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The impact of overseas listing on total factor productivity based on DEA-Malmquist index measurement

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ABSTRACT

In this paper, we measure the productivity change of Chinese entrepreneurial enterprises listed on NASDAQ and on GEM, and then examine the influence of overseas listing on the productivity through the contrast of the both. The results show that, compared with enterprises listed on GEM, companies listed on NASDAQ have a higher total factor productivity and innovation ability due to the binding effect and investor protection mechanisms of overseas Listing.

KEYWORDS

Overseas listing; DEA-malmquist index; Total factor productivity; Efficiency improvement; Technical progress.

INTRODUCTION

Entrepreneurial enterprise is a company with the most vitality and development potential, and their development has great significance to promote the level of the science and technology and economic growth. To encourage the development of start-ups, Shenzhen Stock Exchange launched Chinese Growth Enterprises Market (GEM) in 2009. As of December 31, 2013, there are accumulated 383 companies listed on GEM. Promoting technological progress and technological innovation is one of the original intention of the establishment of GEM, and continuous improvement of productivity is also a vital source of long-term investment returns for shareholders by listed Corporations. Before Chinese GEM board, most of Chinese entrepreneurial enterprises are chosen to be listed overseas, especially on the U.S. Nasdaq stock exchange. Up to now, more than 150 China technology enterprises listed on the NASDAQ. So, we intend to examine whether there is a different in innovation and total factor productivity between China enterprises listed on NASDAQ and GEM? And, what are the causes of the difference? This paper will discuss this problem.

THE RESEARCH CONTENT

First of all, there are a lot of characteristics in common between companies coming from the two market, which provides a basis for comparative research in this article. First, the companies are mainly operating in China, therefore, restricted by Chinese economic environment and legal conditions. Second, they are high-tech enterprises, which generally have a higher potential in growth and innovative capacity. The differences between companies coming from the two market are that: China entrepreneurial enterprises listed in American NASDAQ need to meet the listing requirements of America Nasdaq and to accept their supervision, but the Companies listed in Chinese GEM need to meet the IPO conditions of the GEM, and accept the supervision of the CSRC. There are many differences in the market access conditions, regulatory content and supervision between U.S. Nasdaq market and Chinese Growth Enterprise Market, which leads to inconsistent effects on the company listed on them separately in the operating level and productivity.

Secondly, the main motivation for companies to list overseas was to access to external funds and reduce the cost of financing. The theoretical explanation of companies listed overseas mainly has the Market Segmentation Hypothesis, Bonding Hypothesis and Investor Protection Hypothesis.

Market Segmentation Hypothesis also known as Risk Premium Hypothesis, is one of the earliest and most popular hypothesis to explain the overseas listing. It is believed that due to the existence of equity investment restrictions between different countries, information asymmetries and other factors, the global capital markets in different countries are in fact divided state, resulting in enterprise risk premium rises[1]. Therefore, the enterprises divided in different market can enter more developed capital markets through overseas listing in order to overcome this obstacle of market segmentation barriers.

Bonding Hypothesis, also known as the guaranteed hypothesis, was first used by Stulz[2] and Coffee Jr[3]. The hypothesis suggests that the overseas listing may also be a bonding mechanism by which firms incorporated in a jurisdiction with weak protection of minority rights or poor enforcement mechanisms can voluntarily subject themselves to higher disclosure standards and stricter enforcement in order to attract investors who would otherwise be reluctant to invest (or who would discount such stocks to reflect the risk of minority expropriation).

The bonding hypothesis posits that overseas-listing on a United States stock exchange (including NASDAQ) commits the listing firm to respect minority investor rights and to provide fuller disclosure. On the specific type of binding mechanism, Coffee Jr[3], Coffee Jr[4] pointed out that foreign companies listed in the U.S. is facing at least three mechanisms : (i) the listing firm becomes subject to the enforcement powers of the SEC; (ii) investors acquire the ability to exercise effective and low-cost legal remedies (such as a class action and the derivative action) that are not available in the firm's home jurisdiction; and (iii) the entry into the U.S. markets commits the firm (at least when it lists on an exchange or Nasdaq) to provide fuller financial information and to reconcile its financial statements to

U.S. GAAP accounting principles. Stulz[2] emphasized the reputational intermediaries' role, these intermediaries include Securities Sponsors, auditors, bond rating agencies, securities analysts and the stock exchange. Siegel[5] proposed that reputation binding more than legal binding is the foundation to enhance the value of overseas-listing company, which the constraints of listed overseas are its reputation constraints.

