The Dynamic Global Expansion of China's Iron and Steel Industry: An industrial level assessment on the increasing global imbalance in the global financial crisis era

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Abstract: The rapid and effective global expansion of China's iron and steel industry in recent decade has contributed to the transition of China's export growth model from being reliant on domestic resource to leveraging on international resource. This new China's export growth model has evolved massive international trade and financial flows and become an integral part of the world market. The China's surging export, foreign reserve and savings that are the focus of global imbalance have closely linked to the new China export growth model.

"When you need a lot of money there is no better place to get it than in China."

> - Clive Palmer, the chairman of Resourcehouse Ltd, an Australia mining group, which signed the Australia biggest ever export contract in Feb 2010 to supply $60 billion worth of coal to China Power International Development Ltd, a Chinese company listed in HK stock exchange, over a 20-year period.

1. Introduction

The Chinese iron and steel industry has been experiencing rapid transition from a domestic-oriented industry into a globalised industry which plays a dominant role in the international steel market and nature resource markets in the global financial crisis era. When the world financial market was rapidly building up financial bubble in the mortgage backed security and its related markets in 2006, the China's iron and steel industry achieved another miracle in the world export by replacing Japan as the world top steel exporter as well as top net steel exporter. Since the global financial crisis started in 2008, while the developed economies was desperately trying to find enough financial resources to rescue their deeply troubled financial institutions, China, the world top importer of iron ore and cooking coal, has been trying to shift its huge investment from US debt market into equity investment in foreign iron ore and coal companies such as Australia's Rio Tinto, aiming at securing more resources to support its massive iron and steel production. The rapid global expansion of China's iron and steel industry in the global financial crisis era has sharply contrasted to the depressed world economy, particularly, the developed economies.

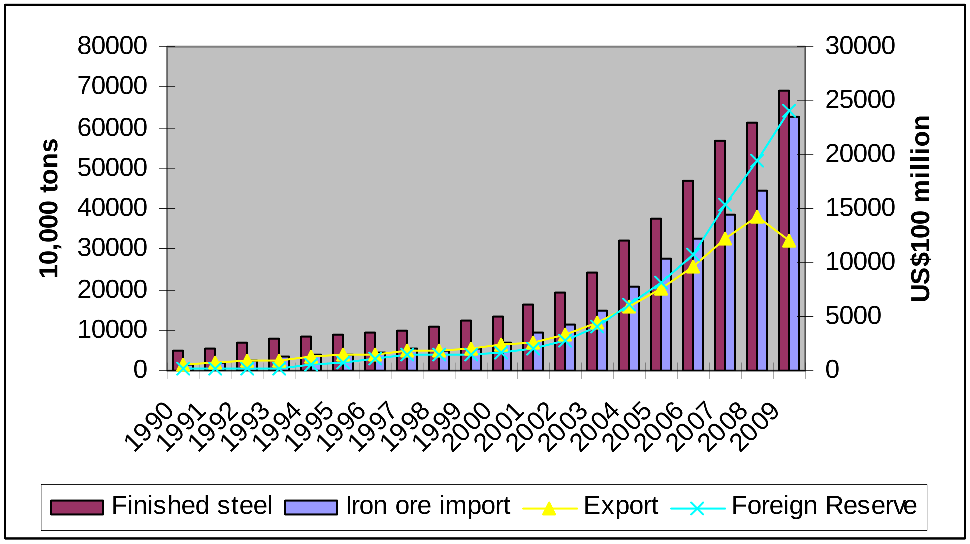
In the recent decade, the rapid global expansion of China's iron and steel industry in recent decade has been closely corresponded to China's surging export and foreign reserve. In the debate of global imbalance and its linkage to the global financial crisis, there are plenty of reports and researches attributing China's export and foreign reserve to the increasing global imbalance. There is nevertheless few studies looking at how China's surging export and foreign reserve have been determined by more fundamental changes in both China's industrial structure and international trade pattern. In this regard, this paper aims at studying the global imbalance from the aspect of the Chinese economy in a more fundamental approach by analyzing how the global expansion of China's iron and steel industry has contributed to China's export and foreign reserve. Moreover, the paper will also look at how the global expansion of China's iron and steel industry has led to the increasing trade flows between the resource-rich countries and the export-reliant countries such as China and thus a new international trade model. Such fundamental approach provides a balanced view on the root causes of global imbalance and a more comprehensive understanding on the complex implication of global imbalance.

Based on the analysis of the dynamic global expansion of China's iron and steel industry in the global financial crisis era, this paper shows that a new China's export growth pattern has emerged from the development of its export-reliant industrial capacity having been adjusted towards more reliance on international resources. By analyzing a structural model linking China's export, foreign reserve and national savings to the variables contributing to the global expansion of China's iron and steel industry, this paper shows that those stylized facts of global imbalance such as the surging China's export and domestic savings have a close linkage to the rapid changes of industrial structure in the China's iron and steel industry and the changing international trade pattern. Such linkage has been developed from the increasing international trade and financial flows and contributed to the increasing economic globalization that could hardly be reversed by any simplistic macroeconomic policy measure from any single country or a single regional country group. The attempt in deterring the development of such linkage would definitely damage the international trade flow and global economic recovery from the global financial crisis. The paper is then organized as the follows: section 2 studies the global expansion of China's iron and steel industry and its impact on China's export; section 3 analyses the industrial structural change in the China's iron and steel industry in connection to its global expansion; section 4 constructs a structural model to study the linkage between the global expansion of China's iron and steel industry and China's export, foreign reserve and national savings, the final section concludes the paper with policy implications of this study.

2. The rapid surge of China's iron and steel industry as the global dominant industrial player

The global imbalance debate has centered on the surging China's export and its corresponding surging foreign reserve and domestic savings which have occurred since early 2000s. While such international debate on the cause of global imbalance becomes increasingly frequent in the international political, economic and financial circles, the industrial and business circles are nevertheless paying more attention to the surging China's steel production and aggressive import of iron ore. As shown in Figure 1, the China's export, foreign reserve, steel production and iron ore import started to surge simultaneously in the early 2000s.

Figure 1: The exponential growth of export, foreign reserve, finished steel production and iron ore import



Source: Derived from (1) China State Statistic Bureau, "China's Statistic Yearbook", Beijing: various years; (2) China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years.

The aggressive development of China's iron and steel industry is not a new story in China. This industry has long been treated as the fundamental and core industry by the Chinese government in the centrally-planned economic period and the market-oriented reform period as well. It has led the Chinese economic growth from one perk to another. Its fate is very much the mirror of the Chinese business cycle. However, the rapid surge of the China's iron and steel industry as a global dominant industrial player in the recent decade is indeed another miracle of the Chinese economy. The impact of such surge on the world resource market as well as international trade pattern is tremendous and is only in its early stage. In 1990, China only produced 8.55% of world crude steel and 7.88% of finished steel. In 2009, China produced 46.6% of world crude steel and 63.5% of world finished steel. The dramatic accelerating change in the landscape of the world iron and steel industry actually occurred in a even shorter period in recent decade. In 2003, China replaced Japan as the No. 1 importer of iron ore. Two year later in 2005, China replaced Japan as the No. 1 finished steel producer. In 2006, China became the net exporter of finished steel product and, more importantly, the No. 1 net finished steel product exporter in the world. Over the merely 4 years, the China's iron and steel industry completely transferred itself from a domestic-orient industry into a globalized industry: the leader of iron ore importers and the leader of net finished steel product exporters!

