta_{i,t-1} + \beta_{i,t} + \beta_{i,t+1})/(1 + 2\rho)$$

(3.4)

where $\rho$ is the first-order auto-correlation of market returns.

3.4.2 Panel Data Analysis

The traditional Fama-MacBeth (1973) method uses two stage regression. First, they estimate sample firms’ betas and other factors, such as residual risk, using a fixed length of data, say 5 years. Second, they use these estimated factors to explain the returns of a subsequent “window” period. To do so, they run cross-sectional regressions period by period. The coefficients of each factor in the cross-sectional regressions are averaged over time, and then a t-statistic is used to test whether each factor coefficient is significantly different from zero.

The Fama-MacBeth (1973) method is a useful way to determine the sign of coefficients for factors that have to be estimated with the rolling data. On the other hand, intuitively one can also see some drawbacks of this method. First, by taking an average of the factor coefficients, the cross-sectional regression in each time period is
given equal weight in the t-statistics. However, the accuracy of the estimated factor coefficients are likely to differ over time. For example, in some time periods, there may be more observations than other periods, making the coefficient estimates more accurate. Also, the cross-sectional differences across different firms are bigger in certain periods than other periods, and so estimated coefficients tend to be more robust against noises in certain periods. The traditional Fama-MacBeth (1973) method fails to account for these differences over time.

Ferson and Harvey (1999) propose a pooled regression rather than the period-by-period cross-sectional regression in Fama-MacBeth (1973). Such a pooled regression addresses the differences in the accuracy of coefficient estimates over different time periods, and hence is more efficient than Fama-MacBeth's method in terms of heteroskedasticity. However, to argue that their pooling method has improved efficiency over Fama-MacBeth (1973), Ferson and Harvey (1999) make an implicit assumption of no time effects, upon which we do not agree. We argue that pooled returns should have significant time effects, which can seriously change the statistics in regressions. One argument in support of the existence of time effects comes from the fact that macroeconomic variables do change over time, which affects the aggregate level of returns in the stock markets in each time period. Fama and MacBeth (1973) have implicitly taken into consideration time effects, and hence have their own advantage over Ferson and Harvey (1999) under a more realistic assumption that acknowledges the existence of time effects in stock returns.
To account for both the heteroskedasticity of coefficient estimates and the time effects of stock returns, we propose panel analysis with fixed time effects rather than the ones employed by Fama-MacBeth (1973) and Ferson and Harvey (1999). In the following, we show that our empirical procedure has improved efficiency over both Fama-MacBeth (1973) and Ferson and Harvey (1999).

The use of panel data analysis with fixed time effects is not new\(^1\). Below we show why panel data analysis with fixed time effects has advantage over both the cross-section method by Fama-MacBeth (1973) and the simple pooled method by Ferson and Harvey (1999). We write the panel data regression with fixed time effects in the following matrix form:

\[
Y = D\alpha + X\beta + \varepsilon
\]  
(3.5)

where

\[
y = [y_1', y_2', ..., y_T']',
\]

\[
\alpha = [\alpha_1, \alpha_2, ..., \alpha_T]',
\]

\[
X = [x_1', x_2', ..., x_T]',
\]

\[
\varepsilon = [\varepsilon_1', \varepsilon_2', ..., \varepsilon_T]',
\]

and

\[
D = [e_1, e_2, ..., e_T], \text{ where } e_t = [0_1', 0_{t-1}', 1_t', 0_{t+1}', ..., 0_T']'.
\]

In addition, the variance-covariance matrix of the error term, \(\varepsilon\), is \(\Omega\).

\(^1\)For full references, see Hsiao (1986) and Greene (1999) who provide good reviews on literature and development in this area.
The panel data regression equation is equivalent to the following after a $M_d$ transformation

$$M_dY = M_dX\beta + M_d\varepsilon$$

(3.6)

where

$$M_d = I - D(D'D)^{-1}D'$$

The intuition for the transformation is as follows. It is easy to see that

$$M_0 \cdot \cdots \cdot \cdot 0$$

$$0 \cdot M_2 \cdot \cdots \cdot \cdot$$

$$\cdot \cdots \cdot \cdot$$

$$\cdot \cdots \cdot \cdot$$

$$0 \cdot \cdots \cdot 0 \cdot M_T$$

with matrix $M_t$ on the diagonal equal to $M_t = I_t - \frac{1}{\text{size}_t}ii'$. Meanwhile, for a vector $Z_t$, $M_tZ_t = Z_t - \bar{z}_t$, where $\bar{z}_t$ is the mean of $Z_t$. Therefore, the panel data regression with fixed time effects is in fact equivalent to a regression with the dependent and independent variables being first transformed to time-period mean-deviations. Such a transformation is very useful in comparing our method with the one used by Fama-MacBeth (1973).

In Fama-MacBeth (1973), the following regression is run for each time period $t$

$$Y_t = \alpha_t + X_t\beta + \varepsilon_t,$$

(3.7)

and then the time-series average of the $\beta$ estimators is used in a $t$-test to determine whether $\beta$ is different from 0. With the $M_t$ transformation in (3.6), we can also get the following from (3.7) for each time period $t$

$$M_tY_t = M_tX_t\beta + M_t\varepsilon_t$$

(3.8)
It is easy to see that the estimator of $\beta$ at time $t$ from (3.8), $b_t$, is in fact the same as the estimator from (3.7).

From the transformed (3.6), we get the GLS estimator of $\beta$

$$b = [X' M_d' \Omega^{-1} M_d X]^{-1} [X' M_d' \Omega^{-1} M_d Y]$$

(3.9)

Assuming that there is no time-series correlation in the residuals $\varepsilon$, we can rewrite (3.9) as

$$b = \left[ \sum X_t' M_t' \Omega_t^{-1} M_t X_t \right]^{-1} \cdot \left[ \sum X_t' M_t' \Omega_t^{-1} M_t Y_t \right]$$

$$= \sum X_t' M_t' \Omega_t^{-1} M_t X_t \cdot b_t$$

(3.10)

where

$$b_t = [X_t' M_t' \Omega_t^{-1} M_t X_t]^{-1} [X_t' M_t' \Omega_t^{-1} M_t Y_t]$$

(3.11)

is the GLS estimate of $\beta_t$ in (3.8).

Since

$$Est \ VAR\{ b_t \} = [X_t' M_t' \Omega_t^{-1} M_t X_t]^{-1},$$

(3.12)

it is clear that the GLS estimator $b$ is a weighted average of $b_t, t = 1, ..., T$, and the weight for each period $t$ is a multiple of the inverse variance-covariance matrix of the estimated $b_t$. Therefore, following logic similar to Ferson and Harvey (1999), the GLS estimator $b$ in panel data regression with fixed time effects has improved efficiency over the simple arithmetic average of $b_t$ as in Fama-Macbeth (1973) stemming from the use of the variance-covariance weighted average.
Now we move on to Ferson and Harvey (1999) who use a simple pooled regression. They assume

\[ Y = \alpha_0 + X\beta + \varepsilon \] (3.13)

where

\[ y = [y_1', y_2', ..., y_T']', \]
\[ X = [x_1', x_2', ..., x_T']', \]
\[ \varepsilon = [\varepsilon_1', \varepsilon_2', ..., \varepsilon_T']', E(\varepsilon \varepsilon') = \Omega \]

and \( \alpha_0 \) is a constant. The GLS estimator \( b \) from specification (3.13) is

\[ b = [X' M_{one}^{-1} M_{one} X]^{-1} [X' M_{one}^{-1} M_{one} Y] \] (3.14)

where \( M_{one} = I - \bar{\Gamma}(\bar{\Gamma}' \bar{\Gamma})^{-1} \bar{\Gamma}' \), \( \bar{\Gamma} = [1_1, 1_2, ..., 1_m, ..., 1_{mt}, ..., 1_{mt}]' \).

By implicitly assuming that there are no fixed time effects, Ferson and Harvey (1999) show that their pooled regression has improved efficiency over Fama-MacBeth (1973). However, with time effects being considered, the estimator in (3.14) is obviously not as accurate or efficient as the estimator in (3.9) and (3.10) because of the difference between \( M_d \) and \( M_{one} \).

The analysis above is mainly for the test of the risk-return relationship related to Chapter II. In Chapter I, we also use panel data regression with fixed firm effects. With either fixed time effects or with fixed firm effects, panel data regression requires cautious explanation of its economic meaning. In the case of fixed time effects, we have \( M_t Z_t = Z_t - \bar{z}_t i \) for any vector \( Z_t \), where \( \bar{z}_t \) is the mean of \( Z_t \). As discussed earlier
in this subsection, it is equivalent to a regression with the dependent and independent variables being first transformed to mean-deviations in each time-period. This needs special attention when one or more of the independent variables are time-specific but common among firms. For example, if one of the independent variable is the market return, which takes a single value at each time period, the transformed market return will be 0 for all observations. Therefore, a panel data regression with fixed time effects is meaningless when market return is one of the variables because of the multicollinearity problem.

For panel data analysis with fixed individual effects, the situation is similar. The regression is equivalent to one with all variables being transformed to mean-deviations of each firm/individual. If there is some variable that is firm-specific but common over time, there is also a problem from multi-collinearity. Such an issue could become more subtle when the independent firm-specific variable does vary slightly over time. For example, Domowitz, Glen, and Madhavan (1997) use each firm’s market capitalization to proxy for the size factor in their panel regression with fixed individual effects. Since a firm is not likely to issue new equity and/or incur large operating gains or losses every month, the market capitalization in the regression by Domowitz, Glen, and Madhavan (1997) should proxy more for each firm’s price changes than differences of size across firms. Such subtle differences in the economic meanings of variables deserve special attention when making a choice between simple pooled panel regression and panel regression with fixed effects.

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In the following section, we begin with the panel data regression with fixed time effects to determine the relationship between firms' betas and price ratios. Then, we use the panel regression with fixed firm effects to determine the relationship between price ratios and other factors, including regime-switching risk in the foreign exchange rate, and liquidity differences between A- and B-Shares. Lagged price ratios are used as an independent variable in the regression to keep the error term stationary. In the test of the risk-return relationship, we use panel data regression with fixed time effects in addition to the traditional Fama-MacBeth tests.

3.5 Tests of Chapter I

3.5.1 International Betas and Price Ratios

Our model in Chapter I implies that the higher the international betas, the higher the A- to B-Share price ratios. To test this relationship with the Asian financial crisis and U.S. stock market boom in late 1990s in mind, we divide the full sample period into two periods: 1993-1996 and 1997-2000. The betas are estimated using the data in the first sample period, and then we use the data from second period to see whether the estimated betas can predict the differences in Price Ratios or not. On one hand, this division of the two periods is a natural choice based on our 8-years sample; on the other hand, the discussion in the subsection above shows that the betas estimated
from sub-period 2 may not be reliable.

We use two methods to check the relationship between the betas and the price ratios so as to check the robustness of the tests. The price ratios in the following tests are the mean of all daily observations so as to reduce noise in the estimates of price ratios.

First, we use the standard Fama-Macbeth test. We regress the price ratios on the estimates of betas in each year, and then see whether the coefficients of Beta are significantly positive.

Table 3.4 shows significant t-statistic with a strong positive relationship between betas and price ratios.

We also pooled all the data together and use the panel data regression with fixed time effects to double check the relationship. These results, shown in Table 3.5, also reveals a significant positive relationship.

### 3.5.2 Test of Other Factors

In addition to the tests above specifically designed for testable implications of Model I, we also look at other secondary factors which may play a role in the differential pricing between A- and B-Shares. In the following, we first discuss the liquidity and regime-switching risk in China, and then present the results of our test.
Liquidity  The lower the liquidity, the higher the required rate of return, or say the lower the price. On the other hand, the difference between A- and B-Share’s market liquidity also changes the difference between domestic and foreign investors’ elasticities of demand, and hence the difference between A- and B-Share supplies. This has a positive effect on the shares with lower liquidity because of a lesser amount of supply. In equilibrium, we show in Chapter I, that the A- vs. B-Share price differences are as follows:

\[ P_A - P_B = \frac{\Gamma_{A-B}}{2(1+r)} \bar{\mu}_D + \frac{1}{2(1+r)} \Gamma_{B} \Omega_{DF} \Omega_{F}^{-1} [\bar{\mu}_F - (1+r) \bar{\mu}_F] \]  

(3.15)

where \( \Gamma_{A-B} \) is a \( m_d \) by \( m_d \) diagonal matrix, with the \( i \)th item on the diagonal being \( \gamma_i^b - \gamma_i^a \). Here \( m_d \) is the number of domestic firms with both types of shares, and \( \gamma_i^a \) and \( \gamma_i^b \) refers to the bid-ask spread of firm i’s A-Shares and B-Shares respectively.

This equation shows that smaller the bid-ask spread of B-Shares than A-Shares, the higher the price difference. This can be empirically tested with price-standardized bid-ask spreads and price ratios. In addition, the liquidity can be measured from two aspects. One is the gap between the ask and bid, as we have discussed before; the other is the dollar amount of trading volume, which measures the depth of liquidity. Bid-ask spread alone cannot tell how large the liquidity cost is for an investor who sells a not-so-small amount of shares. Therefore, we construct two measures of liquidity: one is the average gap between the daily ask and bid prices at market close time divided by closing prices, and the other is the sum of daily trading volume denominated in dollars, not the number of shares. Further, we calculate the difference between the
average bid-ask spread of A- and B-Shares, and the ratio of B- to A-Share trading volume\(^2\). We test whether these two measures play a significant role in determining the price ratios.

In fact, in China there are no market makers. Therefore, the liquidity may be even more important than in North America.

**Regime Switching/Governmental Exchange Rate Risk**  In China, it is the government, not the market, who controls the exchange rate between Chinese Yen (RMB) and other currencies, such as USD and Euro Dollar. In general, the official exchange rate between Chinese Yen and USD may not be consistent with the exchange rate that would be determined by a free market. In such a situation, a foreign investor faces two types of exchange rate risk. First, as any other currency, there is an *intrinsic* exchange rate risk in RMB that comes from the uncertainty of the trade and economy. Second, there is a risk that the government may not be able to maintain the exchange rate target in the future, or the government may switch to a freely convertible currency after an unknown period.

The difference between official and free-market exchange rates can undermine

\(^2\)As a measure for liquidity, trading amount measured by dollars should be more relevant than turnover ratio, for an investor normally cares most about the selling price of his own holdings, not the selling price of all outstanding shares of a firm that he invests. Therefore, we are not using the ratios of B- to A-Share turnover ratios here, though they are probably highly correlated with the ratios of trading amount used here.
the accuracy of A- to B-Share price ratios calculated with official exchange rates. For example, if there would be a 10% appreciation shock of USD vs. Chinese Yen based on market forces, the market value of a Chinese firm denominated in USD should decrease proportionally although the value denominated in Chinese Yen stays the same. If the official exchange rate adjusts right away to fully reflect the 10% appreciation of USD, as what the exchange rate would be in a free market, we would see no change of price ratios. However, if the official exchange rate does not adjust at all, the price ratios will be higher.

