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Journal: Interdisciplinary Environmental Review

ISSN: 1521-0227

Year: 2012

Volume: 13

Issue: 4

Pages: 279-293

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http://dx.doi.org/10.1504/IER.2012.051438

Is Structural Change Taking Place in China's Export Sector? An Analysis of Employment and Energy Consumption Effects[1]

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[1] We are grateful to AusAID for providing financial support for this study under the Australian Leadership Awards Fellowships Program.

Abstract

This paper investigates how changing structure of Chinese foreign trade has impacted on employment and energy-intensity in recent years. Our findings indicate a considerable fall in both employment and energy intensity. A fall in employment intensity appears to be mainly due to an increase in the exports of assembly items which are relatively less unskilled employment intensive, while a decline in energy consumption per billion yuan worth of exports appears to be due to increased use of energy saving technology as the price of energy rises and the pressure for improving Chinese environmental standard grows. While a fall in energy consumption is a welcome development, overall environmental standards in China remain a major concern not only for the Chinese but globally. The paper also suggests that increased investment in human capital is part of the answer to increasing employment in the modern economy while minimising damage to the environment.

I. Introduction

China has become the world's 'manufacturing base' since the opening up of the economy in the late 1970s. Its accession to the World Trade Organization (WTO) in November 2001 provided further impetus to economic growth. The WTO membership not only provided China with most-favoured nation (MFN) status in major markets but also enhanced China's attractiveness to export-oriented investment by reducing the country's investment risk and further attracting multinational companies to invest in China. These developments led to the spectacular developments in its gross domestic products (GDP) and export sector. Over the last two decades China has experienced, in real terms, an average annual growth of nearly 10 percent in GDP and 20 percent in exports - all largely attributed to the opening up its economy. China is now gradually moving away from the exports of traditional labour intensive exports such as agricultural products, toys and garments to electrical and electronics products. Rapid growth, in both production and exports, naturally increases the demand for both labour and energy consumption. While the former is a positive development (helping to reduce poverty), the latter, it is argued, adds to existing environmental concerns both within and outside of China. As China continues to grow, so too does its energy consumption (Appendix I).[2]

In this paper we use the Chinese Input-Output (IO) tables for 1995 and 2005 (the latest year for which Input-Output data is available) and data on employment and energy consumption to investigate how China's growth has impacted on these two variables with a view to ascertaining if the current pattern sustainable? The paper is organised as follows: Section II documents reforms in trade and investment policy in China and its trade performance over the last two decades. Section III reviews the literature while in section IV we discuss methodological and data issues before presenting the results of our analysis. Section V concludes with the policy implications of our findings.

[2] Between 1992 and 2010 energy consumption rose from 987.03 million to 3250.00 million tons of Standard Coal Equivalent.

II. Overview of the Nature of Policy Reform and Trade Performance

(a) Policy Reforms

China had an inward oriented Soviet style economic regime until the mid 1970s. During the inward-oriented regime, foreign trade and investment was regulated by State-owned enterprises (SOEs). It was only after 1978 that liberalisation of trade and investment commenced when Deng Xiaoping opened up the economy, mainly for foreign export-oriented firms, in response to the shortage of foreign currency resulting primarily from the relaxation of import restrictions for domestic firms. To facilitate the development of export-oriented firms, four special economic zones (SEZs) were created along the southeast coast - Shenzhen, Zhuhai, Xiamen and Shantou - in 1980. In 1984, another fourteen SEZs were established as they became increasingly attractive, notwithstanding lingering concerns about the recognition and protection of private property and the industrial dominance of SOEs.[3] In the event, such concerns proved to have little substance. Legislative protection of the property rights of foreign firms was guaranteed in 1982 and the influence of SOEs was rapidly eroded by a burgeoning private sector. Both developments acted to build the confidence of foreign investors (Jiang et al. 2009).