Table 1: China's production, consumption and net export of finished steel products

Year	China's production 10,000 tons	The world production 10,000 tons	China's share in world total %	Import 10,000 tons	Export 10,000 tons	Net export 10,000 tons	Domestic consumption 10,000 tons
1990	5153	65400	7.88%	368	209	-159	5312
1995	8980	65870	13.63%	1397	593	-804	9784
2000	13146	75140	17.50%	1596	621	-975	14121
2005	37771	102340	36.91%	2582	2052	-530	38301
2006	46893	111720	41.97%	1851	4301	2450	44443
2007	56561	120680	46.87%	1687	6252	4565	51996
2008	61379	118480	51.81%	1538	5918	4380	56999
2009	69200	109002	63.49%	1763	2459	696	68504

Source: Derived from (1) China State Statistic Bureau, "China's Statistic Yearbook", Beijing: various years; (2) China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years.

Being the world top finished steel product producer and net finished steel product exporter is essentially not the major significance of the global expansion of China's iron and steel industry. The major significance rests on the following features:

Firstly, China has rapidly established its steel production capacity in recent decade which could supply for the majority of current world steel demand. Before 2000, the fixed capital investment in China's iron and steel industry was relatively moderate. Thus, the growth rate of production capacity was not high at all. For example, the production capacity of finished steel products increased from 145.81 million tons in 1995 to 150.23 million tones in 2000, giving a total growth rate of 3.4% over the 5 years. In 2000, China's production capacity of finished steel products was 17.2% of world total apparent consumption of finished steel products. Since 2000, China's iron and steel industry has rapidly moved into an accelerated growth period. The fixed capital investment has shoot up dramatically. The fixed capital investment in 2005 was about 8 times of the investment in 2000. Such massive investment scale continued steadily into 2009. Accordingly, the production capacities of pig iron, crude steel and finished steel have all expanded enormously. By 2009, China's production capacities in pig iron, crude steel and finished steel are 5 times of the capacities in 2000. China's production capacity of finished steel in 2009 is more than 70% of the world apparent consumption.

Table 2. Fixed capital investment and production capacity in China's iron and steel industry

Fixed	Production Capapcity	World apparent	% of China's

	capital investment				consumption of finished steel products	production capacity over world apparent consumption
		Pig iron	Crude Steel	Finished steel		
Year	100 million RMB	10,000 ton	10,000 ton	10,000 ton	10,000 ton	%
1995	568.02	11073	11715	14581	74705	19.5%
2000	366.96	12572	14960	15023	87197	17.2%
2005	2583.37	38791	40631	47621	109125	43.6%
2006	2642.26	44631	47249	59536	118946	50.1%
2007	2616.71	50754	56840	65143	127273	51.2%
2008	3248.91	56877	66431	74753	126000	59.3%
2009	4042.90	63702	70331	78792	112100	70.3%

Source: Derived from (1) China State Statistic Bureau, "China's Statistic Yearbook", Beijing: various years; (2) China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years. (3) World Steel Association, "World Steel Indicators", Belgium: various years.

Secondly, the majority of China's iron and steel production has relied on the input of iron ore import. In 1990, China's steel production could basically rely on domestic iron ore supply and the imported iron ore is only 7.3% of the total iron ore used in the production. In 2009, the share of imported iron ore in China's total iron ore supply is 41.6%. According to China's Iron and Steel Association (2009), the average iron ore grade from China's domestic iron ore is about 30% but the grade of imported iron ore is above 60%. Since the iron ore grade is directly related to production rate of pig iron, the higher grade imported iron ore can be converted into the lower grade domestic iron ore by simply using the grade difference. This means that the imported iron ore could be used to produce one more time of steel products than that the domestic iron ore could be used to produce. This suggests that the imported iron ore, in terms of conversion rate from iron ore to pig iron, has already become the major input for China's iron and steel production. In 2005, the domestic iron ore production is 420.49 million tons and the imported iron ore is 275.26 million tons. The 275.26 million tons of imported iron ore can be converted into 530.52 million tons of equivalent domestic iron ore. Thus, the imported iron ore has became the dominant source of input for China's iron and steel production since 2005. Based on such calculation, the share of imported iron ore contributed 58.79% of iron ore input for China's iron and steel production in 2009. It should also point out that China's iron ore import has been more than 50% of the world iron ore import since 2008. As such, the strong growth of world iron ore market in recent decade has been mainly due to China's growing iron ore import.

Table 3: China's iron ore production, import and import dependency ratio

Years	Domestic iron ore production	Iron ore import	Import dependency ratio
	10,000 tons	10,000 tons	10,000 tons
1990	17934	1419	7.3%
1995	26192	4115	13.6%
2000	22256	6997	23.9%
2005	42049	27526	39.6%
2006	59712	32630	35.3%
2007	70739	38309	35.1%
2008	78014	44365	36.3%
2009	88000	62778	41.6%

Source: China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years.

Thirdly, the majority of China's iron and steel products has been directly or indirectly used for export. As an export-oriented economy, part of China's total steel production and eventually total steel apparent consumption must be for the production of export products. Hence, China being ranked No.1 in per capita steel production and apparent steel consumption as well doesn't really mean that the consumption of steel products by the Chinese people for the purpose of domestic uses must be ranked No. 1 in the world too. In fact, the standard of per capita steel product consumed by residents for domestic uses in a country should be closely related to its standard of per capita GDP, given that per capita GDP is the indicator of the standard of economic development level. As such, the developed country with high per capita GDP should consume more steel products per person, while the developing country with low per capita GDP should consume less steel products per person. In 2009, the world average GDP per capita is about US$8700 and the China's GDP per capita is US$3711, which is about half of the world average GDP per capita. According to the World Bank's PPP measure of GDP per capita, China's GDP per capita is also well below the world average in 2009. It should thus be reasonably expected that China's per capita steel consumption for the purpose of domestic uses should not be above the world average steel consumption per capita. With this understanding, Table 3 can be used to reveal the feature that the majority of China's steel production has now been used for the export purpose. In 1990, the world average per capita finished steel product consumption is 0.124 ton while China's per capita steel production is 0.045 ton. One should thus expect that the China's finished steel products should be mainly used for its domestic consumption purpose in 1990. In 2000, the China's per capita finished steel production is very close to the world per capita steel consumption. Since China's GDP per capita in 2000 is about US$860 which is well below the world average GDP per capita, one should hence expect that a considerable part of the China's per capita steel production should be used for the purpose of producing export products. In 2005, the China's per capita finished steel production is more than doubled of the world average per capita steel consumption. China's per capita GDP in 2005 is about US$1720 which is still well below the world average. If we make a strong assumption that the Chinese RMB yuan could be seriously undervalued and could be revalued up substantially such that the PPP measure of China's per capita GDP in 2005 may well be equivalent to the world average. With this assumption, one can thus assume that the China's per capita steel consumption for the purpose of domestic uses should be leveled to the world average 0.12 ton in 2005. However, the China's per capita finished steel production is 0.289 ton in 2005. This could mean that more than half of the China's finished steel production could have been used for the purpose of export production. In 2009, the China's per capita finished steel production is 0.518 tons which is more than 4 time of the world average steel consumption. Following the same deduction as for 2005 and considering that the world average consumption of finished steel product per capita is 0.123 ton in 2009, one should expect that more than 70% of 0.518 ton, the China's per capita finished steel production in 2009, could be either for direct export or indirectly for the use of producing export products. Nevertheless, it should be quite certain that the majority of China's finished steel products have now been used either for direct export or indirectly for the use of producing export products.