To better describe the two types of risk, we denote the current official exchange rate of RMB to USD as $\theta_0$, and the future exchange rate as $\tilde{\theta}_1$. In addition, we denote the intrinsic current exchange rate as $\theta'_0$, which is how much the exchange rate should be if the government allow RMB to be freely convertible and chooses not to interfere in the money market. As for the intrinsic future exchange rate, we denote it as $\tilde{\theta}'_1$. Under the assumption of interest rate parity, the expectation of $\tilde{\theta}'_1$ should be equal to $\theta'_0$.

If the government was setting the exchange rate as it should be in a free market, we would have that $\theta_0 - \theta'_0 = 0 = E(\tilde{\theta}_1 - \tilde{\theta}'_1)$. However, we expect to see that $|\theta_0 - \theta'_0| > 0$ in reality. The regime-switching risk in fact refers to the risk that such a difference tend to diminish or disappear in the future, and so $E(\tilde{\theta}_1$ should be somewhere between $\theta_0$ and $\theta'_0$, or equal to $\theta'_0$. To test the null hypothesis that the government does not matter in the dynamics of real exchange rate, we can test how
the price ratios react to shocks of $\Delta_0 = \theta_0 - \theta'_0$.

We include the regime switching risk in our regression out of two considerations. First, it is naturally a interesting phenomenon common to many countries who do not have freely convertible currencies, and may also be a significant pricing factor in determining the price differences between $A$- and $B$-Shares. Second, it can also serve as a control variable for the possible miscalculations of real price ratios owing to the use of official exchange rates.

The difficulty in testing the regime-switching risk in exchange rates lies in the unobservability of intrinsic exchange rates between Chinese Yen and USD/HKD. The black market of currency exchange is illegal in China, and it comes as no surprise that there are no recorded exchange rates available from the black market. Further, the savings rate in China is also controlled by the government, not the market, and so the difference between USD and RMB savings rates cannot reflect the changes in intrinsic exchange rates either.

Therefore, we have to look for a proper proxy for the regime-switching risk. There is a tendency that Asian currencies move together relative to USD, possibly owing to a stronger correlation among Asian economies. Therefore, the change of exchange rates between Asian currencies and USD should be a good proxy for the change of the intrinsic exchange rate between RMB and USD. What we do in the following is to first pick up a portfolio of Asian currencies, including these of Thailand, Korea,
Indonesia, Singapore, Taiwan, Philippine, India, and Japan, and then calculate the equal-weighted changes of this portfolio relative to USD. We use the gap between the change in official exchange rate of RMB vs. USD and the change in the market exchange rates of this Asian portfolio currency vs. USD to measure the magnitude of regime-switching risk in Chinese foreign exchange rates. To check the robustness of the measure, we also use the portfolio without Japanese Yen and see how the results respond to this.

We can also try to further measure the risk of intrinsic exchange rate in China. However, we choose not to do so here. First, such a risk is common among all countries, and hence not so necessary to be investigated in this study on Chinese stock markets. Second, the variance of foreign exchange rate is relatively stable from month to month, and so unlike the regime-switching risk, it is not expected to cause much variation in price ratios.

Tests  To fully utilize the data sample we have and increase the power of the test, we choose to use panel analysis with fixed firm effects in our analysis here, and we have separately tested the effect of international betas on price ratios earlier in this chapter. Table 3.6 shows that the statistics of proxies for both liquidity and regime-switching risk are strongly significant and consistent with our inferences.
3.6 Empirical Evidence and Tests on Chapter II

3.6.1 Empirical Evidence

E/P (P/E) Ratios  P/E ratios are widely used in the literature, both as a measure of price level and a measure of growth opportunity. However, considering the large number of Chinese firms with negative earnings, we choose to use E/P ratios, the inverse of P/E ratios. Our choice lies in the following. First, P/E ratios for firms with negative earnings do not have a consistent economic meaning so as to be pooled together with P/E ratios for firms with positive earnings, while E/P ratios are less vulnerable in this aspect and have consistent meanings for both positive and negative earnings. In fact, the statistics of pooled P/E ratios across firms and/or over time, such as the mean, do not have such a good economic interpretation as corresponding statistics of E/P ratios either. For example, if there is one single firm with a positive earning that is close to 0, which is not unusual since a significant portion of firms can even have negative earnings, then the average P/E ratios of the entire sample can be abnormally high simply because of this normal observation. Further, we wish to present the aggregate accounting performance of firms listed in Chinese stock markets, and it is important for us to include all sample firms rather than just only firms with positive earnings.

From Table 3.7, we can see that E/P ratios in the Shanghai Stock Exchange are extremely low. Contrary to the small firms listed in NASDAQ which may give
investors plenty of room for growth imagination, the firms listed in the Shanghai Stock Exchange (SHSE) are mainly large cap stocks that have been in operation for many years before going public. Moreover, unlike the high tech industry in NASDAQ, most Chinese firms listed in the SHSE are grown and mature companies rather than the high tech ones that may give lots of room for growth imagination.

Table 3.8 compares the E/P ratios with the interest rates on 1-year fixed term bank deposits. In China, treasury bills were not a feasible investment choice for the public until recently, and the official interest rates are the effective riskfree rates to Chinese residents. The rates are matched year to year, and the 1-year interest rate is a compounded rate of different subperiods if there are changes in the official interest rates over a certain year. From table 3.8, it is clear that the interest rate is much higher than the E/P ratio most of the time. This may be explained by two alternative hypotheses: either the high growth rate of Chinese firms or the existence of strong bubbles driven by the UMC\(^3\). If we accept the first hypothesis, then the risk return relationship should still be positive, as predicted by the traditional CAPM or its

\(^3\)Both the mean and median growth rates of Chinese firms’ earnings are believed to be too low to justify the low E/P ratios. We may present such evidence in a later revision. In fact, in the recent study by two official state-owned institutions, State Information Centre and Shanghai Securities News (2002), it is stated that the average earnings to book value ratio in Chinese stock markets for the year of 1998 to 2001 are 7.51, 8.05, 7.58, and 5.56 respectively. These numbers do not indicate any positive sign of high growth at all. Anyhow, right now we just simply give two alternative explanations, and leave the choice to the empirical tests later in this chapter.
variants. On the contrary, if strong bubbles do exist because of the UMC in China, we can see negative risk return relationship. In the rest of this chapter, we mainly test the risk return relationship in China, in addition to the event study on the existence and impact of the UMC in China and risk return tests in the U.S.

**Risk-Return Correlations** Before we carry out the formal analysis of the risk-return relationship in China, it is interesting just to see the correlations between risk and return in Chinese stock markets. First, we estimate the standard deviation of a firm’s, say firm i’s, returns in the estimation window and take it as the measure for firm i’s total risk. Further, we use the following market model to decompose firm i’s risk into market risk and firm-specific, or say idiosyncratic, risk.

\[ r_{it} = \alpha_i + \beta r_{mt} + \varepsilon_{it} \]  

(3.16)

The coefficient Beta, \( \beta \), is the measure for market risk. The standard deviation of the residual term \( \varepsilon \) is taken as the measure for firm i’s idiosyncratic risk.

In traditional CAPM, only a firm’s market risk is priced in the stock market, and the residual risk should not matter. Consequently, the total risk is not a good measure for priced risk either. However, in the Agency CAPM developed in the chapter *Unbalanced Management Compensation and Asset Pricing*, it is shown that a firm’s idiosyncratic risk does matter. Meanwhile, a firm’s market risk matters as well, and the best measure for priced risk should be the measure of total risk. Moreover, in traditional CAPM, a firm’s market risk should be positively correlated
with the expected rate of return. That is, the higher the risk, the higher the expected rate of return. However, in our Agency CAPM, the risk-return relationship can be negative. Before we carry out the formal tests of risk-return relationships later in this chapter, we first have a look at the correlations between the different risk measures and different return measures.

Table 3.9 presents the product-moment correlations between the two measures of returns, the log excess returns adjusted by riskfree rates and abnormal returns adjusted by market returns, and various measures of risk, including total variance, beta, and residual variance. We also put in the square of β, which is used in the literature as one of many ways to capture the non-linear relationship between risk and returns. We use a three year rolling window period to estimate the measures of risk and return, and then the returns in the subsequent period are matched with risk measures estimated previous window period for calculation of correlation coefficients.

In addition to the widely used Person product-moment correlations, we also calculate nonparametric correlations including the Spearman rank correlations and Kendall’s tau-b so as to capture possible non-linear relationship between risk and return. All results strongly indicate that there is a negative risk-return relationship in both the Shanghai Stock Exchange and the Shenzhen Stock Exchange. See table 3.10 and table 3.11

The values of the correlation coefficients are significant both statistically and eco-
nomically. Most of the coefficients are statistically significant at a level less than 0.0001, and such a relationship is persistent as we investigate the data from different angles with various methods. Specifically, the results are robust and consistent regardless of the choice of sample firms (SHSE, SZSE, or both Chinese stock exchanges), the choice of cross-section unit (individual firms or portfolios sorted by rank of risk measures), the choice of benchmark index (either local exchange indices or the entire Chinese stock market index which can be either equal weighted or value weighted average of local exchange indices), the time interval of data (weekly observations or monthly observations), the updating period of beta and other risk measures (updated annually, quarterly, monthly, or even weekly), and the methods of calculating correlations (standard product-moment/Person correlation, rank/Spearman correlation, and other non-parametric correlations such as Kendall's tau-b). Later in Fama-MacBeth cross-sectional regression we will also show that the negative relationship is economically significant.

Kendall's tau-b is a nonparametric measure of association based on the number of concordances and discordances in paired observations. Concordance occurs when paired observations vary together, and discordance occurs when paired observations vary differently. The formula for Kendall's tau-b is:

\[
r = \frac{\sum_{i<j} \text{Sign}(x_i - x_j) \text{Sign}(y_i - y_j)}{\sqrt{(T_0 - T_1)(T_0 - T_2)}}
\]

where \( T_0 = n(n - 1)/2 \), \( T_1 = \sum t_i(t_i - 1)/2 \), and \( T_2 = \sum \mu_i(\mu_i - 1)/2 \). Here \( t_i \) is the number of tied \( x \) values in the \( i \)th group of tied \( x \) values, \( \mu_i \) is the number of tied \( y \) values.
values in the \( i \)th group of tied \( y \) values, \( f \) is the number of observations, and \( \text{Sign}(z) \) is defined as \( \text{Sign}(z) = 1 \) if \( z > 0 \), \( \text{Sign}(z) = 0 \) if \( z = 0 \), and \( \text{Sign}(z) = -1 \) if \( z < 0 \).

### 3.6.2 An Event Study: Crack-down on UMC Managers

In China, UMC takes many forms. Some are legal, such as the management compensation contracts of investment companies, pension funds, and consulting companies. Meanwhile, many others are illegal, such as SOE managers and government officials who invest in the stock markets with state-owned capital that is allocated for productions and operations. In addition, banks are not allowed in the stock markets either, though many of them do invest. The illegal investment in the stock markets is widespread, and hence stands as one important factor for the existence of UMC in China. The May 1997 announcement by Chinese government provides some specific information on this situation, and an excerpt of the announcement is available in Appendix B.1.

In May 1997, the government announced a crack-down on illegal stock trading by managers and officials in the state-owned sectors. This offers a natural opportunity for us to conduct an event study and see whether the UMC is a significant factor priced in the stock markets. Some people may argue that the government faces a serious problem in monitoring, and so the crack-down on illegal trading may be far from so enforcing as what the government announces. We argue that, while acknowledging
the limit of the government’s enforcing ability, such a crack-down should at least have some marginal effect on the illegal trading, and hence offers a good case to empirically investigate the existence of one type of UMC in Chinese stock markets.

The Result: see table 3.12. The returns in the event window are significantly negative. This provides empirical support for the existence of UMC managers in Chinese Stock Markets, and such UMC managers do have an important role in Chinese asset pricing. Furthermore, the pre-event window period also shows significant negative returns, which indicates leakage of the information on the crackdown before the government makes the public announcement on May 22, 1997.

Some people may be concerned about the changing of parameters in the market model after the event window period. To check the robustness of our tests, we also use the after-event window period as the estimation window. The results are similar, strongly supporting the claim that there are statistically and economically significant negative market reactions up and before the announcement of the crack down on May 22, 1997.

To address the issue of heteroskedacity among firms, we also use the standardized daily returns of each firm to test the significance of market reactions in the three window periods, and the t-statistics are similar. The results are not presented here because the economic meanings of such standardized mean and media are not clear.
3.6.3 Tests of the Risk and Return Relationship in China

From Chapter II, we see that negative risk and return relationship is the sufficient condition for a strong form of bubble to exist. Such a negative relationship also indicates significant impact of UMC (unbalanced management compensation) on asset prices. In the following, we test the risk-return relationship in China using both the traditional Fama-MacBeth method and a new method with improved efficiency. Further, we also conduct the test in U.S., where the management compensation is unbalanced in a different manner. Such a different compensation structure in the U.S. offers a natural data sample for our comparison study.

Fama-Macbeth Test of Risk and Return Relationship  Use the standard Fama-Macbeth (1973) cross-sectional regressions to test the relationship between risk and returns.

See Table 3.13.

Improved Method: Panel Data Analysis with Fixed Time Effects  As discussed earlier in the test of Chapter I, panel data analysis with fixed time effects has improved efficiency over both Fama-MacBeth (1973) and Ferson and Harvey (1999). We conduct such a panel regression with fixed time effects, and the results are shown in Table 3.16, 3.17, and 3.18.
From Table 3.16, first we see that there are strong time effects based on the F-test statistics. This supports our choice of panel regression with fixed time effects against Ferson and Harvey (1999). Second, the significance level of each risk measure coefficient is much stronger in this table than the counterpart in 3.13, which indicates the improved efficiency of our empirical procedure than Fama-MacBeth (1973).

We see in Table 3.16 that each of the three risk measures has a significant negative coefficient when used separately in the regression. This indicates that the higher the risk, the lower the return. Moreover, the measure of total risk dominates two other risk measures: the residual risk and the market risk ($\beta$). This is exactly as what is predicted in our model, where we state that the UMC managers do not diversify and only care about the total risk rather than the systematic risk in their valuation of the securities in the stock markets.