By the mid 1980s, export subsidies had been introduced and the Chinese currency (RMB) was significantly devalued - from RMB 1.7 to the US dollar in 1981 to RMB 2.9 to the dollar in 1985 (Dwight, 1994).[4]. In the early 1980s and early 1990s, SEZs were extended to three deltas—the Pearl River Delta, the Minnan Delta and Yangzi River Delta—and the Hainan province and the Pudong New Area in Shanghai. Foreign firms located in SEZs were granted preferential tax treatment (an income tax-holiday for the first two years followed by a 50 per cent discount on income tax for a further three years). In addition, some provinces offered additional tax incentives and lower land-use fees to attract export oriented foreign investment. By the early 1990s, the central government had acted to permit 100 per cent foreign ownership of foreign-investing enterprises and amended the joint venture (JV) law to permit JV terms to extend beyond 50 years. Furthermore, foreign firms were allowed to

[3] These include Dalian, Qinhuandao, Tianjin, Yantai, Qingdao, Lianyungang, Nantong, Shanghai, Ningbo, Wenzhou, Fuzhou, Guanghou, Zhanjiang, and Beijing. In 1990, the concept of SEZ was extended to Shanghai Pudong New area (Chen et al. 1995).
[4] Reforms undertaken until the early 1990s are well documented in Dwight (1994).

operate in more sectors than domestic private firms, clearly demonstrating China's commitment to openness.[5]

In 1992 the government relaxed a number of sectoral and regional barriers relating to foreign investment, decentralised approval authority from the central government to local governments and entered into agreements with the United States to open up its market and protect intellectual property rights vigorously (Lardy 1992 and 1994). Together with a gradual reduction in tariffs, removal of non-tariff barriers and privatisation of many SOEs these changes assisted China's accession to WTO membership in November 2001. By 2009, the average manufacturing tariff in China was about the same as in many advanced countries (about 5 percent) and China no-longer applied non-tariff measures except in a few areas of national security. Trade as percent of GDP, which is widely used as an indicator of openness, rose from 30 percent in the late 1990s to 51 percent by 2010. Following its accession to the WTO, China also pursued a number of Free Trade Agreements (FTAs). China's first FTA was signed with Chile (China-Chile Free Trade Agreement) in November 2005. Currently, China has 15 FTAs involving 28 national economies. Both WTO membership and the development of bilateral FTAs have been major factors in convincing foreign investors that China is committed to integrating its economy with the rest of the world. The changes have not only provided opportunities for China to enjoy most-favoured nation (MFN) status in the world markets, but have also helped attract export-oriented investment by reducing the country's risk for foreign investors.

(b) Trade Performance

China's ongoing transformation, from planning to market-oriented economy and from agricultural to manufacturing and service-based economy, has transformed the country into a major economic power in the last four decades. By the end of 1990s, growth and development in China had impacted every country in the world and given rise to a widely held view that China's industrial dominance, following accession to the WTO in 2001, would severely weaken the manufacturing base of many countries - including the smaller developing economies of Asia (Athukorala, 2009). However, this 'China fear' soon proved to be groundless as China's imports from the rest of the world (mainly imports of parts and

[5] As noted by the Vice-chairman of the National Peoples Congress by 2002 about 60 sectors were open for foreign investment enterprises as against only 40 for domestic private sector firms (see, Huang and Di (2004) for further discussion on the bias in favor of foreign firms and SOEs in China's policy regime).

components for assembly and subsequent exports) increased rather than decreased.[6] Indeed, China's growing interdependence with the rest of the world has created a win-win situation for both developed and developing countries.

Between 1990 and 2010, China's GDP grew 15 fold, from US$390 billion to US$5,878 billion, while exports rose from US$62 billion to US$1,578 billion (around 12 percent of world exports). In the first half of this period exports grew at 14 percent per annum on average. However, between 2001 and 2010, and notwithstanding the impact of the Global Financial Crisis (GFC) in 2009 when exports fell for the first time in many years, exports grew at an astounding 21 percent per annum on average. Since 2005, export growth has substantially outstripped import growth resulting in massive net trade surpluses (equal to about 3 percent of China's GDP by 2010). One reason for this is the dramatic increase in imports of parts and components for re-export after domestic processing and value adding utilising China's abundant labour.[7] Most assembly activities are undertaken by foreign investment enterprises which have increased phenomenally in China post-WTO with FDI inflows rising from just over US$3 billion in 1990 to about US$106 billion by 2010. With its ever-increasing balance of payments surplus, China has accumulated a foreign exchange reserve which is equivalent to more than two years' worth of imports.