Table 4. China's finished steel production per person vs world finished steel consumption per person

	China's steel production per person	**World steel consumption per person**
Years	**ton**	**Ton**
1990	0.045	0.124
1995	0.074	0.118
2000	0.104	0.116
2005	0.289	0.120
2006	0.357	0.117
2007	0.428	0.117
2008	0.462	0.124
2009	0.518	0.123

Source: Derived from (1) China State Statistic Bureau, "China's Statistic Yearbook", Beijing: various years; (2) China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years. (3) United Nation, "World Population Prospects", Various years.

The rapid transformation of China's iron and steel industry into a globalized industry in recent decade clearly shows a new model of China's export growth model. This new model is a new development from the so-called new international division of labor (NIDL). The NIDL emerged from 1980s when the process of industrial production was no longer completely operated within a nation's economy but relocated partly or even wholly to other nations where cost advantage, particularly low labor cost advantage, could be explored. This relocation or globalization of processing industry has resulted in global industrial shift (Pol and Helpman 2004, Frobel et al 2008). With abundant labor resource, China has leveraged on this global industrial shift to build its strong export industry. In the period of 1980s and 1990s, China's export industry mainly relied on the assembly operations of foreign companies who invested in China mainly thorough foreign direct investment (FDI). But China has been consistently pushing for the development of domestic industrial capacity that could produce the components of export products and then transfer the assembly operation into non-assembly production. This is to raise the so-called "domestic content of non-assembly processing products' in China's export products. From late 1990s, the domestic contents of China's export started to rise rapidly as processing exports move away from pure assembly operation (Jahangir and Li

2007). In the composition of China's total export, the percentage of machinery and electronic product export has increased from 20% in 1995 to more than 60% in 2009. The majority of China's machinery and electronic product export is defined as the processing product export. According to China's custom trade statistics, the share of domestic content of non-assembly processing products roses from 20% in 1995 to about 50% in 2009 (General Administration of Customs of the People's Republic of China 2009). Such change has lead to increasing demand for domestically produced industrial inputs. In the early 2000s, the transition of China's export industry from reliance on assembly processing products to the development of non-assembly processing products with domestic contents relied mainly on domestic resource for producing domestic industrial inputs. But such transition has faced a big challenge: China's relatively limited nature resource such as iron ore and coal. China has won this challenge simply by importing resources from international markets. Since China started to import international resource to meet the growing demand of industrial material input from its export industry, China's export growth has thus overcome the constraint of domestic resource and rapidly moved into a new era of accelerated export growth. A new China's export growth model has then emerged quickly.

The tremendous potential of the new China's export growth model is from the combination of China's abundant labor resource and manufacturing capacity and the world abundant natural resource. This is surely a model of new international trade and international division of labor also. The growth chain of the China's iron and steel industry over the past decade shows the key growth mechanism of this new international trade model: the increasing demand of steel input from the growing export industry has lead to the expansion of steel production capacity which has leveraged on the iron ore import; the massive expansion of steel industry has provided enormous input of steel products to the export industry that has been using more and more domestic inputs for the export products; China's export has then entered into a new stage of accelerated growth; the once sluggish world mineral resource industry, particularly the iron ore industry, is thus revitalized and becomes one of the new growth engines of world trade; the growing china's export and the growing international resource trade are thus complementary each other; the scale of NIDL has thus been expanded enormously and so has the international trade flow.

3. Dynamics of globalizing China's iron and steel industry

Will the highly globalized China's iron and steel industry sustain its current growth momentum or even be able to effectively utilize its established production capacity? Will it ultimately fail due to its industrial inefficiency compared to international benchmarks?[1] Will such failure lead to the collapse of the emerging new China's export

[1] A study by Movshuk (2003) shows that the technical efficiency in China's iron and steel industry was eventually deteriorating in the mid-1990s. Numerous comments also appears recently in various websites concerning on the future of growing China's iron and steel industry. For example, Bethel (2009) believes that there are hundreds of inefficient China's iron and steel firms. But he didn't provide any concrete evidence to support his assertion.

growth model and the revitalized world resource market and industrial development? These questions have to be answered from analyzing the determinants of the recent expansion of China's iron and steel industry from a deeper industrial level analysis.

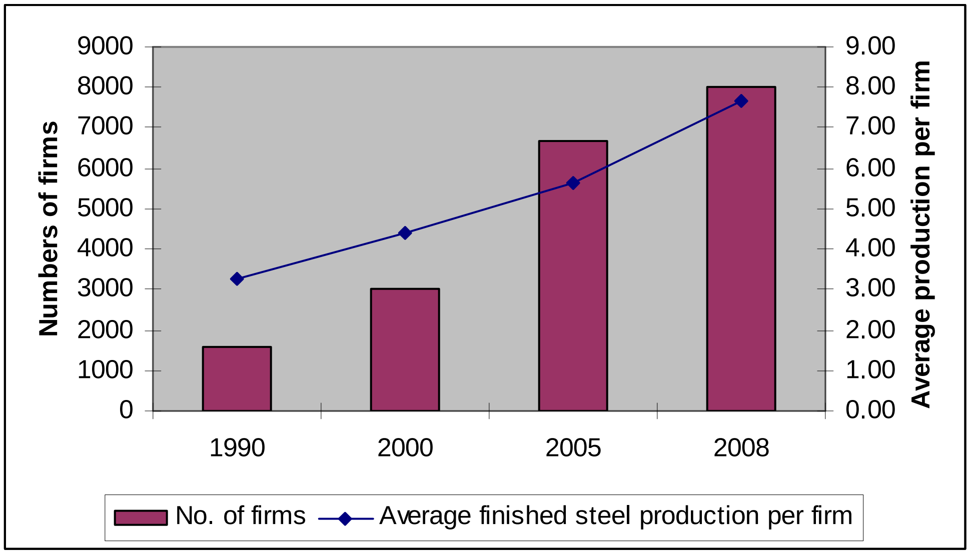
3.1. The improving scale efficiency

In the highly globalized world market, the competitiveness of a nation's industry must rely on its distinctive economic efficiency. In the iron and steel industry, the most noticeable economic efficiency is its efficiency in economics of scale. The Chinese iron and steel industry has long divided its enterprises into key large-sized enterprises and the other small and medium-sized enterprises or SMEs. [2] The SMEs has become relatively more important in the China's iron and steel industry as its production share has increased substantially since 2000. One could then concern about the impact of the increasing importance of the SMEs on the industrial scale efficiency. Some popular industrial scale efficiency indicators have also shown such concern on the scale efficiency in the China's iron and steel industry in recent global expansion. For example, the number of enterprises in the China's steel industry has increased sharply from 1589 in 1990, to 2997 in 2000 and 8012 in 2008; the share of key large-sized enterprises' production has declined from 80% in 2000 to 60% in 2008.