Noting that the total risk of each firm is in fact the sum of its market risk and idiosyncratic risk, a problem of multi-linearity probably shows up when all three risk measures are used together in the same regression. However, we still see that $\text{TotRiskStd}$, the measure for total risk, remains strongly significant and still dominates two other risk measures in the all-in-one regression in Table 3.16. Meanwhile, it is not surprising to see that the significance level of the measure for total risk is not so high in the last regression of Table 3.16 as in other regressions of the same table.

Table 3.17 and 3.18 present the results for the Shanghai Stock Exchange and the
Shenzhen Stock Exchange respectively. The results are similar, and the sign of the coefficients are still significant or consistent with Table 3.16, though the significance levels are not so strong. The reason probably lies in the loss of test power with a smaller sample size.

In Table 3.16, we also see that the loading for the measure of market risk, $\beta$, is over 1% for the entire sample of listed Chinese firms. This indicates that an aggregate Chinese investor is willing to sacrifice more than 1% of return in a typical month to hold a stock with exactly the same level of risk as the market index.

Some people may be concerned that the market return may be negative in our sample period, and hence contribute to the negative risk return relationship. This can be addressed by the following two arguments. First, the market return in the sample period is strongly positive in both the Shanghai Stock Exchange and the Shenzhen Stock Exchange. In fact, the market indices have risen around 100% in our sample period, and even more considering the cutting off the first three years as the initial estimation window period. Therefore, such an argument of the conditional market movement can only strengthen our results. Second, we have used fixed time effects in our model, which can absorb the impact of the market-level return variations over time.

To check the robustness of our tests, we have also used different market indices in the tests, including the local indices in each stock exchanges and the equal-weighted
and value-weighted indices of the local market indices. The results are persistent.

3.6.4 Tests of the Risk-Return Relationship in the U.S.: A Comparison

Since the fund management compensation problem in China is different from that in the U.S., U.S. data sample is a natural source for a comparison study. Using the same sample period as that of Chinese data set, which is 1993-2000, we replicated all the tests on risk-return relationships using U.S. data sample. We choose SP 500 firms as our U.S. data sample in the comparison study. In addition to the obvious fact that SP 500 firms are the most representative firms in the U.S. and have been chosen as data sample in various empirical tests, there are additional reasons why this sample is chosen in our study.

First, the universe of firms available in CRSP includes a large number of small firms with thin trading, and the estimates from firms with thin trading may cause special problems in the statistical inferences, such as Heinkel and Kraus (1988) who show that thin trading can markedly affect the significance level of empirical tests. In the meantime, no Chinese A-Shares suffer from thin trading problem in our sample period. Even not in a specific situation as in our comparison study, some people choose to drop firms with thin trading in their data sample. With the consideration of thin trading's impact on test results, SP 500 is a better candidate for our comparison
study than the total universe of CRSP firms.

Second, Chinese firms listed in A-Share markets are uniformly "large" firms. Based on PPP or GNP per capita, the smallest firms listed in China are comparable with, or even larger than, the smallest firms in SP 500. Therefore, using SP 500 firms can also help to control for the size effect.

Third, there is a question about which index is the best proxy for index-adjusted performance calculated in the industry. SP 500, in our opinion, is a very good choice because of its historical notability in the industry and its reputation in terms of representation and scientific construction. SP 500 also has the advantage of accessibility to the people in the industry, and other academic indices such as CRSP NYSE/NASDAQ/AMEX Value-Weighted Indices may not be so likely to be widely adopted by the mutual funds in setting up the compensation contracts for their managers. Moreover, this may also interacts with the fact that a variety of different mutual funds exist in the real world, many of which aim at only a subset of stocks, such as big cap vs. small cap. In such a situation, their benchmark in compensation should be an index close to the subgroup of stocks that they can invest, and hence the decomposition of idiosyncratic risk and systematic risk should be based on corresponding sub-index rather than the market index of the entire U.S. equity market. By looking at the SP 500 firms only, we can alleviate the need for an extra process to determine different benchmark indices for different firms.
There are frequent changes in the list of SP500 firms from year to year, mainly resulting from the change of firm sizes. Therefore, the active members of SP500 may be subject to a size survivorship bias which means firms that are successful and growing tend to stay or join SP500. To at least partially adjust for this survivorship bias, we include all firms that ever show up in SP500 during the 1993-2000 period in our entire sample period. This adjustment also makes our sample firms more comparable with the situation in China, where few firms are ever delisted though only big and successful state-owned enterprises (SOEs) tend to be listed in the stock markets.

The statistics in our study show that the beta-return relationship is WEAKLY positive in the U.S.. This is not surprising considering the weak empirical support for CAPM in the past and the special situation (the conceived bubbles in the stock market) in the U.S. in the past several years. Further, our tests show that the relationship between residual risk and return is more than weakly negative. This is not consistent with traditional CAPM, which states that residual risk does not matter, but consistent with our agency model where the fund managers' compensation has a huge impact on asset pricing in stock markets. For details, please see the appendix of one chapter in this thesis titled *Unbalanced Management Compensation and Asset Pricing*. 
Fama-Macbeth Test of Risk and Return Relationship  We first use the traditional Fama-MacBeth (1973) method and find the consistent evidence supporting negative residual risk-return relationship. See table 3.19. The statistics are not significant, though. The lack of power in Fama-MacBeth method, in addition to the short time period in our sample, may give an explanation to the low level of significance.

Improved Method: Panel Data Analysis with Fixed Time Effects  See table 3.20. Note: In analysis, we used both individual and portfolio data to test the models so as to get stronger robustness in our results. On one hand, our tests based on portfolios makes the results comparable with the tests in the literature where portfolios are the popular choice; on the other hand, our tests based on individual firms addresses the problems arisen from portfolio formation, such as the over-rejection of models discussed in Berk(2000). The tables presented here are based on individual firms’ returns and risks only, for the results based on portfolios are similar.

Both the coefficient for the residual risk, or say idiosyncratic risk, and the coefficient for the total risk are on the boundary of being significant at a 10% level when $\beta$ is included as the other independent variable. This gives strong support to our model. The negative coefficient of total risk in the first and fifth regression in the table is consistent with the evidence that idiosyncratic risk is taking up a much larger portion of total risk than the systematic risk, as documented in Campbell, et al (2001). Despite the high correlation between total risk and residual risk implied from the regressions,
total risk still has a positive coefficient when the only other independent variable is residual risk. This further corroborates our explanation that the negative coefficient of total risk in the first and fifth regression solely comes from its high correlation with residual risk. In the seventh regression, all three risk measures are included in the regression, and the results are less stable because of a problem of multi-collinearity: total risk is in fact the sum of residual risk and market risk.

3.7 Conclusion

In this study, we have found supporting evidence for both Chapter I and Chapter II. On Chapter I, we first find that the A-to-B price ratios are significantly larger than one, and it holds for every subperiod and every single firm. Second, firms with only B-Shares have significantly lower international betas than firms with both types of shares, and the betas of B-Share only firms are negative, though not statistically significant. Third, international betas have significantly positive impact on price ratios, and this supports the key inference from our model. Further, we also find that the liquidity and exchange rate risk also play significant roles in asset pricing.

Regarding implications of Chapter II, we have found supporting evidence from the event study for the existence of the Unbalanced Management Compensation in Chinese stock markets. More importantly, our tests also show that the risk-return relationship in China is negative, which is in sharp contrast with the traditional
CAPM but consistent with our Agency Capital Asset Pricing Model (ACAPM). We also call this ACAPM the Chinese version of CAPM, though our ACAPM can be modified to apply in the North American stock markets as well. In addition, we also find a negative idiosyncratic risk and return relationship in North American stock markets, though the market risk and return relationship stays in the positive range. Such results are consistent with the application of our model to the U.S. stock markets, as discussed in the appendix of the chapter titled *Unbalanced Management Compensation and Asset Pricing*.

In the design of our empirical study, we employ an empirical procedure with theoretically improved efficiency over Fama-MacBeth (1973) and Ferson and Harvey (1999), and find such a procedure does provide more significant statistics in the empirical tests. Meanwhile, we have also conduct the tests using the more traditional methods, and the results are robust and consistent.

We also adjust our empirical procedure to deal with the thin trading in the Chinese *B-Share* market. The thin trading problem is largely neglected in existing literature of empirical studies on Chinese stock markets, and such a neglect can cause serious distortion in many aspects of empirical tests and give rise to spurious results. In addition, we also use the panel data analysis with fixed effects more carefully than some previous studies.

There is a variety of other tests which may shed more light on other secondary
implications of our model in Chapter I and Chapter II, and we mainly carry out the tests of the key implications in this study. Further, there are also many other interesting empirical topics in Chinese stock markets, such as tests of agency problems, a search for the empirical pricing factors in China, and tests of implications from behavioral finance models. These are the work that we will continue in future research.
Bibliography


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Figure 3.1: Agency Capital Asset Pricing Model — Cross-sectional Views

This figure shows the price-risk relationship in equilibrium with $c_t$ taking fixed values at 0.001, 0.03, 0.05 = $c_g$, and 0.1. Here $c_t$ refers to the compensation ratio is when a fund managers makes money, and $c_g$ is the penalty ratio when he incurs a loss. For details on the agency capital asset pricing model, please refer to the chapter in this thesis titled *Unbalanced Management Compensation and Asset Pricing*. This figure gives cross-sectional views of the Figure I in *Unbalanced Management Compensation and Asset Pricing*. For each fixed value of $c_t$, a price-risk curve is obtained as the standard deviation of the risky asset’s payoff, $\sigma$, varies from 50 to 350. The bonus ratio, $c_g$, is set to 0.05. The values of other parameters are set as follows. $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, $c_0 = 0.05$, $\gamma_q = \gamma_k = 1$. 

![Figure 3.1: Agency Capital Asset Pricing Model — Cross-sectional Views](image-url)
This figure shows the Shanghai Stock Exchange A-Share and B-Share index returns in 1992. The top graph is the time series of daily index levels, and the bottom two graphs are the time series of index returns for A-Share index and B-Share index respectively. A-Share index and return show that A-Share prices in the Shanghai Stock Exchange more than double after the removal of daily price movement limits in May 1992. They also indicate that A-Share price movements before the removal of the daily price limits are not random; instead, prices just go up along a straight line most of the time during the pre-removal period. Consequently, A-Share prices in 1992 cannot reflect the true market values in equilibrium, nor could A- to B-Share price ratios reflect the true gaps between domestic and foreign investors' valuation of Chinese firms.
Figure 3.3: SHSE A- and B-Share Index Level and Returns during 1993-2000

This figure shows the Shanghai Stock Exchange A- and B-Share index levels and returns from 1993 to 2000. The top graph is the time series of daily index levels, and the bottom two graphs are the time series of index returns for A-Share index and B-Share index respectively. Relative to the 1992 price movement in Shanghai Stock Exchange, as shown in Figure 3.2, the stock prices in the period from 1993 to 2000 resemble more of a random walk.
This figure shows the Shenzhen Stock Exchange A- and B-Share index levels and returns from 1993 to 2000. The top graph is the time series of daily index levels, and the bottom two graphs are the time series of index returns for A-Share index and B-Share index respectively. Relative to the 1992 price movement in Shanghai Stock Exchange, as shown in Figure 3.2, the stock prices in the period from 1993 to 2000 resemble more of a random walk.
Figure 3.5: The Development of A- vs. B-Share Markets

This figure presents the historical development of Chinese stock markets. Here we use the cumulative numbers of shares issued in A- and B-Share markets by assuming that the number of A-Shares issued before 1990 is 0, noting that no B-Shares were issued before 1990, and the first Chinese stock exchange, SHSE, was established in December 19, 1990. The figure looks similar when we use the RMB amount of shares issued rather than the numbers of shares.
Table 3.1: The Statistics of A- to B-Share Price Ratios

This table presents the price ratios of Chinese firms with outstanding A- and B-Shares, which are identical shares issued to domestic and foreign investors by the same Chinese firms with the only difference being the ownership restrictions. The P95, P5, and median are respectively 95%, 5%, and 50% percentiles of price ratios. T-statistics are against the null hypothesis that the mean of price ratios is equal to 1, and it is obvious that all T values indicate rejection of this null hypothesis at any commonly used significance level. The time period is from January 1, 1993 to December 31, 2000.

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Table 3.2: Auto-correlations of \textit{A-} and \textit{B-Share} market index returns

This table shows that there are significant auto-correlations in \textit{B-Share} index returns, while the auto-correlations of \textit{A-Share} index returns are very small and insignificant. We have also checked the auto-correlations for the subperiods 1993-1996 and 1997-2000, and the results are similar.

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<tr>
<th>Shanghai Stock Exchange</th>
<th>A Share Index Return</th>
<th>B Share Index Return</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>Auto Corr -0.0204</td>
<td>0.1889</td>
<td>2086</td>
</tr>
<tr>
<td>P-Value 0.3524</td>
<td></td>
<td>&lt;0.0001***</td>
<td></td>
</tr>
<tr>
<td>Spearman Correlation</td>
<td>Auto Corr -0.0344</td>
<td>0.1693</td>
<td>2086</td>
</tr>
<tr>
<td>P-Value 0.1166</td>
<td></td>
<td>&lt;0.0001***</td>
<td></td>
</tr>
<tr>
<td>Kendall's tau-b</td>
<td>Auto Corr -0.0245</td>
<td>0.1190</td>
<td></td>
</tr>
<tr>
<td>P-Value 0.0940</td>
<td></td>
<td>&lt;0.0001***</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shenzhen Stock Exchange</th>
<th>A Share Index Return</th>
<th>B Share Index Return</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>Auto Corr -0.0026</td>
<td>0.1741</td>
<td>2086</td>
</tr>
<tr>
<td>P-Value 0.9050</td>
<td></td>
<td>&lt;0.0001***</td>
<td></td>
</tr>
<tr>
<td>Spearman Correlation</td>
<td>Auto Corr 0.0147</td>
<td>0.1804</td>
<td>2086</td>
</tr>
<tr>
<td>P-Value 0.5013</td>
<td></td>
<td>&lt;0.0001***</td>
<td></td>
</tr>
<tr>
<td>Kendall's tau-b</td>
<td>Auto Corr 0.0129</td>
<td>0.1309</td>
<td></td>
</tr>
<tr>
<td>P-Value 0.3800</td>
<td></td>
<td>&lt;0.0001***</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at 0.05; ** Significant at 0.01; *** Significant at 0.001.
Table 3.3: International Betas and Issuance of A- vs. B-Shares

This table shows the difference between the mean of international betas between two groups of firms: group I, firms with both A- and B-Shares, and group II, firms with only outstanding B-Shares. The t-tests in both the subperiod 1993-1996 and the entire sample period show that the mean of group I is significantly larger than the mean of group II. Meanwhile, the mean of group I remains larger in the subperiod 1997-2000, though the statistics are not as strong. This is not surprising considering the boom of US stock markets in late 1990s and the Asian financial crisis from 1997. These two events, which should be treated as outliers, strongly bias the estimated international betas of Chinese firms in the subperiod 1997-2000 towards negative values. Consequently, the power of the test of the mean differences between groups can be significantly reduced by such a distortion in estimation.