Over the years, the composition of Chinese exports and imports has changed dramatically. For instance, its exports of primary products have fallen while that of manufactured goods has increased rapidly. In the early 1990s, exports of primary goods (mainly food, mineral fuels and crude materials, which were relatively pollution intensive) accounted for about 22 percent of Chinese exports. By 2010, this had fallen to about 5 percent (Table 1). This decline is compensated for by the growth in high value-added manufactured exports whose share rose to 95 percent by 2010. In particular, the export share of machinery and transport equipment (SITC 7 group) surged from about 10 percent of total exports in 1991 to 49 percent by 2010 (Table 1). This change in the composition of exports derives primarily from China's growing involvement in 'assembly trade' (Athukorala, 2008 and Dean et. al., 2009) as reflected in its bilateral trade with both developed and developing countries. For example, in 2007 over 62 percent of China's exports to the US and 57 percent to Japan were assembly exports. On the other hand, about 20 percent of its imports from the newly industrialised countries of Asia (South Korea, Taiwan and Hong Kong) and ASEAN (mainly from Malaysia, Singapore, Thailand and Indonesia), as well as a significant proportion of its imports from the US, Japan

[6] About 70 percent of Chinse imports now consist of a large number of parts and components.
[7] Note that the share of parts and components in total imports of machinery and transport equipment (SITC 7 group) in China rose from 32 percent in the early 1990s to about 70 percent by 2010.

and EU countries, involved parts and components for processing into finished products. China's success in assembly trade has been facilitated by its open door policy, excellent physical infrastructure (including ports) and well-disciplined labour force.

The share of the more pollutant associated exports, such as chemicals and manufactured goods chiefly classified by materials (e.g. textiles, rubber products, pulp of wood, and leather products, etc.) has remained relatively constant. Although this is a welcome development, the overall pollution brought about by China's rapid urbanisation and industrialisation remains a major concern.

Table 1: Composition of Exports by SITC, China: 1991-2010 (value in billion US$)

Category	1991	1995	2001	2005	2008	2009	2010
Total Value of Export (USD)	71.91	148.78	266.1	761.95	1430.69	1201.61	1577.93
Total (% share)	100	100	100	100	100	100	100
Primary Goods (% share)	22.47	14.44	9.9	5.46	5.45	5.25	5.18
Food and Live Animals Chiefly for Food	10.06	6.69	4.8	2.65	2.29	2.71	2.51
Beverages and Tobacco	0.73	0.92	0.33	0.12	0.11	0.13	0.12
Crude Materials, Inedible, Except Fuels	4.85	2.94	1.57	0.81	0.79	0.68	0.73
Mineral Fuels, Lubricants and Related Materials	6.62	3.59	3.16	1.83	2.22	1.7	1.8
Animal and Vegetable Oils, Fats and Waxes	0.21	0.3	0.04	0.04	0.04	0.03	0.02
Manufactured Goods(% share)	77.53	85.56	90.1	94.54	94.55	94.75	94.82
Chemicals and Related Products	5.32	6.11	5.02	4.6	5.55	5.16	5.57
Manufactured Goods Classified Chiefly by material	20.12	21.67	16.46	18.04	18.34	15.38	16.13
Machinery and Transport Equipment	9.95	21.11	35.66	47.1	47.06	49.12	49.03
Miscellaneous Manufactured Articles	23.13	36.66	32.74	24.56	23.48	24.95	24.01
Products not Classified Elsewhere	19.01	0.01	0.22	0.24	0.12	0.14	0.08

Source: Based on China Trade and External Economic Statistical Yearbook, China Statistics Press, Various Years. Data for 2010 is estimated.

Chinese imports have also witnessed a structural change over the last two decades (Table 2). Significant changes have been observed in imports of both primary products and manufactured goods. The share of primary goods in total imports rose from 17 percent in the early 1990s to 31 percent by 2010, while that of manufactured goods fell from 83 percent to 69 percent during this period. About 82 percent of the increase in imports of primary goods is due to a rise in imports of crude materials and fuels driven by China's rapid urbanisation and industrialisation.. The combined share of these two product groups rose from 11 percent in 1991 to about 29 percent by 2010. On the other hand, the fall in manufactured mainly came from a fall in imports of chemicals and manufactured goods chiefly classified by materials,

while imports of machinery and transport equipment increased from 31 percent in 1991 to 39 percent in 2010.