Investor Protection Hypothesis proposed by Coffee Jr[3], Coffee Jr[4] and Stulz[2]. They believe that the degree of protection to the interests of the shareholders can influence the cost of raising external funds. Previously, La Porta, et al.[6], La Porta, et al.[7] considered that in countries with relatively weak investor protection, the company's external financing is more difficult, so they tend to choose the foreign market. Reese Jr and Weisbach[8] examined the relationship between the overseas listing, investor protection and the refinancing. They found that overseas-listing increased equity financing, and the better protection of shareholders' interests, the greater increase of the financing. Therefore, they believe that the overseas listing is an effective measure to protect the interests of minority shareholders.

Finally, to examine whether Chinese entrepreneurial enterprises of overseas listing has a higher management efficiency and productivity compared with the partners listed on GEM because of binding effect and mechanism of protection of investors, this paper will estimate total factor productivity of companies listed on American Nasdaq and Chinese GEM using the DEA-based Malmquist index, and then compare the differences between the both groups in technical efficiency and technical progress.

THE MODEL

Measurement and decomposition of TFP growth by the DEA-based Malmquist index

TFP growth change can be decomposed into efficiency improvement and technical progress, and efficiency improvement can be decomposed into pure efficiency change and Scale efficiency change using the DEA-based Malmquist index.

Data envelopment analysis (DEA) is a nonparametric technique that measures the efficiency of decision making units (DMUs). First introduced by Farrell[9], the frontier efficiency concept was later developed by Charnes, et al.[10](CCR) and further modified by Banker, et al.[11](BCC). DEA is a nonparametric approach and does not places any constraint on the functional form of the production relationship, which is a very suitable characteristic in empirical cases with relatively small sample sizes. Hence DEA thus optimizes for each observation an efficient frontier—the maximum output empirically obtainable for any DMU in the observed population given its level of inputs.

Following Färe, et al.[12] to define the output-based Malmquist index of productivity change, we assume that, for each time period $t = 1, \ldots, T$, the production technology S^t models the transformation of inputs, $x^t \in R_+^N$, into outputs, $y^t \in R_+^M$, as follows:

$$S^t = \left\{ \left(x^t, y^t \right) : x^t \text{ can produce } y^t \right\} \quad \textbf{(1)}$$

The output distance function is defined at t as

$$\begin{aligned} D_0^t\left(x^t, y^t\right) &= \inf\left\{\theta : \left(x^t, y^t / \theta\right) \in S^t\right\} \\ &= \left(\sup\left\{\theta : \left(x^t, \theta y^t\right) \in S^t\right\}\right)^{-1} \end{aligned} \quad \textbf{(2)}$$

This function is defined as the reciprocal of the "maximum" proportional expansion of the output vector y^t, given inputs x^t. In particular, note that $D_0^t(x^t, y^t) \le 1$ if and only if $(x^t, y^t) \in S^t$. In addition, $D_0^t(x^t, y^t) = 1$ if and only if (x^t, y^t) is on the boundary or frontier of the technology. According to Farrell[9], this occurs when production is technically efficient.

To define the Malmquist index, we set a distance function with respect to two different time periods such as:

$$D_0^t\left(x^{t+1}, y^{t+1}\right) = \inf\left\{\theta : \left(x^{t+1}, y^{t+1} / \theta\right) \in S^t\right\} \quad \textbf{(3)}$$

This function measures the maximal proportional change in outputs required to make (x^t, y^t) feasible in relation to the reference or benchmark technology at t. Similarly, a distance function that measures the maximal proportional change in output required to make (x^t, y^t) feasible in relation to the technology at t+1, denoted $D_0^{t+1}(x^t, y^t)$ may be defined. In order to avoid choosing an arbitrary benchmark between t and t+1, we specify the output-based Malmquist productivity change index as the geometric mean of two Malmquist productivity indexes, one with technology at t and the other at t+1 as benchmarks, as follows:

$$M_0\left(x^{t+1}, y^{t+1}, x^t, y^t\right) = \left[\left(\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)}\right)\left(\frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)}\right)\right]^{1/2} \quad \textbf{(4)}$$