<table>
<thead>
<tr>
<th></th>
<th>Group I (with outstanding A Shares)</th>
<th>Group II (with no A Shares)</th>
<th>Difference (Group I - Group II)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.7197</td>
<td>-0.313</td>
<td>1.0331</td>
</tr>
<tr>
<td>Std Dev</td>
<td>1.3137</td>
<td>1.3802</td>
<td>1.3194</td>
</tr>
<tr>
<td>Std Err</td>
<td>0.1755</td>
<td>0.5635</td>
<td>0.5567</td>
</tr>
<tr>
<td>N</td>
<td>56</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>F-test</td>
<td>1.10 (0.7381)</td>
<td>Pooled T-test</td>
<td></td>
</tr>
<tr>
<td>T-test</td>
<td>1.82</td>
<td>(ProbT)</td>
<td>(0.0367)</td>
</tr>
<tr>
<td>1993-1996</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-0.343</td>
<td>-0.475</td>
<td>0.1317</td>
</tr>
<tr>
<td>Std Dev</td>
<td>0.5368</td>
<td>0.6722</td>
<td>0.5637</td>
</tr>
<tr>
<td>Std Err</td>
<td>0.0576</td>
<td>0.1503</td>
<td>0.1398</td>
</tr>
<tr>
<td>N</td>
<td>87</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>F-test</td>
<td>1.57 (0.1670)</td>
<td>Pooled T-test</td>
<td></td>
</tr>
<tr>
<td>T-test</td>
<td>0.94</td>
<td>(ProbT)</td>
<td>(0.1741)</td>
</tr>
<tr>
<td>1997-2000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-0.163</td>
<td>-0.453</td>
<td>0.2892</td>
</tr>
<tr>
<td>Std Dev</td>
<td>0.4526</td>
<td>0.6399</td>
<td>0.4918</td>
</tr>
<tr>
<td>Std Err</td>
<td>0.0485</td>
<td>0.1431</td>
<td>0.122</td>
</tr>
<tr>
<td>N</td>
<td>87</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>F-test</td>
<td>2.00 (0.0328)</td>
<td>Satterthwaite T-test</td>
<td></td>
</tr>
<tr>
<td>T-test</td>
<td>1.91</td>
<td>(ProbT)</td>
<td>(0.0339)</td>
</tr>
</tbody>
</table>

Note: F-test is the test against the null hypothesis of equal variances, and T-test is against equal means. The choice of pooled t-test or Satterthwaite t-test is based on the result of F-test at a significance level of 10%.
Table 3.3: International Betas and Issuance of A- vs. B-Shares

This tables shows the difference between the mean of international betas between two groups of firms: group I, firms with both A- and B-Shares, and group II, firms with only outstanding B-Shares. The t-tests in both the subperiod 1993-1996 and the entire sample period show that the mean of group I is significantly larger than the mean of group II. Meanwhile, the mean of group I remains larger in the subperiod 1997-2000, though the statistics are not as strong. This is not surprising considering the boom of US stock markets in late 1990s and the Asian financial crisis from 1997. These two events, which should be treated as outliers, strongly bias the estimated international betas of Chinese firms in the subperiod 1997-2000 towards negative values. Consequently, the power of the test of the mean differences between groups can be significantly reduced by such a distortion in estimation.

<table>
<thead>
<tr>
<th></th>
<th>Group I (with outstanding A Shares)</th>
<th>Group II (with no A Shares)</th>
<th>Difference (Group I - Group II)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean 0.7197</td>
<td>-0.313</td>
<td>1.0331</td>
</tr>
<tr>
<td></td>
<td>Std Dev 1.3137</td>
<td>1.3802</td>
<td>1.3194</td>
</tr>
<tr>
<td></td>
<td>Std Err 0.1755</td>
<td>0.5635</td>
<td>0.5667</td>
</tr>
<tr>
<td></td>
<td>N 56</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F-test 1.10 (0.7381) : Pooled T-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-test 1.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( ProbT ) (0.0367)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean -0.343</td>
<td>-0.475</td>
<td>0.1317</td>
</tr>
<tr>
<td></td>
<td>Std Dev 0.5368</td>
<td>0.6722</td>
<td>0.5637</td>
</tr>
<tr>
<td></td>
<td>Std Err 0.0576</td>
<td>0.1503</td>
<td>0.1398</td>
</tr>
<tr>
<td></td>
<td>N 87</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F-test 1.57 (0.1670) : Pooled T-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T-test 0.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( ProbT ) (0.1741)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean -0.163</td>
<td>-0.453</td>
<td>0.2892</td>
</tr>
<tr>
<td></td>
<td>Std Dev 0.4526</td>
<td>0.6399</td>
<td>0.4918</td>
</tr>
<tr>
<td></td>
<td>Std Err 0.0485</td>
<td>0.1431</td>
<td>0.122</td>
</tr>
<tr>
<td></td>
<td>N 87</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F-test 2.00 (0.0328) : Satterthwaite T-test</td>
<td>1.91</td>
<td>( ProbT ) (0.0339)</td>
</tr>
</tbody>
</table>

Note: F-test is the test against the null hypothesis of equal variances, and T-test is against equal means. The choice of pooled t-test and Satterthwaite t-test is based on the result of F-test at a significance level of 10%.
Table 3.4: International Betas and Price Differences: Fama-MacBeth $T$-Test

This table presents the adapted Fama-MacBeth $t$-test of the relation between firms' international betas and $A$- vs. $B$-Share price differences. The top half of the table presents the annual cross-sectional regression of price differences on each firms' international betas. The price differences are the averages of each firm-year from 1997 to 2000, and the betas are estimated with data from 1993 to 1996. The second stage of the test is to pool together the estimates of international betas' coefficients, and then use the $t$-test to check whether the coefficients over year are significantly different from 0 or not.

<table>
<thead>
<tr>
<th>Cross-sectional Regression</th>
<th>Estimator</th>
<th>Std Err</th>
<th>T</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>0.2865</td>
<td>0.1453</td>
<td>1.97</td>
<td>0.0539</td>
</tr>
<tr>
<td>1998</td>
<td>0.3361</td>
<td>0.2640</td>
<td>1.27</td>
<td>0.2086</td>
</tr>
<tr>
<td>1999</td>
<td>0.6025</td>
<td>0.2417</td>
<td>2.49</td>
<td>0.0159</td>
</tr>
<tr>
<td>2000</td>
<td>0.4968</td>
<td>0.2020</td>
<td>2.46</td>
<td>0.0173</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fama-MacBeth $T$-Test</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.4305</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std</td>
<td>0.1457</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T$</td>
<td>5.91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prob$T$</td>
<td>0.0097</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.5: International Betas and Price Differences: Panel with Fixed Effects

This table presents the adapted Fama-MacBeth t-test of the relation between firms' international betas and A- vs. B-Share price differences. The top half of the table presents the annual cross-sectional regression of price differences on each firms' international betas. The price differences are the averages of each firm-year from 1997 to 2000, and the betas are estimated with data from 1993 to 1996. The second stage of the test is to pool together the estimates of international betas' coefficients, and then use the t-test to check whether the coefficients overs year are significantly different from 0 or not.

<table>
<thead>
<tr>
<th></th>
<th>Beta</th>
<th>R-Square</th>
<th>DFE</th>
<th>F-Statistic (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient</td>
<td>0.4305</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std Err</td>
<td>0.1085</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>3.9700</td>
<td>0.4187</td>
<td>211</td>
<td>45.43 (&lt;0.0001)</td>
</tr>
<tr>
<td>Prob</td>
<td>0.0001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shanghai</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient</td>
<td>0.1657</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std Err</td>
<td>0.1414</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>1.1700</td>
<td>0.4684</td>
<td>115</td>
<td>33.32 (&lt;0.0001)</td>
</tr>
<tr>
<td>Prob</td>
<td>0.2438</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shenzhen</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient</td>
<td>0.3136</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std Err</td>
<td>0.1222</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>2.5700</td>
<td>0.5309</td>
<td>91</td>
<td>32.13 (&lt;0.0001)</td>
</tr>
<tr>
<td>Prob</td>
<td>0.0119</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.6: Factors in Pricing Differences: Panel with Fixed Effects

This table presents the adapted Fama-MacBeth t-test of the relation between firms’ international betas and A- vs. B-Share price differences. The top half of the table presents the annual cross-sectional regression of price differences on each firms’ international betas. The price differences are the averages of each firm-year from 1997 to 2000, and the betas are estimated with data from 1993 to 1996. The second stage of the test is to pool together the estimates of international betas’ coefficients, and then use the t-test to check whether the coefficients overs year are significantly different from 0 or not.

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Spread</th>
<th>Amount</th>
<th>Diff</th>
<th>R-Square</th>
<th>DFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pratio _Last</td>
<td>0.8910</td>
<td>3.6378</td>
<td>-0.0362</td>
<td>1.9058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pratio _Diff</td>
<td>0.0067</td>
<td>0.5412</td>
<td>0.0087</td>
<td>0.4580</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shanghai</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.8542</td>
<td>4929</td>
</tr>
<tr>
<td>T</td>
<td>133.64</td>
<td>6.72</td>
<td>-4.18</td>
<td>4.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prob</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shenzhen</td>
<td>0.8759</td>
<td>5.9592</td>
<td>-1.5334</td>
<td>3.2904</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>87.99</td>
<td>6.01</td>
<td>-6.34</td>
<td>4.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prob</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shanghai</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.8321</td>
<td>2377</td>
</tr>
<tr>
<td>T</td>
<td>102.49</td>
<td>2.92</td>
<td>-4.45</td>
<td>1.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prob</td>
<td>&lt;.0001</td>
<td>0.0035</td>
<td>&lt;.0001</td>
<td>0.1608</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Table 3.7: The Statistics of E/P Ratios in China

This table presents the E/P ratios of Chinese firms, and the time period is from January 1, 1993 to December 31, 2000. Firms with negative earnings are also included in the data sample. The data presented are filtered by cutting off the top and bottom percentiles. The unfiltered data have very close values of means and medians, though their maximum and minimum observations have much larger absolute values than the filtered data here.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Mean</th>
<th>Median</th>
<th>Std</th>
<th>P95</th>
<th>P5</th>
<th>Range</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINA (1993-2000)</td>
<td>2.92%</td>
<td>2.58%</td>
<td>5.39%</td>
<td>8.79%</td>
<td>-2.74%</td>
<td>82.56%</td>
<td>4833</td>
</tr>
<tr>
<td>SHSE (1993-2000)</td>
<td>3.10%</td>
<td>2.58%</td>
<td>6.02%</td>
<td>7.74%</td>
<td>-1.44%</td>
<td>80.28%</td>
<td>2506</td>
</tr>
<tr>
<td>SZSE (1993-2000)</td>
<td>2.72%</td>
<td>2.56%</td>
<td>4.62%</td>
<td>9.79%</td>
<td>-3.92%</td>
<td>67.48%</td>
<td>2327</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>Year</th>
<th>Mean</th>
<th>Median</th>
<th>Std</th>
<th>P95</th>
<th>P5</th>
<th>Range</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINA</td>
<td>1993</td>
<td>3.51%</td>
<td>3.40%</td>
<td>1.59%</td>
<td>6.22%</td>
<td>1.35%</td>
<td>11.66%</td>
<td>162</td>
</tr>
<tr>
<td></td>
<td>1994</td>
<td>5.68%</td>
<td>5.14%</td>
<td>3.58%</td>
<td>12.16%</td>
<td>1.20%</td>
<td>31.86%</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>1995</td>
<td>4.87%</td>
<td>4.28%</td>
<td>5.20%</td>
<td>14.17%</td>
<td>-1.28%</td>
<td>33.54%</td>
<td>302</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>2.52%</td>
<td>2.98%</td>
<td>3.18%</td>
<td>5.50%</td>
<td>-2.61%</td>
<td>53.09%</td>
<td>487</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>3.25%</td>
<td>2.78%</td>
<td>7.20%</td>
<td>10.16%</td>
<td>-2.26%</td>
<td>769</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1998</td>
<td>3.39%</td>
<td>3.95%</td>
<td>5.39%</td>
<td>8.65%</td>
<td>-6.73%</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1999</td>
<td>1.80%</td>
<td>2.11%</td>
<td>3.36%</td>
<td>5.36%</td>
<td>-4.26%</td>
<td>912</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>2.14%</td>
<td>1.38%</td>
<td>6.32%</td>
<td>6.51%</td>
<td>-2.66%</td>
<td>1126</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>Year</th>
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<th>Median</th>
<th>Std</th>
<th>P95</th>
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Table 3.8: The Comparison Between E/P Ratios and Interest Rates in China

This table compares the mean and median of E/P ratios in Chinese stock markets with the corresponding 1-year interest rates of bank deposits. The time period is from January 1, 1993 to December 31, 2000. Firms with negative earnings are also included in the data sample.
Table 3.9: Pearson Correlations Between Risk and Return in China

This table presents the correlations between realized returns and estimated risk measures of Chinese firms listed in both the Shanghai Stock Exchange and the Shenzhen Stock Exchange. The statistics are based on monthly observations, and the time period is from January 1, 1993 to December 31, 2000.

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<td>-0.0511</td>
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<td>&lt;.0001</td>
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Table 3.10: Spearman Correlations Between Risk and Return in China

This table presents the correlations between realized returns and estimated risk measures of Chinese firms listed in both the Shanghai Stock Exchange and the Shenzhen Stock Exchange. The statistics are based on monthly observations, and the time period is from January 1, 1993 to December 31, 2000.

<table>
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<tr>
<th>Sample</th>
<th>Risk Measure</th>
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<th>LnRet</th>
<th>N</th>
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Table 3.11: Kendall's tau-b Between Risk and Return in China

This table presents the nonlinear correlation measure, Kendall's tau-b, between realized returns and estimated risk measures of Chinese firms listed in both the Shanghai Stock Exchange and the Shenzhen Stock Exchange. The statistics are based on monthly observations, and the time period is from January 1, 1993 to December 31, 2000.