But to use of these simple indicators to judge the changing pattern of industrial scale efficiency of China's iron and steel industry in recent years could be very misleading. As shown in Figure 2, with the increasing numbers of enterprises in China's iron and steel industry, the average finished steel production per enterprise has also increased correspondingly. This at least means that the increasing number of enterprises in China's iron and steel industry in the recent decade has been closely associated with the increasing industrial scale efficiency. This also reflects the fact that the newly established iron and steel enterprises and the remaining enterprises in the China's iron and steel industry are on average becoming larger and larger in production scale over time. Table 5 shows the changing numbers of ironmaking furnace in different sizes in China from 2000 to 2008. It clearly shows that there is a systematic and dramatic upgrading of scale efficiency in the China's iron and steel industry. As one can clearly see that the small sized production equipments have been reduced or demolished and the large-sized production equipments been increased.

[2] The Chinese Iron and Steel Association, previously the Ministry of Metallurgy Industry, has long classified the enterprises in the China's iron and steel industry into the key large-sized enterprises and the other small and medium -sized enterprises. In 2008, the number of key large-sized enterprises is 71 out from the total 8012 enterprises. While the large-sized iron and steel enterprises are definitely large, the small and medium-sized iron and steel enterprises are quite large in term of assets and sale revenue if comparing to enterprises in other manufacturing industries. Hence, the use of the term SMEs in China's iron and steel industry only has relative meaning within the industry.

Figure 2: The number of enterprises and finished steel production per enterprises in China's iron and steel industry



Source: China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years.

Table 5: The changing iron and steel equipment sizes in China

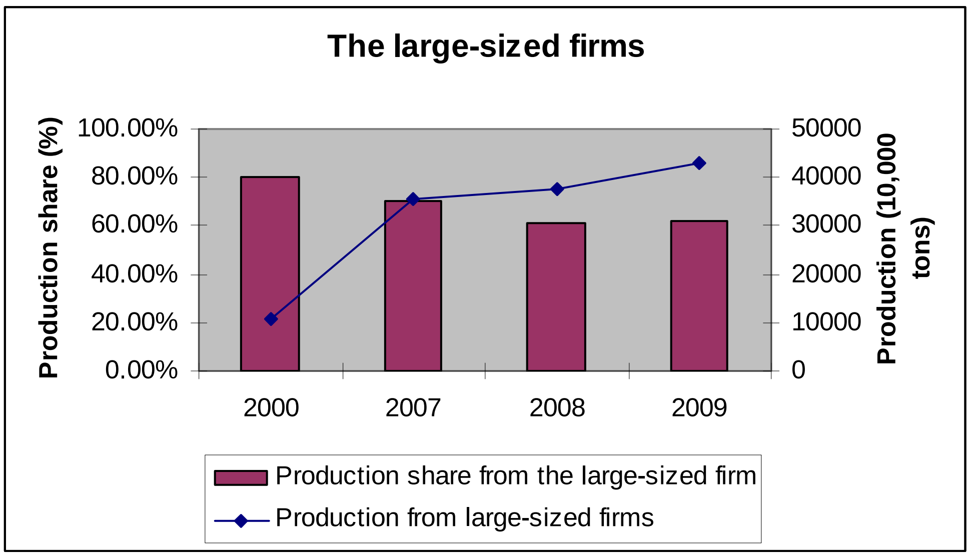
		2000	2005	2008
Ironmaking furnaces	Total	243	437	513
(numbers)	$3000m^3$ and above	4	9	19
	$2000m^3$-$2999m^3$	15	33	46
	$1000m^3$-$1999m^3$	28	48	89
	$300m^3$-$999m^3$	126	260	332
	$101m^3$-$299m^3$	55	75	27
	$100m^3$ and below	15	12	0

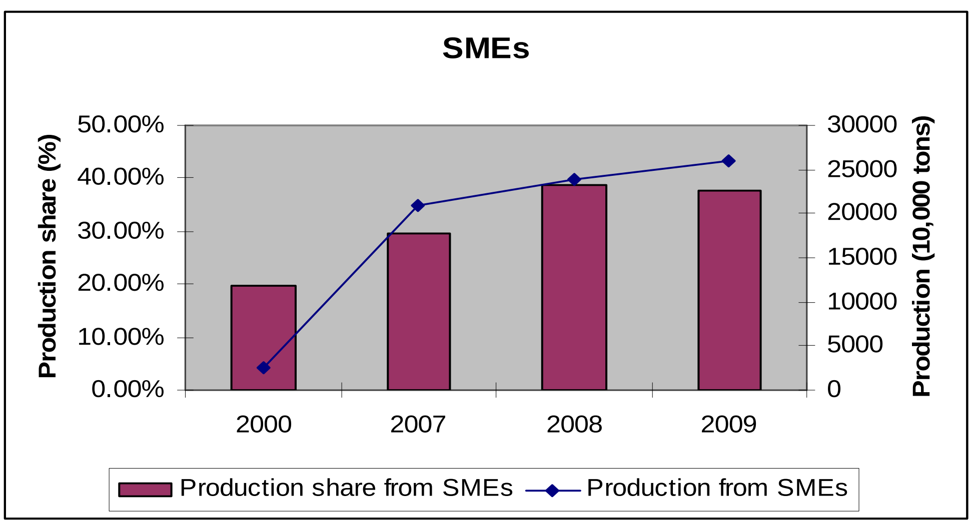
Source: China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years.

One also has to carefully explain the industrial concentration ratio, usually used by the industrial economists in explaining scale efficiency, for the Chinese iron and steel industry. As shown in Figure 3, the production share of the large-sized enterprises has indeed reduced over time. However, the total production of the large-sized enterprises has nevertheless increased considerably over time. The large-sized enterprises' production share in 2000 is 80.28% and falls to 62.33% in 2009. But it produced 431.62 million tons of finished steel in 2009 which is 4 times of their production in 2000 and moreover, is more than the production from the whole industry in 2000. It should also point out that the number of large-sized enterprises has little change. Hence, average production of the large-sized enterprises has increased substantially. Figure 3 also shows that the production from the SMEs has increased over time. This suggests that the expansion of China's iron and steel industry in recent decade has followed a dual track expansion: one from the large-sized enterprises and another from the small and medium-enterprises.