In all definitions concerning Malmquist indexes, Färe and Grosskopf[13] suggested to assume constant returns to scale for the technology and then disaggregated The Malmquist productivity index (Total factor productivity change, TFPCH) in (4) into two component measures: Efficiency change (EFFCH) and Technical change (TECHCH). Färe, et al.[14] further assumed variable returns to scale and decomposed efficiency change into two component measures: Pure efficiency change (PECH) and Scale efficiency change (SECH).

$$EFFCH = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})_{VRS}}{D_0^t(x^t, y^t)_{VRS}} \times \frac{\dfrac{D_0^{t+1}(x^{t+1}, y^{t+1})_{CRS}}{D_0^{t+1}(x^{t+1}, y^{t+1})_{VRS}}}{\dfrac{D_0^t(x^t, y^t)_{CRS}}{D_0^t(x^t, y^t)_{VRS}}} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})_{VRS}}{D_0^t(x^t, y^t)_{VRS}} \times \frac{SE^{t+1}(x^{t+1}, y^{t+1})}{SE^t(x^t, y^t)} \quad \textbf{(5)}$$

$$TECH = \left(\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})}\frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)}\right)^{1/2} \quad \textbf{(6)}$$

TFPCH=EFFCH×TECH = PECH×SECH×TECH **(7)**

Where the expression in (5) measures the change in efficiency between periods t and t+1, which we denote efficiency change. Expression (6) captures shifts in the frontier technology, which we denote to be the technical change component; values less than one in both cases signify deterioration in productivity. We calculate the Malmquist productivity index using non-parametric programming techniques. To calculate the Malmquist Total factor productivity of enterprise k between t and t+1, we solve four different linear-programming problems: $D_0^t(x^t, y^t)$, $D_0^{t+1}(x^t, y^t)$, $D_0^t(x^{t+1}, y^{t+1})$,

$D_0^{t+1}(x^{t+1}, y^{t+1})$. We assume that there are K enterprises, N input variables, M output variables, for each k'= 1,..., K,

$$
\begin{aligned}
&(D_0^t(x^{k',t}, y^{k',t}))^{-1} = \max \theta^{k'} \\
&\text{subject to:} \\
&\theta^{k'} y_m^{k',t} \le \sum_{k=1}^{k} z^{k,t} y_m^{k,t}, m = 1,\ldots, M, \\
&\sum_{k=1}^{k} z^{k,t} y_m^{k,t} \le x_n^{k',t}, n = 1,\ldots, N, and \\
&z^{k,t} \ge 0, k = 1,\ldots, k.
\end{aligned}
\qquad (8)
$$

EMPIRICAL ANALYSES

Sample selection and data sources

we select 130 Chinese companies listed on NASDAQ in the United States and 339 companies listed on GEM in China as the study population. Sample selection through the following steps: (1) Delete companies which data are not available between the year of 2007-2011; (2) excluding the company with missing or anomalous data. Finally, we get 47 Chinese companies listed on NASDAQ and 38 companies listed on GEM as sample.

The data using in this paper mainly come from the OSIRIS database or GTA database. Specifically, the data of Chinese enterprise listed on the U.S. Nasdaq come from Osiris Global listed companies analytical database, and the data of Chinese companies listed on GEM come from The CSMAR Database developed by GTA. The data before listing on GEM of Chinese companies come from manually compiled prospectus.

The following inputs and output were used in this study: inputs were employees and Non-current assets, while the outputs were Total operating income. Therefore, a panel data with 190 observations of GEM and 235 observations of NASDAQ is used in the analysis. The Panel data was used to arrive to TFP estimates, with a total of 38 startups listed on GEM and 47 startups listed on NASDAQ. The TABLE 1 depicts descriptive statistics of data and variables used in this study.