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Table 3.12: Event Study of the Crack-Down on UMC in May 1997

This tables presents the market reaction to the crack-down on various forms of unbalanced management compensation in May 1997. It shows that the market prices dropped significantly upon the announcement of the crack-down by the government. The test is based on daily returns, and the four window periods are as follows: base window (-221,-22), pre-event window (-21, -2), event window (-1,9), post-event window (1,20). The mean returns of the base window is compared with the means of all other window periods to determine whether there are significant market reaction around the announcement. The gap between the base window and the event window, called the pre-event window here, is the buffer zone to account for potential release of information on the announcement to the market. The test is also carried out with the 200 daily observations after the post-event window period, and the results are similar, strongly supporting the claim that there are strong negative market reaction on and before the announcement.

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<th>Event Window</th>
<th>Post-Event Window</th>
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Note: F-test is the test against the null hypothesis of equal variances, and T-test is against equal means. The choice of pooled t-test or Satterthwaite t-test is based on the result of F-test at a significance level of 10%.
Table 3.13: Fama-MacBeth Regression Coefficients in China

This is a test of the risk coefficients when in cross-sectional regression of returns on each risk measures. The data are monthly observations from the full sample period. The negative risk premium for Beta in the full sample is slightly over 1% per month on average, which is not only statistically significant, but also economically impressive.

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This is a test of the risk coefficients when in cross-sectional regression of returns on each risk measures. The data are monthly observations from the full sample period. The negative risk premium for Beta in the full sample is slightly over 1% per month on average, which is not only statistically significant, but also economically impressive.

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This is a test of the risk coefficients when in cross-sectional regression of returns on each risk measures. The data are monthly observations from the full sample period. The negative risk premium for Beta in the full sample is slightly over 1% per month on average, which is not only statistically significant, but also economically impressive.

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Table 3.16: Panel Data Analysis with Fixed Time Effects in China

This table shows the coefficients and related statistics from the panel data regression with fixed time effects in China, including the firms listed in both the Shanghai Stock Exchange and the Shenzhen Stock Exchange. The sample time period is from January 1, 1993 to December 31, 2000. The F-statistics in the last column of the table are the results of F-tests in each regression against the null hypothesis of no fixed time effects, and the null is being rejected in all regressions at a significance level $\alpha$ (alpha) < 0.0001. The dependent variable in the regression is the log returns of each firm, and the dependent variable ranging from each risk measure alone and different combinations of the three risk measures. The rest of the table should be self-explanatory.

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Table 3.17: Panel Data Analysis with Fixed Time Effects in the SHSE

This table shows the coefficients and related statistics from the panel data regression with fixed time effects in the Shanghai Stock Exchange. The sample time period is from January 1, 1993 to December 31, 2000. The F-statistics in the last column of the table are the results of F-tests in each regression against the null hypothesis of no fixed time effects, and the null is being rejected in all regressions at a significance level $\alpha$ (alpha) < 0.0001. The dependent variable in the regression is the log returns of each firm, and the dependent variable ranging from each risk measure alone and different combinations of the three risk measures. The rest of the table should be self-explanatory.

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<th>Coefficient</th>
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<th>R-Square</th>
<th>DFE</th>
<th>F-Value (alpha)</th>
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Table 3.18: Panel Data Analysis with Fixed Time Effects in the SZSE

This table shows the coefficients and related statistics from the panel data regression with fixed time effects in the Shenzhen Stock Exchange. The sample time period is from January 1, 1993 to December 31, 2000. The F-statistics in the last column of the table are the results of F-tests in each regression against the null hypothesis of no fixed time effects, and the null is being rejected in all regressions at a significance level \( \alpha \) (alpha) < 0.0001. The dependent variable in the regression is the log returns of each firm, and the dependent variable ranging from each risk measure alone and different combinations of the three risk measures. The rest of the table should be self-explanatory.

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<th>F-Value (alpha)</th>
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Table 3.19: Fama-MacBeth Regression Coefficients in the U.S.

This is a test of the risk coefficients when in cross-sectional regression of returns on each risk measures. The data are monthly observations from the full sample period. The negative risk premium for Beta in the full sample is slightly over 1% per month on average, which is not only statistically significant, but also economically impressive.

<table>
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<th>Beta</th>
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<td><strong>Mean</strong></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>60</td>
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| **Mean**   | **Mean**      | **Mean** | **Mean** |
| -0.01369   |               | 0.00271  |               |
| Median     | 0.14055       | 0.0009   |               |
| **t-value**| **t-value**   | **t-value** | **t-value** |
| -0.14      | 0.74          |         |               |
| alpha      | 0.89928       | 0.7219  |               |
|           |               |         | 60              |

| **Mean**   | **Mean**      | **Mean** | **Mean** |
| 0.00197    |               | 0.00271  |               |
| Median     | 0.06615       | 0.0009   |               |
| **t-value**| **t-value**   | **t-value** | **t-value** |
| -0.0234    | 0.74          |         |               |
| alpha      | 0.79866       | 0.46353 |               |
|           |               |         | 60              |

| **Mean**   | **Mean**      | **Mean** | **Mean** |
| 0.23491    | -0.25146      | 0.00262  |               |
| Median     | 0.37176       | 0.00578  |               |
| **t-value**| **t-value**   | **t-value** | **t-value** |
| 1.24       | -1.58         | 0.65     |               |
| alpha      | 0.21919       | 0.11942  |               |
|           |               |         | 60              |

| **Mean**   | **Mean**      | **Mean** | **Mean** |
| 0.29744    | -0.31774      | -0.00043 |               |
| Median     | 0.4758        | -0.59878 | -0.00817     |
| **t-value**| **t-value**   | **t-value** | **t-value** |
| 1.05       | -1.25         | -0.07    |               |
| alpha      | 0.29652       | 0.21778  | 0.94211      |
|           |               |         | 60              |
Table 3.20: Panel Data Analysis with Fixed Time Effects in the U.S.

This table shows the coefficients and related statistics from the panel data regression with fixed time effects in the U.S. The data sample are these firms that are included in the SP 500. To be consistent with the sample period in China, we use the CRSP data of the SP 500 firms from January 1, 1993 to December 31, 2000. The F-statistics in the last column of the table are the results of F-tests in each regression against the null hypothesis of no fixed time effects, and the null is being rejected in all regressions at a significance level $\alpha$ ($\alpha < 0.0001$). The dependent variable in the regression is the log returns of each firm, and the dependent variable ranging from each risk measure alone and different combinations of the three risk measures. The rest of the table should be self-explanatory.

<table>
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Appendix A

Appendix of Chapter II

A.1 Managers' Personal Investment

In the main text of this chapter, it is assumed that managers are not allowed to make any personal investment in the market. This is solely for ease of presentation, and such an assumption does not affect any results in the model. In this appendix, we explain why it is so: managers do not invest in the stock market with their own money even if they are allowed to do so, under the plausible condition that UMC managers have a larger bonus rate, $c_g$, than penalty rate, $c_l$. 
A.1.1 Setup

To consider the potential interaction between manager k’s personal investment and his compensation contract, we set manager k’s personal wealth at the beginning of the period as $W'_k$, and manager q’s as $W'_q$. The stock market is competitive, as assumed in the main text of this chapter, and every manager takes the market price as given without considering the impact of his own investment decision on the market price. Different from the main model where a manager only maximizes his personal utility from the consumption of his end-of-period compensation, in this appendix a manager maximizes his utility from the consumption of both his compensation and personal wealth. Everything else in this appendix is as defined in the main model of this chapter.

A.1.2 Managers with Balanced Compensation

At the beginning of the period, the representative manager, q, makes simultaneous investment decisions for Fund Q and his own endowed wealth, $W'_q$. The assets available for investment are the riskfree bonds and the single risky asset. Manager q’s utility maximization problem can be written as follows:

$$\max_{D_q, C_q, D'_q, C'_q} E\{U_q(\tilde{w}_q)\} = E\{-exp(-a\tilde{w}_q)\}$$  (A.1)
\[ W_q = D_q P + C_q \]  
\[ W_{q'} = D_{q'} P + C_{q'} \]  
\[ \tilde{w}_q = \delta_q + c_0 D_q (\tilde{\pi} - RP) \]  
\[ \tilde{w}_{q'} = D_{q'} (\tilde{\pi}_d - RP) + RW_{q'} \]  
\[ \tilde{w}_{q''} = \tilde{w}_q + \tilde{w}_{q'} \]  
\[ D_q \geq 0; D_{q'} \geq 0 \]

where \( D_q \) is the number of shares that Fund Q purchases, and \( D_{q'} \) is the number of shares that manager q purchases with his own personal wealth; \( C_q \) and \( C_{q'} \) are, respectively, the amount of bonds purchased with money from Fund Q and manager k's personal wealth; \( \tilde{w}_q \) is manager q's compensation at the end of the period, \( \tilde{w}_{q'} \) is the payoff on manager q's personal investment, and \( \tilde{w}_{q''} \) is the total income of manager q from both his management compensation and his personal investment. Equation (A.2) is fund q's budget constraint from Fund Q, equation (A.3) is the budget constraint from manager k's personal investment, equation (A.4) is the compensation contract for manager k, equation (A.5) is the end-of-period payoff of manager q's personal investment, equation (A.6) is manager k's total wealth at the end of the period from both his compensation and his personal investment, and equation (A.7) is the no short-sale constraint in the stock market. Please note that \( c_0 \) denotes the portion of fund q's investment payoff that goes to manager q's compensation.
Substituting (A.2), (A.3), (A.4), and (A.5) into (A.6), canceling \( C_q, C_{q'}, W_q, \) and \( W_{q'} \), we get:

\[
\bar{w}_{q'} = (D_{q'} + c_0 D_q)(\bar{\pi}_d - RP) + RW_{q'} + \delta_q
\]  

From the equation above, we can see that manager q’s problem is equivalent as choosing an optimal level of \( D^*_{q+q'} = (D_{q'} + c_0 D_q) \) to maximize his personal utility.

For a given price \( P \), manager k can tolerate a certain amount of risk in exchange for a portion of the risky asset’s payoff \( \bar{\pi} \), assuming the expected rate of return \( \mu / P - 1 \) is higher than the riskfree rate \( r \). Once manager k’s optimal consumption is achieved at a certain level of \( D^*_{q+q'} \), he is indifferent to whatever combination of \( D_{q'} \) and \( D_q \) as long as the sum of \( D_{q'} \) and \( c_0 D_q \) is equal to \( D^*_{q+q'} \). In other words, manager q does not care whether the risk he undertakes comes from his personal investment or from his compensation contract, providing the total amount of absolute risk stays at the optimal level. In such a situation, it is reasonable to assume that manager q chooses to focus on his job as the manager of Fund Q, and follow the rule of no personal investment by fund managers in the stock market. Such an action by manager q is in alignment with the interests of fund q’s owners.

### A.1.3 Managers with Unbalanced Compensation

For manager k, he faces the following problem:

\[
\max_{D_k, C_k, D_{k'}, C_{k'}} E\{U_k(\bar{w}_{k'})\} = E\{-\exp(-a\bar{w}_{k'})\}
\]  

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s.t.

\[
W_k = D_k P + C_k \quad \text{(A.10)}
\]

\[
W_{k'} = D_{k'} P + C_{k'} \quad \text{(A.11)}
\]

\[
\bar{w}_k = \delta_k + c_g D_k (\hat{\pi} - RP)^+ + c_i D_k (\hat{\pi} - RP)^- \quad \text{(A.12)}
\]

\[
\bar{w}_{k'} = D_{k'} (\hat{\pi}_d - RP) + RW_{k'} \quad \text{(A.13)}
\]

\[
\bar{w}_{k''} = \bar{w}_k + \bar{w}_{k'} \quad \text{(A.14)}
\]

\[
D_k \geq 0; D_{k'} \geq 0 \quad \text{(A.15)}
\]

where \( D_k \) is the number of shares that Fund Q purchases, and \( D_{k'} \) is the number of shares that manager k purchases with his own personal wealth; \( C_k \) and \( C_{k'} \) are, respectively, the amount of bonds purchased with money from Fund Q and manager k's personal wealth; \( \bar{w}_k \) is manager q's compensation at the end of the period, \( \bar{w}_{k'} \) is the payoff on manager q's personal investment, and \( \bar{w}_{k''} \) is the total income of manager k from both his management compensation and his personal investment. Equation (A.10) is fund q's budget constraint from Fund Q, equation (A.11) is the budget constraint from manager k's personal investment, equation (A.12) is the compensation contract for manager k, equation (A.13) is the end-of-period payoff of manager k's personal investment, equation (A.14) is manager k's total wealth at the end of the period from both his compensation and his personal investment, and equation (A.15) is the no short-sale constraint in the stock market. In the compensation contract (A.12), \( c_g \) and \( c_i \) are, respectively, the bonus and penalty rate for manager k.
Substituting (A.10), (A.11), (A.12), and (A.13) into (A.14), canceling \( C_k \), \( C_k' \), \( W_k \), and \( W_k' \), we get,

\[
\tilde{w}_{k'} = D_k'(\tilde{\pi} - RP) + c_y D_k(\tilde{\pi} - RP)^+ + c_l D_k(\tilde{\pi}_d - RP)^- + RW_k + \delta_k \tag{A.16}
\]

Rewriting the equation above, yields,

\[
\tilde{w}_{k'} = D_k'(\tilde{\pi} - RP) + c_y D_k[(\tilde{\pi} - RP)^+ + (c_l/c_y)(\tilde{\pi}_d - RP)^-] + RW_k + \delta_k \tag{A.17}
\]

Noting that the third and fourth terms on the right hand of (A.17) are constants, we infer that manager k's problem is equivalent as choosing an optimal portfolio of two risky assets, whose random payoffs are

\[
\tilde{\pi}_I = (\tilde{\pi} - RP) \tag{A.18}
\]

and

\[
\tilde{\pi}_{II} = (\tilde{\pi} - RP)^+ + (c_l/c_y)(\tilde{\pi}_d - RP)^- \tag{A.19}
\]

Both assets have a price of 0. Since \( c_y > c_l \), it is clear that Asset I is preferred over Asset II, and this is a First Degree Stochastic Dominance, for \( \tilde{\pi}_{II} = \tilde{\pi}_I + (c_l - c_y)/(c_y - c_g)(\tilde{\pi}_d - RP)^- \) and \((c_l - c_g)/c_y(\tilde{\pi} - RP)^- \geq 0 \). Thus, any investor with a continuous utility function that is increasing with regard to wealth prefers Asset II over Asset I, and so manager k surely chooses to put all of his endowed wealth into the bonds market, noting that short sales are not allowed in the market.
A.1.4 Conclusion

From the analysis in this appendix, we can conclude that neither manager q or manager k chooses to invest in stock markets with their own personal wealth even if they are allowed to do so, as long as short sales are not allowed. For manager q, the representative BMC manager, he cannot gain anything by switching the risk between his own investment and his compensation contract, and so it is reasonable for him to choose to follow the rule and make no investment with his own wealth. For manager k, the representative UMC manager, it is strictly preferred not to buy any stocks with his own money, for it is always better off for him to hold $\tilde{\pi}_I$, the equivalent of undertaking risk from his compensation, rather than $\tilde{\pi}_I$, the equivalent of undertaking risk from his personal investment. Therefore, limiting managers from making any personal investment in the stock market does not affect the results in our model, and so this chapter does not lose any generality from this assumption.
A.2 An Extension to Multiple Assets

To study the portfolio choice of managers, we replace the assumption of one single risky asset in our main model with an assumption of two risky assets. With this extension to two assets, we can study managers' optimal portfolio choices and examine how the unbalanced compensation can affect managers' portfolio holdings.