The dynamic feature of the dual track expansion is that the rapid expansion and increasing importance of SMEs production in the China's iron and steel industry hasn't constrained the rapid expansion of the production from large-sized enterprises to capitalize on their scale efficiency. Also, since the production size of all types of enterprises has been upgraded over time, the dual track expansion has been closely associated with the improved scale efficiency for the industry as a whole.

Figure 3: The change of production and production shares of finished steel products from both large-sized enterprises and SMEs: the dual track expansion





Source: Derived from China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years.

3.2. The improving productivity

The improvement of scale efficiency in the China's iron and steel industry in recent decade can be clearly identified from the increasing labor and capital productivities from all different-sized enterprises, defined as the ratio of finished steel product (ton) per person and per 1 million assets. The most obvious improvement is in labor productivity. The large-sized enterprises' labor productivity in 2008 is 3.38 time of that in 2000. The SMEs' labor productivity in 2008 is 5.04 times of that in 2000. Clearly, the SMEs' productivity improvement is much more impressive. This is why the labor productivity difference between the large-sized enterprises and SMEs has been reduced from 2.48 times in 2000 to 1.62 times in 2008.

The SMEs has also achieved substantial improvement in capital productivity as its capital productivity in 2008 is 1.90 times of that in 2000. Interestingly, the capital productivity of large-sized enterprises remains very much the same over the period of 2000 and 2008. This suggests that the large-sized enterprises have had a parallel increase in both production size and capital investment or a capital-intensive production expansion. One should also notice that the SME's capital productivity improvement is not as impressive as its labor productivity improvement, suggesting that SMEs' capital intensity has also increased considerably. The capital productivity difference between the large-sized enterprises and SMEs has reduced substantially from 2.78 in 2000 to 1.48 in 2008 too. This is a clear indication that the increased capital intensity in SMEs has greatly improved its capital utilization effectively.

Since labor productivities have been increased from both large-sized enterprises and SMEs and capital productivity remains the same from the large-sized firms but increased from SMEs, it can be concluded that the overall productivity in the China's iron and steel industry has been increased in its recent rapid expansion period. Once more, the dynamic feature of this productivity change is that the productivity improvement from SMEs is more impressive. As such, SMEs are quickly catching up with the large-sized firms through faster productivity gain.

Table 6: Comparative productivity between large-sized enterprise and SMEs

	Labor productivity			Capital productivity		
	large-sized	SMEs	Productivity comparison*	Large-sized	SMEs	Productivity comparison
Year	Tons of finished steel product per person	tons of finished steel product per person	%	tons of finished steel product per 1 million yuan asset	tons of finished steel product per 1 million yuan	%

					asset	
2000	63.38	25.59	2.48	157.13	56.52	2.78
2008	212.93	131.06	1.62	158.72	107.59	1.48
Productivity improvement**	3.38	5.04		1.01	1.90	

Source: Derived from China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years.
*: The productivity comparison is defined as the ratio between the large-sized enterprises' productivity and the SMEs' productivity.
**: The productivity improvement is defined as the ratio between the productivity in 2008 and the productivity in 2000.

3.3. The improving financial performance

The China's iron and steel industry has achieved substantial gain in financial performance since 2000. Judging from the key financial performance indicator of return of equity (ROE), ROE from the large-sized enterprises rose from 3.5% in 2000 to 16.1% in 2007 and then fall considerably to 8.9% in 2008 when the global financial crisis occurred, ROE from the SMEs rose from 6.9% in 2000 to 33.8% and fall slightly to 26.2% 2008. This suggests that the substantial investment in the China's iron and steel industry from different sources of investors, particularly private investors from SMEs, in recent years have gained enormous financial return. Once more the SMEs have achieved much more impressive and consistent improvement in financial performance than the large-size enterprises could have achieved and showed quite resilient ability in responding to market volatility. Following the conventional Dupont equation analysis, ROE can be divided into its three components of profit margin (net profit/sales revenue), asset utilization ratio (sales revenue/asset) and financial leverage ratio (asset/equity).[3] Table 7 shows the changing pattern of the three ROE components from 2000 to 2008.

Table 7: Comparative financial performance between the large-sized enterprises and the SMEs: The Dupont Equation Analysis

	ROE		Profit margin		Asset utilization ratio		Financial leverage	
	large-sized	SMEs	large-sized	SMEs	large-sized	SMEs	large-sized	SMEs
Year	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
2000	3.5%	6.9%	3.4%	2.6%	46.5%	97.3%	224.2%	275.4%
2004	16.9%	19.2%	8.0%	3.3%	90.0%	192.0%	235.6%	306.8%
2006	14.1%	20.0%	6.7%	3.2%	89.6%	177.0%	235.4%	352.3%
2007	16.1%	33.8%	7.7%	3.4%	90.8%	226.2%	229.9%	436.3%
2008	8.9%	26.2%	3.4%	3.5%	103.4%	205.7%	250.6%	368.2%

Source: Derived from China Iron and Steel Association, "China Iron and Steel Statistics", Beijing: various years.

[3] The Dupont equation is defined as ROE = profit margin *asset utilization ratio*financial leverage ratio = (net profit/sales revenue)*(sales revenue/asset)*(asset/equity).

The profit margin from the large-sized enterprises shows considerable volatility. It had a big jump from 3.4% in 2000 to about 7.7% in 2007 but fall to 3.4% in 2008. The profit margin from SMEs has been consistently low at about 3%. The stable profit margin from SMEs means that their enormous financial return in the recent expansion period is basically not due to its ability in changing the structure of its products' price and cost. More specifically, the increases of cost such as the rising input price of imported iron ore should have been very much absorbed from the improved cost efficiency such as the reduced unit cost of production from improved labor and capital productivities. Thus, the profit margin from their sales revenue could have been maintained to sustain the market competitiveness. This could explain why SMEs could be able to expand relatively more rapidly than the large-sized enterprises although they have considerable disadvantage in scale efficiency. Moreover, having faced the impact from the global financial crisis and economic recession in 2008, the large-sized enterprises' profit margin reduced by more than 50% and the SMEs' profit margin didn't fall but instead went up slightly from 3.4% to 3.5%. The resilient ability from the SMEs in immunizing their business operation from the adverse impact of global market business volatility could become the long-term competitiveness of China's iron and steel industry in the world market.

The improvement of asset utilization ratio has been absolutely impressive from both large-sized enterprises and SMEs. However, the SMEs have again shown much more impressive improvement. The large-sized enterprises almost doubled their asset utilization ratio from 46.5% in 2000 to 90% in 2004. But they could only manage to keep the ratios around 90% to 100%. Compared to the large-sized enterprises, the SMEs asset utilization ratio achieved a relatively high asset utilization ratio of 97.3% in 2000 already. They could then improve the ratio considerably and manage to keep the ratio around 200%. The much higher asset utilization ratio from the SMEs is part of the reasons for why the SMEs could have achieved much higher ROE with much lower profit margin than the large-sized enterprises. Ultimately, the SMEs have on average committed their investment relatively more on the production technology which not only requires relatively less capital investment but also provides the products that are more demanded from the market. For example, in 2008, the large-sized enterprises produced 91.10% of their crude steel from using the blast furnace and 8.83% from EAF furnace while the SMEs produced 71.62% of their crude steel from using blast furnace and 27.49% from electric arc furnace. Compared to the large-sized enterprises, by producing relatively more crude steel from EAF furnace, SMEs could save more initial fixed capital investment as the size of electric arc furnace is much smaller than the size of blast furnace and achieve higher energy efficiency as well (Fruehan 1998, Drizo et al 2006).