TABLE 1: Descriptive statistics of the sample

Panel A: Sample of companies from GEM					
Variable	**Obs**	**Mean**	**Std.Dev**	**Min**	**Max**
OprIncm	190	3.35E+08	4.81E+08	16536076	5.13E+09
Non-CurAst	190	1.13E+08	1.15E+08	1457833	6.08E+08
employees	190	574	437	68	2320
Panel B: Sample of companies from Nasdaq					
OprIncm	235	1.75E+09	2.48E+09	75383472	1.8E+10
Non-CurAst	235	9.39E+08	1.26E+09	29948860	7.45E+09
employees	235	2761	3744	112	26670

The empirical results

Based on a balanced panel data for 85 startups from 2007 to 2011, in this subsection we use Data Envelopment Analysis (DEA) and the Malmquist index to evaluate the productivity performance of Chinese Entrepreneurial Firms. TFP growth is decomposed into efficiency improvement and technical progress, and efficiency improvement is further decomposed into pure efficiency change and scale efficiency change.

We used DEAP 2.1 program developed by Coelli[15] to measure the productivity indexes with Variable Returns to Scale Output oriented.

TABLE 2: Malmquist index summary of annual means

year	effch	techch	pech	sech	tfpch
2007/2008	1.145	0.944	1.007	1.137	1.081
2008/2009	1.002	0.980	1.146	0.874	0.982
2009/2010	0.760	1.192	0.748	1.015	0.906
2010/2011	0.964	1.009	0.905	1.066	0.973
mean	0.958	1.027	0.940	1.018	0.983

Note: Technical change (techch), Efficiency Change (effch), Pure Technical efficiency change (pech), Scale efficiency change (sech) and Total factor productivity change (tfpch).

The TABLE 2 indicates the trend of the most changes deteriorates from 2009 to 2011. Overall, total factor productivity deteriorates by 1.7 percent, which is caused by a 4.2 percent decline of efficiency change and an improvement of technological change by 2.7 percent. Actually, pure efficiency change deteriorates by 6 percent, which is the main reason of the decrease of TFP. So, we can find that the global financial crisis beginning in 2007 led to a significantly decline of productivity of Chinese enterprises during this period.

The results show that, the financial crisis has a large impact on many startups which result in a deterioration of technical efficiency, but little effect on technology progress. A higher proportion of startups listed on GEM has a deterioration in technical efficiency.

(a) Productivity change by group categories

The main objective of this subsection is to compare the productivity change of Chinese startups listed on GEM with NASDAQ, this will provide a precise description as to the differences between the both groups, The TABLE 3 indicates productivity change of startups by peer groups.

TABLE 3: Malmquist index summary of Companies groups

group	effch	techch	pech	sech	tfpch
GEM	0.947	1.015	0.891	1.064	0.962
NASDAQ	0.966	1.036	0.983	0.983	1.001
mean	0.958	1.027	0.940	1.018	0.983

The TABLE 3 indicates Chinese startups listed on both GEM and NASDAQ recorded productivity change in all perspective. More specifically startups listed on NASDAQ had an improvement of TFP by 0.1 percent while startups listed on GEM had a deterioration of TFP by 3.8 percent, which shows that entrepreneurial companies listed on NASDAQ have a higher productivity than companies listed on GEM. This is mainly caused by the difference of the pure technical efficiency between two groups. Under the impact of the financial crisis, pure technical efficiency of Chinese companies listed on GEM declined by 10.9 percent, while the Chinese entrepreneurial companies listed on NASDAQ fell by only 1.7 percent. This suggests that due to the binding effect and investor protection mechanisms, Chinese companies listed in the United States has a higher ability to resist risks.

The mean efficiency change, technical progress and pure efficiency change of sample companies listed in NASDAQ is higher compared to these listed on GEM, which is the source of a faster TFP growth of companies listed in NASDAQ. However, scale efficiency change of companies listed on NASDAQ is lower than one, while it is above one for companies listed on GEM. This also means that Companies listed on GEM have an increasing returns to scale, while companies listed on NASDAQ have a decreasing returns to scale. As can be seen from the description statistics before, this may be due to companies listed on NASDAQ with a large scale and long listed time, which are in the mature stage of enterprise life cycle, while companies listed on GEM are the start-up stage with a small scale and short listed time.