A.2.1 Setup

There are two risky assets in the stock market, whose end-of-period payoffs are \( \tilde{\pi}_1 \) and \( \tilde{\pi}_2 \) respectively. \( \tilde{\pi}_1 = \tilde{\pi}_m + \tilde{\epsilon}_1 \), and \( \tilde{\pi}_2 = \tilde{\pi}_m + \tilde{\epsilon}_2 \), where \( \tilde{\pi}_m \sim N(\mu_m, \sigma_m^2) \) and \( \tilde{\epsilon}_1, \tilde{\epsilon}_2 \sim N(\mu_0, \sigma_0^2) \). \( \tilde{\epsilon}_1 \) and \( \tilde{\epsilon}_2 \) are identical independent variables, and they are independent of \( \tilde{\pi}_m \). The price of asset I is \( P_1 \), and the price of asset II is \( P_2 \).

Under such a setup, asset I and asset II must have the same price in equilibrium. Otherwise, all managers will purchase more of the asset with a lower price, and hence push its price up. This logic holds no matter managers exhibit risk-averse or risk-seeking behaviour. Therefore, we can denote the price of asset I and asset II at the beginning of the period with the same symbol: \( P = P_1 = P_2 \). This setup enables us to focus on the major issue of concern: whether a manager has the incentive to diversify when making portfolio selection for the fund under his management.

For a portfolio of \( \alpha \) unit of asset I and \( 1 - \alpha \) unit of asset II, it follows a normal
distribution $N(\mu_p, \sigma_p^2)$, where $\mu_p = \mu_m + (\alpha + (1 - \alpha))\mu_0 = \mu_m + \mu_0$, and $\sigma_p^2 = \sigma_p^2 + (\alpha^2 + (1 - \alpha)^2)\sigma_0^2$. Taking $\alpha\tilde{\pi}_1 + (1 - \alpha)\tilde{\pi}_2$ one portfolio asset, a manager needs to choose $\alpha$, which determines the percentage of each risky asset in his portfolio, and $D_p$, the number of such portfolio to purchase. The price of this portfolio is $\alpha P + (1 - \alpha)P = P$.

Everything else in this appendix are just as specified in the setup of the main model.

### A.2.2 Managers with Balanced Compensation

Manager $q$, a representative manager with balanced compensation, faces the following maximization problem:

$$\max_{D_{q,p}, \alpha_q, C_q} E\{U_q(\tilde{w}_q)\} = E\{-\exp(-\alpha\tilde{w}_q)\}$$

s.t.

$$W_q = D_{q,p}P + C_q$$  \hspace{1cm} (A.20)

$$\tilde{w}_q = \delta_q + c_0D_{q,p}[\alpha_q\tilde{\pi}_1 + (1 - \alpha_q)\tilde{\pi}_2 - RP]$$  \hspace{1cm} (A.21)

$$D_{q,p} \geq 0, \quad 0 \leq \alpha_q \leq 1$$  \hspace{1cm} (A.22)

Where equation (A.20) is the budget constraint, equation (A.21) is the compensation contract for manager $q$, and equation (A.22) is the no short-sale constraint. Manager $q$ can invest in bonds and a portfolio of the two risky assets in stock market, and he
maximizes his personal utility with regard to his end-of-period wealth by allocating
fund Q between bonds and a portfolio of the two risky assets.

From the standard literature, we know that manager q will choose a well diversi-
sified portfolio for Fund Q. In addition, manager q will not invest in the market if
there are strong bubbles in the market.

A.2.3 Managers with Unbalanced Compensation

Manager k, a representative manager with unbalanced compensation, faces the fol-
lowing maximization problem:

$$\max_{D_{k,p}, \alpha_k, C_k} E\{U_k(\tilde{w}_k)\} = E\{-\exp(-a\tilde{w}_k)\}$$

s.t.

$$W_k = D_{k,p}P + C_k \quad (A.23)$$

$$\tilde{w}_k = \delta_k + c_g D_{k,p}[(\alpha_k \tilde{\pi}_1 + (1 - \alpha_k)\tilde{\pi}_2 - RP)^+ + c_l D_{k,p}[\alpha_k \tilde{\pi}_1 + (1 - \alpha_k)\tilde{\pi}_2] - (A.24)$$

$$D_{k,p} \geq 0, \quad 0 \leq \alpha_k \leq 1 \quad (A.25)$$

Where equation (A.23) is the budget constraint, equation (A.24) is the compensation
contract for manager k, and equation (A.25) is the no short-sale constraint. Manager
k can invest in bonds and a portfolio of the two risky assets in stock market, and he
maximizes his personal utility with regard to his end-of-period wealth by allocating
fund K between bonds and a portfolio of the two risky assets.
Manager k's utility maximization problem is equivalent as follows:

\[
\max_{D_{k,p} \geq 0, 0 \leq \alpha_k \leq 1} f(\Delta_p) \left( \frac{-1}{h(l_p)} + \frac{-1}{h(g_p)} \right)
\]  

(A.26)

where

\[
\Delta_p = \frac{\mu_p - RP}{\sigma_p} \tag{A.27}
\]

\[
l_p = \Delta_p - c_l a D_{k,p} \sigma_p \tag{A.28}
\]

\[
g_p = -\Delta_p + c_g a D_{k,p} \sigma_p \tag{A.29}
\]

\[
\sigma_p = \sqrt{\sigma_m^2 + (\alpha_k^2 + (1 - \alpha_k)^2)\sigma_0^2} \tag{A.30}
\]

\[
h(x) = \frac{f(x)}{1 - N(x)} \tag{A.31}
\]

Here \(f(x)\) and \(N(x)\) are, respectively, the density function and distribution function of a standard normal variable. As shown earlier, function \(h(x)\) is increasing, convex, approaches \(x\) as \(x \to \infty\), and approaches 0 as \(x \to -\infty\).

Compared with equation (2.10), manager k’s simplified objective function in the main model where only one risky asset is available, equation (A.26) has one more multiplicative term: \(f(\Delta_p)\). The corresponding term in the main model, \(f(\Delta)\), does not show up in the simplified objective function (2.10) because \(\Delta\) does not contain any decision variables in the single asset model, and so it can be regarded as a positive constant and taken away from the simplified maximization problem (2.10). However, in this model with multiple assets, \(\alpha_k\) is both a decision variable and a component of \(\Delta_p\), which makes the term \(f(\Delta_p)\) an indispensable part of the objective function (A.26).
Taking the first order condition of equation (A.26) w.r.t. $D_{k,p}$, yields:

\[ B_{g,p}c_g = B_{l,p}c_l \]  

(A.32)

where

\[ B_{g,p} = 1 - \Phi(g_p) \]  

(A.33)

\[ B_{l,p} = 1 - \Phi(l_p) \]  

(A.34)

\[ \Phi(x) = \frac{x}{h(x)} \]  

(A.35)

where $l_p$, $g_p$, and $h(x)$ are as defined in equation (A.28), (A.29), and (2.12).

We can see that this result is similar to Lemma 2. Taking the portfolio as one asset, we can derive properties of the market similar to those in the main model where there is only one risky asset.

The more interesting part in this multiple asset model is the implication on a manager’s portfolio choice. Assuming the boundary condition “$0 < \alpha_k < 1$” is not binding, and taking first order condition of (A.26) w.r.t. $\alpha_k$, we get

\[
\frac{\partial \Pi}{\partial \alpha_k} = f(\Delta_p)\left\{ (\Delta_p)'_\alpha \left( \frac{c_l a D_{k,p} \sigma_p}{h(l_p)} + \frac{c_g a D_{k,p} \sigma_p}{h(g_p)} \right) + a D_{k,p} (\sigma_p)'_\alpha \left[ c_l \left( \frac{l_p}{h(l_p)} - 1 \right) - c_g \left( \frac{g_p}{h(g_p)} - 1 \right) \right] \right\} = 0
\]

(A.36)

where

\[
\Pi = f(\Delta_p)(-1/h(l_p) - 1/h(g_p))
\]

(A.37)

\[
(\Delta_p)'_\alpha = \frac{\partial \Delta_p}{\partial \alpha_k} = \frac{(RP - \mu_p)(4\alpha_k - 2)\sigma_0^2}{2\sigma_p^3}
\]

(A.38)

\[
(\sigma_p)'_\alpha = \frac{\partial \sigma_p}{\partial \alpha_k} = \frac{(4\alpha_k - 2)\sigma_0^2}{2\sigma_p}
\]

(A.39)

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From equation (A.32), the first order condition with regard to \( D_{k,p} \), we know that the second term in the middle of equation (A.36) can be cancelled off. Therefore, the first order condition with regard to \( \alpha_k \) collapses to

\[
 f(\Delta_p)(\Delta_p)'\alpha(c_1 a D_{k,p} \sigma_p \frac{h(l_p)}{h(g_p)}) = 0
\]

(A.40)

Since \( f(\Delta_p) > 0 \) and \( \frac{c_1 a D_{k,p} \sigma_p}{h(l_p)} + \frac{c_2 a D_{k,p} \sigma_p}{h(g_p)} > 0 \), \((\Delta_p)'\alpha \) must be equal to 0. From equation (A.38), we infer that \( \alpha_k = 1/2 \) when \( \Delta_p = (\mu_p - RP)/\sigma_p \neq 0 \).

To verify whether \( \alpha_k = 1/2 \) is the optimal portfolio weight that maximizes manager k's utility, we examine the sign of \( \frac{\partial \Pi}{\partial \alpha_k} \) in equation (A.36) as \( \alpha_k \) takes different values in the range of [0, 1].

When \( \Delta_p > 0 \), \( \frac{\partial \Pi}{\partial \alpha_k} < 0 \) for \( \alpha_k \in (1/2, 1] \), and \( \frac{\partial \Pi}{\partial \alpha_k} > 0 \) for \( \alpha_k \in [0, 1/2) \). Therefore, \( \alpha_k = 1/2 \) maximizes manager k's personal utility when \( \Delta_p > 0 \). This means that when there are no strong bubbles in the market, manager k chooses a well diversified portfolio though he purchases more market shares than manager q, a representative manager with balanced compensation, does.

However, when \( \Delta_p < 0 \), \( \frac{\partial \Pi}{\partial \alpha_k} > 0 \) for \( \alpha_k \in (1/2, 1] \), and \( \frac{\partial \Pi}{\partial \alpha_k} < 0 \) for \( \alpha_k \in [0, 1/2) \). In this case, the constraint \( 0 \leq \alpha_k \leq 1 \) is binding, and manager k chooses either \( \alpha_k = 0 \) or \( \alpha_k = 1 \) for Fund K’s investment portfolio so as to maximizes his own personal utility. This means that manager k holds only one risky asset when the strong form of bubbles exists in the market.
A.2.4 A Numerical Explanation

In section 2.3.3 where there is only one risky asset, we find that the market price can be decreasing with regard to risk at certain circumstances even when the stock market is in the stage of strong bubbles. This seems to be not so consistent with the inference we have just obtained in the above, which states clearly that UMC managers always choose not to diversify in a market with strong bubbles. The explanation to this lies in the different characteristic between the risk of a diversified portfolio and the risk of a single asset. Under the strong form of bubbles, asset II, $\tilde{\pi}_{II}$ as defined in equation (A.19), has a higher expectation when manager k chooses a single asset rather than a well diversified portfolio. Therefore, although UMC managers may prefer not to have a larger amount of absolute risk, he still prefers to hold a single asset rather than a diversified portfolio owing to a higher level of expected payoff for holding the same amount of absolute risk.

To better explain this, we carry out a numerical analysis and present the results in Figure V. In this analysis, the values of parameters are set as follows: $a = 0.5$, $S = 0.5$, $\mu = 1100$, $r = 0.1$, $n_B = n_U = 25$, $c_0 = c_g = 0.05$, and $\delta_q = \delta_k = 1$. Also, we set $c_l = 0.03$. To study how the market price changes at different risk levels, we set $\sigma_m = \sqrt{0.99}\sigma$ and $\sigma_e = \sqrt{0.02}\sigma$ while allowing $\sigma$ to take values from 50 to 350. Under such a setting, the standard deviation of the portfolio, $\sigma_p$, is just equal to $\sigma$ when we fix the value of $\alpha_k$ at 0.5. Here the value of $\sigma_e$ is set to be very small relative to $\sigma_m$ so that the choice of $\alpha_k$ only changes the value of $\sigma_p$ a little bit. We allow
to take values between 50 and 350 so as to study a manager's portfolio choice at different risk levels, at some of which the price-risk relationship take different signs from at others.

In the first stage of the analysis, we force both UMC managers and BMC managers to hold a well diversified portfolio with \( \alpha_k \) being fixed at 0.5. The choice of \( D_p \), though, is left to the managers. This is in fact equivalent to the case where only one risky asset is available in the market. We solve out the market price, \( P \), which is as shown in the second diagram from the top in Figure V. Clearly, \( P \) is higher than 1000 for all values of \( \sigma \), and \( P \) is decreasing with regard to \( \sigma \) in the range of \([260, 350]\). The demand of manager \( k \) in equilibrium, \( D_p \), is presented in the top diagram as the line “\( D_p \) with \( \alpha_k = 0.5 \)”. The demand of manager \( q \) in equilibrium is obviously 0 since \( P > 1000 = \mu/R \), which means there are strong bubbles in the market.