The large-sized enterprises have maintained a stable financial leverage ratio, measured by the asset/equity ratio, of 220% to 250% or a debt/asset ratio of 55% to 60% from 2000 to 2008. The SMEs have used much higher financial leverage to finance their investment and business operation. Their financial leverage ratios increased from 275% in 2000 to as high as 436.3% in 2007, or the debt/asset ratio from 65% to 78%. Compared to the large-sized firms, the higher financial leverage used by SMEs is also part of the reasons for why the SMEs could have managed higher ROE with lower profit margin. The high financial leverage means higher financial cost as well as financial risk. While it has enhanced SMEs' financial performance, it could also expose SMEs to potential high insolvency risk. In 2000, the SMEs only used the debt of RMB 85.4 billion yuan. In 2008, the SMEs' total debt surged to RMB 659.5 billion yuan. The interest question is why the SMEs could be able to obtain such huge debt finance in the China's financial system or why the China's commercial banks were willing to lend so aggressively to the SMEs. It could be due to the great economic performance from the SMEs that has provided safeguard to the lending. It could be also due to the substantial savings from the commercial banks that have been desperately looking for borrowers.

In sum, the dynamics of the China's iron and steel industry in its rapid expansion and transformation from a domestic-oriented industry into a dominant globalized industry are featured from its dynamic changes in industrial structure, productivity and financial performance. The key feature of such dynamics is the surprising surge of SMEs as the key force driving the dramatic global expansion of China's iron and steel industry in the recent decade. The surge of the SMEs is not the kind of massive nation-wide movement of steelmaking through the mushrooming small furnaces in the household backyards in the great-leap-forward period of the late 1950s. Instead, the SMEs have upgraded their scale efficiency dramatically in a short period and demonstrated great ability in improving their productivity as well as financial performance. They have demonstrated impressive catching-up ability. The full exploitation of their "later-comer" advantage could push the China's iron and steel industry into a new high. More importantly, majority of the SMEs are privately owned enterprises which are fully market-oriented and are subject to lee constraint from government administrative control and regulations. The increasing importance of the SMEs has thus considerably changed the landscape of the China iron and steel industry which was once highly dominated by the state-owned enterprises. It could be largely due to the competition from SMEs, the large-sized enterprises have also shown great ability and potentials in improving scale efficiency, productivity and financial performance too. Hence, the dual track expansion from both large-sized enterprises and SMEs has enabled the China's iron and steel industry to quickly grow into a dominant global industry.

4. The new China's export growth model, the new international trade pattern and global imbalance

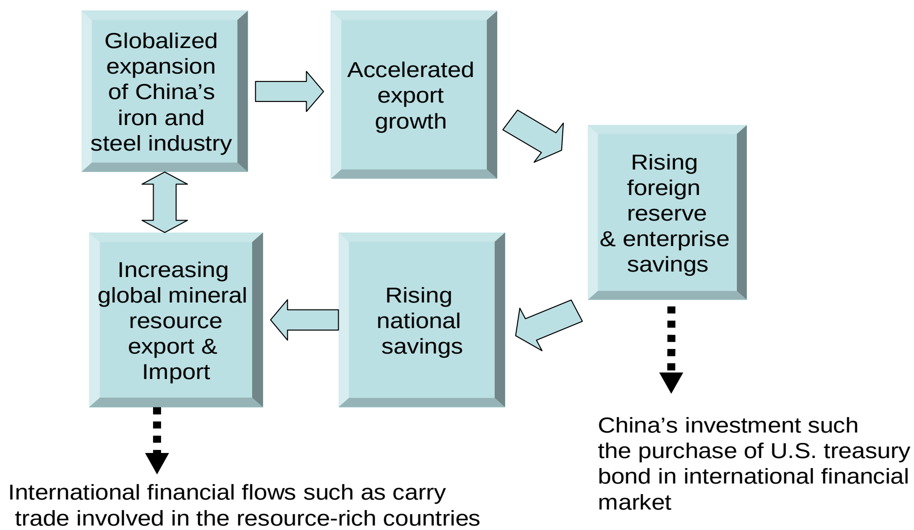
The dramatic expansion of China's iron and steel industry and its transformation from a domestic oriented-industry into a dominant global industry have led to an emerging new model of international trade pattern featured by massive trade flows between resource-rich countries and export-oriented economies such as the Chinese economy. The development of this new model has been driven by the rapid industrial structural change in the China's iron and steel industry. This industrial structural change has evolved great improvement of scale efficiency, productivity and financial performance and has been establishing the China's iron and steel industry as the new leader of world iron and steel industry. As this new model essentially removes the domestic resource constraint for China's export growth, China's export has thus moved into a new stage of strong and sustainable growth. This China's new export growth model has a distinctive difference from the Japanese export growth model. Japan has overcome the limited domestic resource constraint on its export growth largely by relocating most of its export production to overseas through FDI.[4] As these oversea operations basically use the industrial material inputs supplied from the local countries, the Japanese export growth model hasn't created massive trade flows between resource-rich countries and manufacture product export-producing countries. Compared to Japan, China has much bigger territory and more importantly much more abundant labor resource. Hence, China could have export production to be based in China and then import industrial materials from resource-rich countries to sustain its export growth from domestic production. So far, the development of this new China's export growth model shows great potential to mobilize international resources effectively for increasing international trade flows. While the new China's export growth model provides China's export industry a new competitive edge, it also has benefited the resource export countries and the countries which import the competitive China's export products. A new international trade pattern has then emerged in recent decade featured by increasing bilateral trade between China and Australia, Brazil, Russia, India, Indonesia and many other countries.

The impact of the new China's export growth pattern on international trade and financial flows has been viewed by many economists, analysts and commentators as the key reasons for the global imbalance (Ben Bernanke 2007, 2008, Bini Smarghi 2008, Wolf 2008, Greenspan 2010). In their view, China's reliance on export-led growth, accumulation of foreign reserves and domestic savings, and recycling of surplus foreign exchange back into the market for U.S. government bonds and mortgage-backed securities created a "global savings glut". This glut led to artificially low global interest rates and unsustainable build up of debt in the United States. It is hence the root causes of the global financial crisis. They further claim that this global trade and finance imbalance has to be rebalanced. Otherwise, the world economy may not be fundamentally recovered from the current economic recession and instead could potentially get into the next global crisis. **(**Dunaway 2009)**.** Apparently, by having China's increasing export and savings as the root causes of global imbalance, this view has eventually looked at the consequences rather than the causes of the new China's export growth model and the new international trade pattern. It also ignores the benefits of the new international trade pattern that have enjoyed by many countries around the world. With these limitations, this view would not lead to effective measures that could resolve the problems of global imbalance. Instead, it may lead to misleading policies that could substantially reduce the international trade flows. As international trade and financial flows are bilateral, a balanced view is needed to comprehensively evaluate the consequences and causes of the global imbalance from multinational trade and financial flows. In this regard, this study will take a more comprehensive and balanced view by looking at the linkage between China's increasing export and savings and the global expansion of China iron and steel industry that has been the center of the new international trade model.