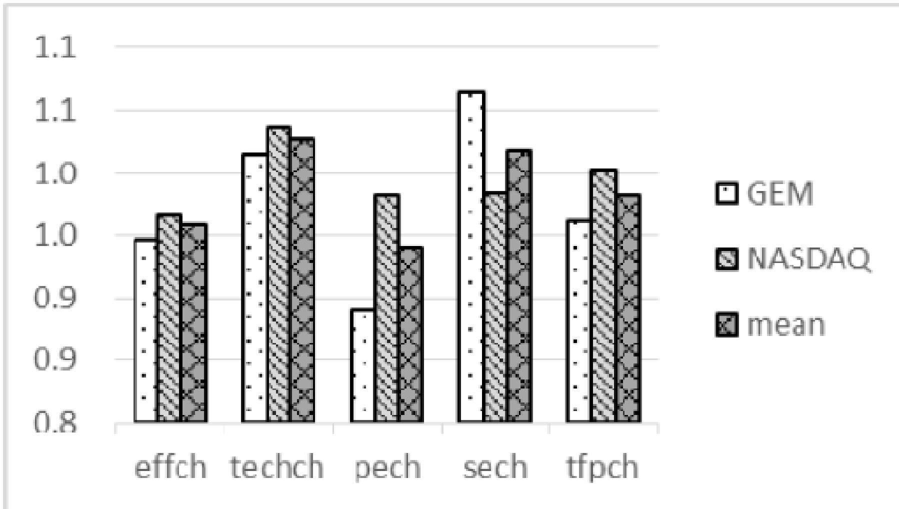

Figure 1: Productivity change by group

Note: GEM=sample companies listed on Chinese Growth Enterprises Market, NASDAQ= sample companies listed on NASDAQ

(b) Productivity change of companies groups by times

The TABLE 4 indicates Malmquist index summary of Companies groups by times. The result shows that TFP growth of enterprises listed on NASDAQ is bigger than those listed on GEM apart from 2009, which is similar situation in efficiency change. Technical progress of enterprises listed on NASDAQ is lower in previous two years than those listed on GEM, but exceed in followed two years.

TABLE 4: Malmquist index summary of companies groups by times

year	group	effch	techch	pech	sech	tfpch
	GEM	1.057	0.945	0.866	1.220	0.998
2007- 2008	NASDAQ	1.222	0.943	1.138	1.074	1.153
	mean	1.145	0.944	1.007	1.137	1.081
	GEM	1.075	0.981	1.017	1.057	1.055
2008- 2009	NASDAQ	0.946	0.979	1.262	0.750	0.926
	mean	1.002	0.980	1.146	0.874	0.982
	GEM	0.742	1.144	0.809	0.918	0.850
2009- 2010	NASDAQ	0.774	1.232	0.703	1.102	0.954
	mean	0.760	1.192	0.748	1.015	0.906
	GEM	0.954	1.003	0.883	1.080	0.956
2010- 2011	NASDAQ	0.973	1.013	0.923	1.054	0.986
	mean	0.964	1.009	0.905	1.066	0.973

CONCLUSIONS

We used the DEA-based Malmquist index to measure productivity change of Chinese entrepreneurial enterprises listed on NASDAQ and GEM and then compare the differences between the both groups. The Malmquist productivity index can be decomposed into efficiency improvement and technical progress, and efficiency improvement is further decomposed into pure efficiency change and scale efficiency change. Overall, total factor productivity of Chinese entrepreneurial enterprises deteriorates from 2009 to 2011, which is mainly caused by a decline of efficiency change. Actually, the deterioration of pure efficiency changes is the main reason of the decrease of TFP. The financial crisis has a large impact on many startups, which results in a deterioration of technical efficiency, but little effect on technology progress. A higher proportion of startups listed on GEM has a deterioration in technical efficiency. The result shows that entrepreneurial companies listed on NASDAQ have a higher productivity than companies listed on GEM. This is mainly caused by the difference of the pure technical efficiency between two groups. Under the impact of the financial crisis, pure technical efficiency of Chinese companies listed on GEM declined by 10.9 percent, while the Chinese entrepreneurial companies listed on NASDAQ fell by only 1.7 percent. The result implies that due to the binding effect and investor protection mechanisms of overseas Listing, Chinese companies listed in the United States have a higher ability to resist risks, and therefore, have a higher productivity.

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CONFLICT OF INTERESTS

The author declares that there is no conflict of interests regarding the publication of this paper.

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