In the second stage of the analysis, we allow the managers to choose not only \( D_p \), the demand of the entire portfolio, but also \( \alpha \), the components of the portfolio. The market price, however, is fixed to be the same as in the second diagram for each value of \( \sigma \). Under such a setting, we calculate the optimal choice of \( D_p \) and \( \alpha_k \) simultaneously by the representative UMC manager \( k \), and present the results as the line “\( D_p \) with \( \alpha_k \in [0, 1] \)” in the top diagram and the straight line in the third diagram respectively. We can see that the value of \( \alpha_k \) is always 0 no matter the value of \( \sigma \) is above or below 260, which means that UMC manager \( k \) chooses not to diversify throughout the range of \( \sigma \in [50, 250] \). Manager \( k \)'s demand for the entire
portfolio is, however, not always higher than his demand when $\alpha_k$ is fixed at 0.5. Denoting $D_{p,\alpha_k=0.5}$ as manager k's demand when $\alpha_k$ is fixed at 0.5, and $D_{p,\alpha_k\in[0,1]}$ as manager k's demand when $\alpha_k$ is a free choice between 0 and 1, we can see that $D_{p,\alpha_k\in[0,1]} > D_{p,\alpha_k=0.5}$ when $\sigma < 260$, and $D_{p,\alpha_k\in[0,1]} < D_{p,\alpha_k=0.5}$ when $\sigma \geq 260$. Since a smaller demand by each UMC manager would cause the equilibrium market price to fall, this is why equilibrium market price in the range of $\sigma \in [260, 350]$ decreases as risk increases, noting that $\sigma_p$ is larger when $\alpha_k$ changes from 0.5 to 0.

In short, in the range of $\sigma \in [260, 350]$ with $c_l$ being fixed at 0.03, manager k chooses not to diversify because $\bar{\pi}_{II}$ has a higher level of expectation when the portfolio is not diversified, and the equilibrium market price decreases with regard to $\sigma$ because manager k prefers to have a lesser amount of absolute risk. The negative relationship between $P$ and $\sigma$ is consistent with manager k's choice of no diversification.

A.2.5 Conclusion

From the analysis in this appendix, we conclude that a manager with unbalanced compensation chooses to diversify his portfolio if and only if no strong bubbles exist in the market. When the price is not higher than the risk-neutral price, $\mu/(1 + r)$, manager k does diversify in his portfolio selection though he demands more of the risky assets than manager q because of his lower penalty rate, $c_l$. However, when
market price is higher than the risk-neutral price, manager k does not diversify in his portfolio selection. Instead, he puts all of his money in one single asset so as to take full advantage of his low penalty rate. This has important implication in the empirical tests of risk-return relationship. In a market with no strong bubbles, returns are still determined by risky assets' market risk as long as a well diversified market portfolio is available, similar to the case in standard capital asset pricing models. On the contrary, in a market with strong bubbles, returns are no longer determined by the market risk alone, but by the risky assets' total risk instead.
A.3 Index-Adjusted Incentive Compensation in North America

In North America, the structure of management compensation is different from that in China. First, it is index based. Second, short sales are allowed.

The monitoring of managers is much more effective in North America than in China, and so the problem of UMC is far from such a serious problem in North America as in China. However, certain form of unbalanced compensation still exists in North America as well. Generally speaking, the popular incentive fees in North America is based on index-adjusted performance rather than riskfree-rate-adjusted performance. Such index based incentive fees may come directly from compensation contract, or indirectly from other means such as convex relationship between money under management and performance. From now on, we tend to use “asymmetric compensation” to refer to such unbalanced compensation based on index-adjusted performance, and the purpose is just to make it easier to identify what type of unbalanced compensation we are discussing.

Recently, there have been very a few studies on the asymmetric compensation in North America. Cuoco and Daniel (2001) use two stocks in their model to analyze the difference between the pricing of index stocks and non-index stocks, with one stock being set as the index and the other being set as an non-index asset. In reality, however, it is likely that a manager’s security selection would be more or less restricted
to the securities within the benchmark index. Therefore, it would be of practical interest to look into the impact of such asymmetric compensation on the pricing of different components of the index itself, rather than on the pricing of stocks outside the index. In this appendix, we study the impact of management compensation on the pricing of an asset’s different parts of risk, namely the market risk and idiosyncratic risk. As usual, market risk refers to the portion of a risky asset’s risk that cannot be diversified away in the market, and idiosyncratic risk refers to the portion of risk that is unique to a risky asset and can be diversified away in the market portfolio. Our analysis is also more tailored to empirical tests as well.

Brennan (2000) also studies the asymmetric compensation in North America. Different from Cuoco and Daniel (2000), Brennan uses a one period static model rather than a continuous-time model. Brennan also focuses his study on the difference in the pricing of index versus non-index stocks.

A.3.1 Setup

There are n risky assets in the market, whose end-of-period payoffs are as follows.

\[ \tilde{\pi} = \tilde{\beta} \tilde{\pi}_m + \tilde{\epsilon} \]

where \( \tilde{\pi}_m \) and all elements of \( \tilde{\epsilon} \) are independent of each other, with \( \tilde{\pi}_m \sim N(\mu_m, \sigma^2_m) \) and \( \tilde{\epsilon}_i \sim N(0, \sigma^2_i), \forall i \in [1, ..., n] \). We normalize the vector of \( \beta \) such that each asset
has a \textit{beta} of 1, and then get

\[ \tilde{\pi}_i = \tilde{\pi}_m + \tilde{\varepsilon}_i \sim N(\mu_m, \sigma_m^2 + \sigma_i^2), \forall \ i \in [1, \ldots, n] \]  
(A.41)

The utility function of each manager is still assumed to be an exponential function of CARA type. Such a type of function enables us to focus on the risk analysis without interference of wealth effect. It also makes the results much nicer because of the separability of unrelated risk components.

The compensation contract for manager \( q \), a representative manager with balanced compensation, is

\[ w_q = \delta_q + c_p \bar{\theta}_q \bar{\pi} + c_0 (\theta_q \tilde{\pi} - \bar{\theta}_q \bar{\pi}_m) \]

and the compensation contract for a representative UMC manager, \( k \), is

\[ w_k = \delta_k + c_p \bar{\theta}_k \bar{\pi} + c_0 (\theta_k \tilde{\pi} - \bar{\theta}_k \bar{\pi}_m)^+ + c_l (\bar{\theta}_k \bar{\pi} - \bar{\theta}_k \bar{\pi}_m)^- \]

In the above, a manager's compensation includes a fixed amount of wage, a proportional fee based on the size of the fund, and an incentive fee based on market-adjusted performance. \( \theta \) is a vector of investment in each asset.

\subsection*{A.3.2 Discussion}

Substituting (A.41) into the compensation contracts, we get

\[ \tilde{w}_q = \delta_q + c_p \bar{\theta}_q \bar{\pi} + (c_p + c_0)(\bar{\theta}_q \tilde{\varepsilon}) \]
\[ \tilde{w}_k = \delta_k + c_p \tilde{\theta}_k \tilde{\pi}_m + (\tilde{c}_g + c_p)(\tilde{\theta}_k \tilde{\xi})^+ + (c_l + c_p)(\tilde{\theta}_k \tilde{\xi})^- \] (A.42)

For manager \( q \), his incentive fee is proportional, and so the second variable part of his compensation, \((c_p + c_0)(\tilde{\theta}_q \tilde{\xi})\), has a mean of 0 regardless of the variance. As a risk-averse individual, manager \( q \) does not like the second part, and he must choose to diversify in his portfolio choice so as to minimize the risk undertaken. As a side note, it is assumed that the idiosyncratic risk of each asset can be completely diversified. If the ability to diversify was limited in this model, even symmetric compensation alone would also lead to some form of distortion in the market, such as underinvestment by fund managers.

However, the situation is different for manager \( k \) because of the unbalanced compensation based on market-adjusted performance. The market-based incentive compensation for manager \( k \) includes the last two terms on the right side of equation (A.42), which can be regarded as a special risky asset and called \( \tilde{\pi}_k \) here. For asset \( \tilde{\pi}_k \), its mean is non-zero. When \( c_g > c_l \), the expectation of \( \tilde{\pi}_k \) is positive, and its value is increasing at the variance of \( \tilde{\theta}_k \tilde{\xi} \). Such a situation is similar to the analysis in the main text of this chapter, where the riskfree-adjusted incentive fee causes a distortion in the risk attitude of the representative UMC manager. Here the individual risk of an asset, \( \tilde{\xi}_i \), becomes desirable because of the asymmetric incentive fee based on market-adjusted performance. The smaller \( c_l + c_p \) is relative to \( c_g + c_p \), the more desirable the idiosyncratic risk of a risky asset is to manager \( k \). This causes a
distortion in the risk attitudes of manager k towards the risk of each asset, which in
turn has an impact on the pricing of risky securities in equilibrium.

In a standard risk-averse world without agency problem caused by incentive com-
pensation, the normal notion is that a risky asset’s price is determined by its market
risk, with its idiosyncratic risk being irrelevant By contrast, a risky asset’s idiosyn-
cratic risk does matter in this model and can be priced in equilibrium. In fact, when
\( c_i + c_p \) is smaller enough relative to \( c_g + c_p \), there can be a positive relationship between
a risky asset’s idiosyncratic risk and its price.

Meanwhile, the market risk of each asset is still undesirable as usual, for the
incentive fee here only distorts the risk attitude towards the idiosyncratic risk com-
ponent, not the market risk component. This is a key difference between the pricing
behaviour in this model of North American securities markets and in the model of
Chinese stock markets in the main text. It indicates that the different pricing of mar-
et risk in China and North America. In Chinese stock markets, only a firm’s total
risk matters, no matter it is market risk or idiosyncratic risk. Further, the risk can be
positively related with price in China because of the unbalanced management com-
pensation and the no short-sale constraint. In North America, however, the market
price is negatively related with risk, though the idiosyncratic risk may be positively
related with market price owing to the risk distortion from asymmetric compensation
based on index-adjusted performance. This is very important for empirical tests.
A.4 General Equilibrium

In Chapter I, *Market Segmentation and Ownership Restrictions*, we explain how the discrimination among different groups of investors by the monopolistic government can result in a lower price of *B-Shares* than *A-Shares*. In this chapter, we study the impact of Chinese managers’ unbalanced compensation on asset pricing, which can also partially explain why *A-Share* prices can higher than *B-Share* prices. We now discuss how two chapters would be related in a general equilibrium.

The model in Chapter I is partial in the sense that it does not consider Unbalanced Management Compensation (UMC), which is widespread in Chinese stock markets. Meanwhile, the model in this chapter is also partial because it is only a partial equilibrium with exogenous supply. A general equilibrium would consider both the monopolistic government on the supply side and the UMC on the demand side. The required mathematical analysis would be too complex in the general model to solve it here, but it is worth speculating on the form of a more general equilibrium here.

General equilibrium involves both domestic investors and foreign investors, who are investing in *A-Share* market and *B-Share* market respectively. In the main text of this chapter, we are only studying the situation in *A-Share* market, and we do not add a subscript $A$ or $D$ to the parameters related to *A-Share* market. For consistency of notation, we keep all parameters defined earlier in this chapter without adding subscripts. Meanwhile, we do add subscripts to new parameters first defined in this
subsection, especially these parameters related to B-Share market and foreign market.

We first add foreign investors and a monopolistic supplier, the Chinese government. We then solve their problems and characterize a general equilibrium with both monopolist supplier and UMC managers.

A.4.1 Foreign Investors

With short sales allowed, the impact of unbalanced compensation on asset prices is limited. Meanwhile, unbalanced compensation is also much milder due to significant stock option compensation, active monitoring of fund/company owners, and an overall more sensitive compensation system. Therefore, it is reasonable to claim that UMC is negligible in highly developed capital markets relative to the situation in Chinese stock markets, though we do not deny that a certain form of asymmetric compensation may exist in international capital markets as well.

For ease of analysis and without loss of generality, here we assume UMC does not exist in the foreign market. The analysis remains similar if we relax this assumption to a setting where a milder UMC exists in the foreign country than in China.

The number of foreign investors is $n_f$, and there is only one risky foreign asset in the foreign market. The foreign asset's liquidating payoff at the end of the period is $\tilde{\pi}_f \sim N(\mu_f, \sigma_f)$, whose covariance with $\tilde{\pi}$ is $\sigma_{df}$, and the price at the beginning of the period is given as $P_f$. Each foreign investor, endowed with an initial wealth of $W_f$
at the beginning of the period, can invest not only in the Chinese market, but also in the foreign market. The bond market is perfectly integrated between China and the foreign country. Each foreign investor, with a CARA utility function with regard to end-of-period wealth expressed as $-\exp\{-aw_f\}$, allocate his endowed wealth, $W_f$, among the foreign risky asset, the Chinese asset, and riskfree bonds at the beginning of the period. The objective is, as usual, to maximize his end-of-period utility.

The number of shares of the Chinese asset issued to foreign investors is $S_B$. As mentioned earlier, the shares issued to Chinese investors are called $A$-Shares, and the shares issued to foreign investors are called $B$-Shares.

Under such a setup and following the steps in the Chapter titled Market Segmentation and Ownership Restrictions, one can get the following $B$-Share price for any given $S_B$:

$$P_B = \frac{\mu - aS_B\sigma^2(1 - \rho_{df}^2)/\gamma_f - \beta_{df}(\mu_f - RP_f)}{R}$$  \hspace{1cm} (A.43)

where $\rho_{df} = \frac{\sigma_d}{\sigma_f}$, and $\beta_{df} = \frac{\sigma_d^2}{\sigma_f^2}$.

A.4.2 Domestic Investors, Monopolistic Government and the Equilibrium

Domestic investors are just like the investors in the main model of this chapter, or say the UMC and BMC managers. We can simply put the main model, which has been analyzed earlier in this chapter, into this model as the analysis about domestic
investors.

The government is the single supplier of Chinese shares in the market, and acts as a monopoly. In such a situation, the government has the incentive to discriminate between different groups of investors whenever they have different elasticities of demand, as discussed in another chapter titled *Market Segmentation and Ownership Restrictions*. Formally, we write such a principal in the following statement.

**Statement 3** Differential pricing is the optimal choice of the monopoly government if and only if the price elasticity of demand for Chinese shares is different between domestic investors and foreign investors.

From (2.25), (A.43), and \(\varepsilon_i(S_i) = -\frac{P_i(S_i)}{S_i} \frac{\partial P_i(S_i)}{\partial S_i}\), the definition of price elasticity of demand, we can see that foreign investors' elasticity of demand is different from Chinese (domestic) investors's elasticity of demand. Therefore, based on the statement above, Chinese government has the incentive to impose ownership restrictions and discriminate between domestic and foreign investors.

As for the relationship between *A-Share* and *B-Share* supply in the market, we can infer the following result. Under the conjecture \(\frac{\partial^2 P_i}{\partial S_i^2}(S) < -\frac{1}{2} \frac{\partial P_i}{\partial S_i}(S)\), the optimal supply of *A- and B-Shares* are still positively correlated. A sufficient condition for \(\frac{\partial^2 P_i}{\partial S_i^2}(S) < -\frac{1}{2} \frac{\partial P_i}{\partial S_i}(S)\) is \(\frac{\partial^2 P_i}{\partial S_i^2}(S) < 0\), which means the marginal impact on *A-Share* price by increasing supply decreases as the absolute level of *A-Share* supply increases.
A.5 Proofs

A.5.1 Properties of Several Mathematical Functions

Property 1 Define \( h(x) = f(x)/(1 - N(x)) \), where \( f(x) \) and \( N(x) \) are, respectively, the probability density function and cumulative distribution function of a standard normal variable, then

\[
h'(x) > 0, \quad h''(x) > 0, \quad h(x) \to x \text{ as } x \to \infty, \quad h(x) \to 0 \text{ as } x \to -\infty
\]

Proof: Hazard rate function, \( h(x) \), is well-known in Reliability Theory. See Statistics references for details of proof. Proof Complete.