[4] A study by Bojkova and et al (2009) shows that Japan's FDI has been the most important component of income flows in the Asia Pacific region and contributed to economic integration in East Asia.

Graph 1 presents the logic linkage between China's export and savings and the global expansion of China's iron and steel industry. Based on the above discussion, the global expansion of China's iron and steel industry has greatly facilitated the close linkage between China's export industries and the international resource market. China's export has hence entered into a new stage of accelerated growth so as China's foreign reserve, the export enterprises' savings and national savings. It is important to notice that the China's savings could have been greatly contributed from its accumulated massive export earnings which could exist in the forms of either foreign exchange reserve or enterprises' savings. Since the recent accelerated export growth has been largely benefited from the new export growth model that requires massive resource import, the national savings is closely linked to the increasing China's savings. Graph 1 also indicates how international capital flows will be generated from the new China's export growth model and new international trade pattern as the linkages through the dotted lines. But those capital flows are beyond the scope of this study and will not be addressed but can nevertheless be analyzed in more comprehensive study on global imbalance.

Graph 1: The linkages in the new international trade model



Based on Graph 1, a simple structural model is constructed to better understand the interaction between the new China's export growth model and the global expansion of China's iron and steel industry. The structural model emphases the mutual reliance between China's iron and steel industry, international resource market, export and national savings. This stylized structural model is specified as the follows:

(1) $\text{Export}_t = c(1) + c(2) \times \text{Finished-steel}_t$
(2) $\text{Iron-ore-import}_t = c(3) + c(4) \times \text{Finished-steel}_t + c(5) * \text{National-savings}_{t-1}$
(3) $\text{Finished-steel}_t = c(12) + c(13) * \text{Export}_{t-1}$
(4) $\text{Foreign-reserve}_t = c(6) + c(7) \times \text{Export}_t + c(8) \times \text{National-savings}_t$
(5) $\text{National-savings}_t = c(9) + c(10) \times \text{Enterprise-savings}_t + c(11) \times \text{Foreign-reserve}_{t-1}$

where c(1) to c(13) are the coefficients to be estimated and the definitions of the variables are self-explanatory from their names. Annual data from 1990 to 2009 is used in the regression. The subscript *t* and *t-1* indicate the current year and the past one year respectively. All variables are in terms of China's capacity such as China's export, China's import of iron ore and so on. Equation (1) is to analyze how China's export will be affected by the global expansion of China's production in finished steel products; Equation (2) is to analyze how the global expansion of China's production in finished steel product and national savings will determine the import of iron ore. While the increase in finished steel production lead to the increase in iron ore import, the increase in national savings provide the increasing bank lending resource which can be used to finance the increase in iron ore import. The time lag is applied to the national savings for the consideration that the increase in national savings would lead to the increase in bank lending not simultaneously but with a time delay; Equation (3) shows that the current strong export would lead to higher future demand for the finished steel products. This equation is to test the dynamic linkage between the expansion of China's export and steel production. Equation (4) assesses how China's foreign reserve are determined by China's export and national savings, where export apparently contributes to foreign reserve and the national savings are related to foreign reserve in the way that part of national savings will be eventually going through the foreign exchange reserve to be invested in the international capital market;[5] Equation (5) shows how the rising national savings will be determined by the rising foreign reserve and enterprise savings[6]. A time-lag is applied to foreign reserve implies that the increase in money base from the increase in foreign reserve will later lead to the increase in total national savings through money generation process in the commercial bank system. From the specification of these equations, it is expected that the estimated coefficients of all variables should be positive.

The method of iterative weighted two stage least squares (WTSLS) is used to estimate the coefficients of variables included in the structural model.[7] Since export is for the foreign market and foreign reserves will be invested in foreign securities, their uses are all for the external market. But other variables will not be used all for the external market. For example, part of iron ore import should have been used for producing products consumed purely in the domestic market and the same is for the finished steel products. It is then expected that export and foreign reserve are more directly linked to the external market conditions than other variables. Considering such difference between the variables, all those variables which have less degree of external exposure than export and foreign

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[5] In China's foreign exchange management system, the net foreign exchange earnings from firms and individuals can be converted into Chinese RMB yuan at official exchange rate from China's commercial banks. The converted Chinese RMB yuan will be saved in the banks as firms' and individuals' savings. Correspondingly, the increased foreign reserves from these conversions will be invested in international capital markets.

[6] A study from Fan gang et al (2009) shows that the rapid rise in enterprise savings is the main reason behind the rise in the overall savings rate.

[7] The WTSLS estimator is an appropriate econometric technique used in structural model estimation when some of the right-hand side variables are expected to be correlated with the error terms. As this structural model is a simplified model which does not attempt to specify the comprehensive determinants of the variables, it is expected that some of the right-hand variables could be correlated with the error terms. WTSLS is thus used in the estimation to address such potential estimation problem. The use of WTSLS also solves the problem of heteroskedasticity without contemporaneous correlation in the residuals.

reserves, namely, the iron ore import, finished steel production, national savings, enterprise savings are used as instrument variables in the estimation of WTSLS regression. By doing so, export and foreign reserve are specifically treated as purely endogenous variables which could be affected by all instrument variables. In terms of identification, in each of the equations, the number of excluded exogenous variables appearing is greater than the number of included endogenous variables appearing as regressors, and so in each equation the necessary conditions for identification are satisfied (Koopmans 1953, Rothenberg 1971). The logarithmic forms of the variables are used in the regression. The estimated coefficients are then the elasticities, i.e. the percentage change of the dependent variable over the percentage change of the independent variable. The estimation results are presented in Table 8.