Property 2 Define \( \Phi(x) = x/h(x) \), where \( h(x) = f(x)/(1 - N(x)) \) as defined in Property 1, then \( \Phi(x) < 1 \), and \( \Psi(x) = \frac{\partial \Phi(x)}{\partial x} > 0 \).

Proof: Define \( M(x) = 1/h(x) \), then

\[
\frac{\partial M(x)}{\partial x} = -\frac{h'(x)}{[h(x)]^2} < 0
\]

Meanwhile,

\[
\frac{\partial M(x)}{\partial x} = \left( \frac{1 - N(x)}{f(x)} \right)' = \frac{-N'(x)f(x) - [1 - N(x)]f'(x)}{[f(x)]^2}
\]

and substitute \( f'(x) = -xf(x) \) and \( N'(x) = f(x) \) into above, we have

\[
0 > \frac{\partial M(x)}{\partial x} = \frac{-[f(x)]^2 - [1 - N(x)][-xf(x)]}{[f(x)]^2} = -1 + x[1 - N(x)]/f(x)
\]

(A.44)
Since $\Phi(x) = x/h(x) = x[1 - N(x)]/f(x)$, so $\Phi(x) < 1$.

Next we prove $\Psi(x) = \frac{\partial \Phi(x)}{\partial x} > 0$. From $h'(x) > 0$ and $h(x) \to x$ as $x \to \infty$, we can infer that $h'(x) \to 1$ as $x \to \infty$. Since $h''(x) > 0$, $h'(x)$ is increasing with regard to $x$, and so $0 < h'(x) < 1 \forall x < \infty$. Therefore,

$$1 > \Phi(x) > h'(x)\Phi(x) \quad (A.45)$$

Taking derivative of $\Phi(x)$ w.r.t. $x$, get

$$\Psi(x) = \frac{\partial \Phi(x)}{\partial x} = \frac{1}{h(x)}(1 - h'(x)\frac{x}{h(x)})$$

Since $h(x) > 0$ from definition and $1 - h'(x)\frac{x}{h(x)} > 0$ from equation (A.45), we have $\Psi(x) > 0$. *Proof Complete.*

### A.5.2 Proof of Lemma 1

**Proof**: Assuming a random variable $x$ follows a normal distribution $N(\mu, \sigma^2)$, we get

$$E_{x \geq 0}\{e^x\} = \int_0^\infty e^x \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-\mu)^2/2\sigma^2} \, dx \quad (A.46)$$

$$= \int_0^\infty \frac{1}{\sqrt{2\pi}\sigma} e^{-(z-\mu)^2/2\sigma^2} \, dx \quad (A.46)$$

$$= e^{\mu+\sigma^2/2} \int_0^\infty \frac{1}{\sqrt{2\pi}\sigma} e^{-(z-\mu)^2/2\sigma^2} \, dz \quad (A.46)$$

$$= e^{\mu+\sigma^2/2} N\left(\frac{\mu}{\sigma} + \sigma\right)$$

where $N(\cdot)$ is the cumulative distribution function of a standard normal variable.

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Similarly, we get
\[ E_{x \leq 0} \{ e^x \} = \int_{-\infty}^{0} e^x \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \, dx = e^{\mu+\sigma^2/2} N \left(-\frac{\mu}{\sigma} - \sigma\right) \quad (A.47) \]

Since
\[
E\{U_k(\tilde{w}_k)\} = E\{-\exp(-aw_k)\} \\
= E\{-\exp(-a[\delta_k + c_gD_k(\tilde{\pi} - RP)^+ + c_dD_k(\tilde{\pi} - RP)^-])\} \\
= -e^{-a\delta_k} E\{-ac_gD_k(\tilde{\pi} - RP)^+ - ac_dD_k(\tilde{\pi} - RP)^-\} \\
= -e^{-a\delta_k} E_{\tilde{\pi} - RP \geq 0} \{\exp\{-ac_gD_k(\tilde{\pi} - RP)^+\}\} \\
- e^{-a\delta_k} E_{\tilde{\pi} - RP \leq 0} \{\exp\{-ac_dD_k(\tilde{\pi} - RP)^-\}\}, \quad (A.48)
\]

and \( \tilde{\pi} - RP \) follows a normal distribution \( N(\mu - RP, \sigma^2) \), we get the following result by substituting (A.46) and (A.47) into (A.48)
\[
E\{U_k(\tilde{w}_k)\} = -e^{-a\delta_k} \left\{ f(\Delta) \left( \frac{1}{h(\Delta - c_l aD_k \sigma)} + \frac{1}{h(-\Delta + c_g aD_k \sigma)} \right) \right\}
\]
where \( f(x) \) and \( N(x) \) are, respectively, the density function and distribution function of a standard normal variable, and
\[
\Delta = \frac{\mu - RP}{\sigma} \quad (A.49) \\
h(x) = \frac{f(x)}{1 - N(x)} \quad (A.50)
\]
Further, \( e^{-a\delta_k} f(\Delta) \) is positive, and \( f(\Delta) \) is independent of \( D_k \), so
\[
\max_{D_k \geq 0} E\{U_k(\tilde{w}_k)\}
\]
is equivalent to
\[
\max_{D_k \geq 0} \frac{-1}{h(\Delta - c_l aD_k \sigma)} + \frac{-1}{h(-\Delta + c_g aD_k \sigma)}.
\]

Proof Complete.

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A.5.3 Proof of Lemma 2

Proof: Define Mill’s Ratio

\[ M(x) = \frac{1 - N(x)}{f(x)}, \]

then rewrite objective function (2.10) as

\[
\max_{D_k \geq 0} -M(\Delta - c_l a D_k \sigma) - M(-\Delta + c_g a D_k \sigma) \tag{A.51}
\]

Noting that \( M'(x) = xM(x) - 1 \), taking first order condition of (A.51) w.r.t. \( D_k \), yields

\[
[-1 + (\Delta - c_l a D_k \sigma) M(\Delta - c_l a D_k \sigma)](-c_l \sigma) + [-1 + (-\Delta + c_g a D_k \sigma) M(-\Delta + c_g a D_k \sigma)](ac_g \sigma) = 0
\]

Rearranging, get

\[
[1 - \Phi(-\Delta + c_g a D_k \sigma)]c_g = [1 - \Phi(\Delta - c_l a D_k \sigma)]c_l
\]

where

\[
\Phi(x) = \frac{x}{h(x)}
\]

Proof Complete.
A.5.4 Proof of Proposition 1

First, many results later in this section are quite cumbersome in notation, and so for simplicity, we define a list of short notations as follows.

\[
\begin{align*}
I_{\Delta-} & = (1 + C_{I/0} N_{B/U}) \Delta - c_I a S \sigma / n_U \\
g_{\Delta-} & = -(1 + C_{g/0} N_{B/U}) \Delta + c_g a S \sigma / n_U \\
l_{\Delta+} & = \Delta - c_I a S \sigma / n_U \\
g_{\Delta+} & = (1 + C_{I/0} N_{B/U}) \Delta - c_I a S \sigma / n_U \\
C_{g/0} & = \frac{c_g}{c_0} \\
C_{I/0} & = \frac{c_I}{c_0} \\
N_{B/U} & = \frac{n_B}{n_U}
\end{align*}
\]

Now we give a brief proof for Proposition 1.

Proof: For \( c_I \in (0, c_g) \), we have

\[
\frac{\partial P}{\partial m} = \frac{\sigma}{R} \frac{1 - \Phi(g_{\Delta-}) + (-C_{g/0} N_{B/U}) \Delta + c_g a S \sigma \Psi(l_{\Delta-}) / m^2}{(1 + C_{I/0} N_{B/U}) \Psi(l_{\Delta-}) + m(1 + C_{g/0} N_{B/U}) \Psi(g_{\Delta-})} > 0
\]

when \( \Delta > 0 \), and, when \( \Delta \leq 0 \),

\[
\frac{\partial P}{\partial m} = \frac{\sigma}{R} \frac{1 - \Phi(g_{\Delta+}) + c_g a S \sigma \Psi(l_{\Delta+})}{\Psi(l_{\Delta+}) + m \Psi(g_{\Delta+})} > 0
\]

where

\[
\Psi(x) = \frac{\partial \Phi(x)}{\partial x} > 0
\]
Further, from the implicit pricing function, we have

\[
P = \mu - \frac{c_0 \sigma^2}{n_B c_\theta + n_U c_\eta} a S \sigma^2 \quad \text{as } m \to 1
\]  

(A.62)

and

\[
P \to \infty \text{ as } m \to \infty
\]  

(A.63)

Proof Complete.

### A.5.5 Proof of Proposition 2

**Proof**: When the values of \( m \) and \( \sigma \) satisfy the inequality \(- \Delta - a S \sigma c_\theta / n_U < 0\), \( P \) is strictly decreasing with regard to \( \sigma \). Mathematically,

\[
\frac{\partial P}{\partial \sigma} = \begin{cases} 
\frac{-\Delta - a S \sigma c_\theta / n_U}{R} < 0; & \Delta > 0 \\
-\frac{-\Delta - a S \sigma c_\theta / n_U}{R} < 0; & \Delta \leq 0
\end{cases}
\]  

(A.64)

Meanwhile, when \( m \) and \( \sigma \) satisfy \(- \Delta - a S \sigma c_\theta / n_U \geq 0\), \( P \) is increasing with regard to \( \sigma \). Mathematically,

\[
\frac{\partial P}{\partial \sigma} = \frac{-\Delta - a S \sigma c_\theta / n_U}{R} \geq 0
\]  

(A.65)

Here

\[
c_\eta = \frac{c_\eta^2 \Psi(g_{\Delta-}) + c_\eta^2 \Psi(l_{\Delta-})}{c_\eta(1 + C_{g/0} N_{B/\Delta}) \Psi(g_{\Delta-}) + c_\eta(1 + C_{I/0} N_{B/\Delta}) \Psi(l_{\Delta-})}
\]  

(A.66)

and

\[
c_\theta = \frac{c_\theta^2 \Psi(g_{\Delta+}) + c_\eta^2 \Psi(l_{\Delta+})}{c_\theta \Psi(g_{\Delta+}) + c_\eta \Psi(l_{\Delta+})}
\]  

(A.67)

where \( \Psi(\bullet) \) is as defined in (A.61). In addition, we have \( c_\eta < c_\theta < c_\eta \) and \( c_\eta / (1 + C_{I/0} N_{B/\Delta}) < c_\eta < c_\eta / (1 + C_{g/0} N_{B/\Delta}) \). **Proof Complete.**
A.5.6 Proof of Proposition 5

Proof: For $c_g \in [0, c_l]$, the lower the value of $m = c_g / c_l$, or say the higher the capital gains tax, the lower the market price, or say, the higher the Equity Premium. Mathematically, $\partial P / \partial m > 0$, for

$$\frac{\partial P}{\partial m} = \frac{\sigma}{R} \frac{1 - \Phi(g_{\Delta-}) + (-C_{g/0}N_{B/U} \Delta + c_g aS\sigma)\Psi(l_{\Delta-})/m^2}{R(1 + C_{g/0}N_{B/U})\Psi(l_{\Delta-}) + m(1 + C_{g/0}N_{B/U})\Psi(g_{\Delta-})} > 0 \quad (A.68)$$

when $\Delta > 0$, and, when $\Delta \leq 0$,

$$\frac{\partial P}{\partial m} = \frac{\sigma}{R} \frac{1 - \Phi(g_{\Delta+}) + \frac{c_g aS\sigma}{m^2n_U} \Psi(l_{\Delta+})}{\Psi(l_{\Delta+}) + m\Psi(g_{\Delta+})} > 0 \quad (A.69)$$

where

$$\Psi(x) = \frac{\partial \Phi(x)}{\partial x} > 0 \quad (A.70)$$

Further, it is straightforward that

$$P \rightarrow \frac{\mu - \frac{c_g c_0}{n_B n_U c_0} aS^2}{R} \quad \text{as } m \rightarrow 1 \quad (A.71)$$

and

$$P \rightarrow \max\left\{\frac{\mu - \frac{1}{n_B} aS^2}{R}, 0\right\} \quad \text{as } m \rightarrow 0 \quad (A.72)$$

Proof Complete.
Appendix B

Appendix of Chapter III

B.1 The 1997 Announcement of Crack Down

On May 22, 1997, the Securities Commission of the State Council, the People’s Bank of China and the State Economic and Trade Commission issued a regulation to prohibit State-owned enterprises from speculating on the stock market and to ban listed companies from using bank credit capital and funds raised from stock issuance to speculate in stocks. The following is our translation of part of the original announcement published in China Security News, the state-owned official newspaper for securities news. This translation is the closest English version of the original one to the best of our understanding. The announcement itself may also offer a glimpse of the rampant UMC problems in Chinese stock markets.
SOEs and Listed Companies Prohibited from Stock Speculation by the SRC and Other State Regulation Agencies

Securities Regulation Commission of the State Council (SRC), The People's Bank of China, and the Economic and Trade Commission collectively issue an order to stop State Owned Enterprises (SOEs) and Listed Companies from speculating in the stock markets. They point out that Chinese securities markets are still in the early stage of development, and there are serious problems of rampant speculation and violations of securities regulations. To secure the social stability and maintain the healthy development of socialist market economy, it is a paramount task of the regulation agencies to crack down on illegal stock trading and suppress the over speculation in stock markets. Recently, there has been a sustained flow of capital from state-owned commercial banks to the stock markets through a variety of channels. Some SOEs and listed companies invest in the stock markets with bank loans. Some listed companies speculate in stock markets with capital raised from stock markets, which is supposed to be used in corporate operations and productions. Some SOEs invest in stock markets with capital allocated for further corporate development and expansion. Such a situation not only boosts the stock speculations in security markets, but also puts the state-owned capital at high risk and
jeopardizes the security of state-owned assets. The illegal trading activities by SOEs and listed firms must be prohibited so as to maintain orders in the stock markets. Without such a prohibition, Chinese stock markets cannot function well as the fund-raising channel for SOEs, or facilitate the transition of Chinese economy to a healthy market economy.

The following rules must be followed: ...

The details of the rules above will be clarified and carried out by corresponding departments of the State Council.