Table 8: The TSLS estimation results of the structural model

Sample: 1990 2009
Included observations: 20
Total system (unbalanced) observations 97
Instruments: C LOG(FINISHED_STEEL) LOG(IRON_ORE_IMPORT)
LOG(ENTERPRISE_SAVINGS) LOG(NATIONAL_SAVINGS)

	Coefficient	Std. Error	t-Statistics	Prob.
C(1)	-3.622432	0.281075	-12.88779	0.0000
C(2)	1.189053	0.028871	41.18481	0.0000
C(3)	-3.376131	0.190740	-17.70016	0.0000
C(4)	1.141145	0.055107	20.70765	0.0000
C(5)	0.128712	0.043439	2.963026	0.0040
C(6)	3.143834	0.202615	15.51630	0.0000
C(7)	0.844700	0.025679	32.89479	0.0000
C(8)	-7.309015	0.390001	-18.74102	0.0000
C(9)	0.729550	0.119004	6.130485	0.0000
C(10)	0.830340	0.110846	7.490960	0.0000
C(11)	2.962676	0.489931	6.047132	0.0000
C(12)	0.635699	0.093612	6.790764	0.0000
C(13)	0.180202	0.068711	2.622615	0.0104
Determinant residual covariance		1.70E-11		

Equation: LOG(EXPORT)=C(1)+C(2)*LOG(FINISHED_STEEL)
Observations: 20

R-squared	0.988346	Mean dependent var	7.912871
Adjusted R-squared	0.987699	S.D. dependent var	1.000994
S.E. of regression	0.111021	Sum squared resid	0.221861
Durbin-Watson stat	1.113421		

Equation: LOG(IRON_ORE_IMPORT)=C(3)+C(4)*LOG(FINISHED_ST
EEL)+C(5)*LOG(NATIONAL_SAVINGS(-1))
Observations: 19

R-squared	0.995863	Mean dependent var	9.156197
Adjusted R-squared	0.995346	S.D. dependent var	1.055808
S.E. of regression	0.072026	Sum squared resid	0.083003
Durbin-Watson stat	1.614615		

Equation: LOG(FINISHED_STEEL01)=C(6)+C(7)*LOG(EXPORT(-1))
Observations: 19

R-squared	0.982572	Mean dependent var	9.761983

Adjusted R-squared	0.981547	S.D. dependent var	0.813317
S.E. of regression	0.110482	Sum squared resid	0.207505
Durbin-Watson stat	0.558769		

Equation: LOG(FOREIGN_RESERVE0)=C(8)+C(9)*LOG(EXPORT)
+C(10)*LOG(NATIONAL_SAVINGS)
Observations: 20

R-squared	0.992491	Mean dependent var	7.515583
Adjusted R-squared	0.991608	S.D. dependent var	1.611411
S.E. of regression	0.147617	Sum squared resid	0.370442
Durbin-Watson stat	1.718969		

Equation: LOG(NATIONAL_SAVINGS)=C(11)+C(12)*
*LOG(ENTERPRISE_SAVINGS)+C(13)*LOG(FOREIGN_RESERVE
(-1))
Observations: 19

R-squared	0.996705	Mean dependent var	11.00815
Adjusted R-squared	0.996293	S.D. dependent var	0.985221
S.E. of regression	0.059985	Sum squared resid	0.057570
Durbin-Watson stat	1.539456		

The estimation provides the expected positive signs of the coefficients for all variables. As showing by the estimated t-statistics, all the estimated coefficients are statistically significant at the 1% significance level. The value of the determinant residual covariance is close to zero (1.7E-11), suggesting that the estimates are efficient (Greene 2002). The values of the estimated variable coefficients are between 0.180 and 1.189 which are the meaningful values of elasticities.

In the estimated equation (1), the estimated coefficient is 1.189 which suggests that the change of finished steel production in China by 1% will lead to 1.189% change in China's export. This result supports the above finding that the expansion of China's iron and steel industry has been closely associated with China's export growth. In the estimated equation (2), the estimated coefficient for finished steel production is 1.141, meaning that 1% increase in China's finished steel production will lead to 1.141% increase in China's iron ore import; the estimated coefficient for national savings is 0.129, meaning that 1% increase in national savings will lead to 0.129% increase in iron ore import. The relatively small elasticity value from the coefficient of national savings is expected as the national savings should only have relatively partial impact on iron ore import. In the estimated equation (3), the estimated coefficient of the lagged export variable is 0.844, suggesting that there is a dynamic linkage between China's export and steel production, i.e. 1% in crease in the current export would lead to the expected increase of steel production by 0.844%. These three equation estimations support the above finding on the dynamics of global expansion of China's iron and steel industry: the expansion of China's iron and steel industry has greatly facilitated China's iron ore import and manufacturing product export and lead to a new China's export growth model and a new international trade pattern that combine the resource-rich countries' resource and China's manufacturing capacities for accelerated growth of international trade flows.

In the estimated equation (4), the estimated coefficients for export and national savings are 0.729 and 0.830 respectively, suggesting that the increases in both export and national savings contribute to the increase in foreign reserve considerably. This result generally supports the view of global imbalance that the increase of China's export and national savings has lead to the increase in international liquidity through the investment of China's foreign reserves in the international capital market. In the estimated equation (5), the estimated coefficient of the enterprise savings is 0.636, suggesting that enterprise savings contribute to national savings considerably. The estimated coefficient of the lagged foreign reserve is 0.180, supporting the above view that the increase in current foreign reserve corresponds to the increase in money base which will ultimately lead to future money supply increase and hence national savings through money generation process in commercial bank system.

In sum, the statistic significance of the estimation result suggests that the linkage between each of the variables in the structural model is very close. It thus verifies that there is a close linkage between the global expansion of China's iron and steel industry through the new China's export growth model, the new international trade pattern, foreign reserve and savings.

5. Conclusion and policy implication

The global expansion of the China's iron and steel industry in the past decade has transformed itself from a domestic-oriented industry into a dominant international industry in the world steel and iron ore market. This transition has been greatly facilitated by the improvement of scale efficiency, productivity and financial performance in the China's iron and steel industry. The dynamic expansion of private small and medium-sized enterprises has enhanced the industry's competitiveness in its global expansion. The rapid global expansion of China's iron and steel industry has closely linked to the new China's export growth model of using imported industrial materials to produce export products. While this new export growth model has effectively removed domestic resource constraint from China's export growth and thus contributed to accelerated China's export growth, it has also evolved massive trade and financial flows between China and resource-rich countries. China's surging export, foreign reserve and savings in recent decade have thus directly linked to the new China's export growth model and the new international trade pattern. Such deepening integration of China's export industry with the world economy has enabled China's export industry to transit from reliance on cheap labor in producing assembly processing products to the production of non-assembly processing products with its upgrading production capacity and improved economic efficiency. The global expansion of China's iron and steel industry is the important development in this transition process. The implication of the rapid global expansion of China's iron and steel industry is that China's surging export and foreign reserve in recent decade has been the result of such transition and the deepening integration of China's export industry with the world economy. Yes, China is the "world manufacturing hub". This "world manufacturing hub" is becoming bigger and bigger as it has been consistently evolving its production capacity upgrading and its integration with world resources. Then we have the growing concern on global imbalance!

The options for correcting global imbalance are not as simple as reducing China's export, foreign reserve and savings. From China's aspect, its massive export production capacity, which also includes its iron and steel industry, transportation industry and many other industries supporting the export productions, have long been established for the world demand and thus could not simply be changed for the domestic demand in a short period or most likely even for decades. From the world market's aspect, China's export growth has become an integral part of the world economic structure and could not simply be substituted in a short period too. Any simplistic approach of trying to deter China's export growth could not only slow down China's economic growth but also bring dramatic damage on international trade and financial flows and, ultimately, slow down the world economic growth too. A more effective policy option has to be relied on the understanding of global imbalance from a more systematic and balanced view.

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