Table 2: Composition of Imports by SITC, China: 1991-2010 (value in billion US$)

Category	1991	1995	2001	2005	2008	2009	2010
Total Value of Import (BnUSD)	63.79	132.08	243.55	659.95	1132.56	1005.92	1394.83
Total (% share)	100	100	100	100	100	100	100
Primary Goods (% share)	16.98	18.49	18.78	22.38	32	28.81	30.94
Food and Live Animals Chiefly for Food	4.39	4.65	2.04	1.42	1.24	1.48	1.56
Beverages and Tobacco	0.31	0.3	0.17	0.12	0.17	0.19	0.15
Crude Materials, Inedible, Except Fuels	7.84	7.69	9.09	10.64	14.72	14.05	14.88
Mineral Fuels, Lubricants and Related Materials	3.31	3.88	7.17	9.69	14.94	12.33	13.76
Animal and Vegetable Oils, Fats and Waxes	1.13	1.97	0.31	0.51	0.93	0.76	0.59
Manufactured Goods (% share)	83.02	81.51	81.22	77.64	68	71.19	69.06
Chemicals and Related Products	14.54	13.1	13.18	11.78	10.52	11.14	10.78
Manufactured Goods Classified Chiefly by Material	16.45	21.78	17.22	12.3	9.46	10.71	9.51
Machinery and Transport Equipment	30.73	39.85	43.94	44.01	39.01	40.54	39.48
Miscellaneous Manufactured Articles	3.82	6.25	6.19	9.22	8.62	8.47	8.23
Products not Classified Elsewhere	17.48	0.53	0.69	0.3	0.39	0.33	1.06

Source: Based on China Trade and External Economic Statistical Yearbook, China Statistics Press, Various Years. Data for 2010 is estimated.

Rapid economic growth has led to a rise in energy consumption in China and it is unable to meet its growing energy demand from domestic production – reflected in a continuous rise in imports of fuels, lubricant and related materials. Having become a net importer of natural resources in by the turn of the century, China became the third largest importer of fuel (US$ 330.3 billion in 2008) after the United States and Japan. Fuel imports increased, on average, by 30.0 percent annually from 2000 to 2008. This trend is likely to continue as growth in China continues. With the rapid increase in imports of mineral fuels and crude materials (which are highly pollution intensive), China may become a net exporter of pollution, i.e. a country that transfers more pollution costs to the other countries, even when considering its tremendous trade surplus. Fortunately, most of China's imports of natural resources are from advanced countries like Australia which can produce them more efficiently and thereby causing less damage to the global environment.[8] If Australia can produce such resources more energy efficiently than China (or other countries), which is most probably the case, this

[8] In 2008, Australia was the largest supplier of China's imports of natural resources. China's import of natural resources from Australia reached US$33 billion by 2008, growing at the average annual rate of 39 percent since 2000.

transfer of pollution cost is not only good for China, but also beneficial for the global environment in aggregate.

III. Literature Review

China's rapid economic growth and the resulting impact on China's employment and energy consumption has attracted increasing attention in recent years. Fu and Balasubramanyam (2005) using the Smith-Myint "vent for surplus" model found that export growth had led to an employment intensive production pattern in China, while Xikang et al, (2008) observed that export growth had resulted in an increase in total domestic value added and domestic employment, and that non-processing exports had higher total domestic value added and domestic employment effects than processing exports. Wei (2011) investigated the relationship between textile exports and employment, based on data from 1980 to 2007, and found that export was a major determinant of employment in the long-term and short-term, with the short-term effect much higher than the long-term. Hao (2011), on the other hand, examined the relationship between net exports and employment growth using manufacturing industry data for 2004 to 2008 and found that with a growing trade surplus in China, a further increase in surplus would not increase the level of employment, and might even result in a decline in employment. Utilising on input-output (IO) tables and data from forty Chinese industries from 1997 to 2007, Rui (2010) examined the impact of domestic consumption, investment and trade on employment. The research found that domestic demand expansion in non-tradable goods was the reason for employment growth and the effect of export expansion on employment showed a downward trend.

Using the 2000 IO tables, Feenstra and Hong (2007) analysed the link between export success and employment generation in China. They concluded that exports had become increasingly important in stimulating employment in China, but argued that similar gains could have been obtained from growth in domestic demand - especially for the tradable goods sector. An extended econometric model was employed by Juan, Xiaobing, Zhang Jian-wu (2010) to investigate the effect of international trade on manufacturing employment in China during the period 2001-2008. They found that export and domestic demand had significant effect on employment and that the effect of exports on employment was larger than that of domestic demand.

With respect to the energy consumption effects of the Chinese growth pattern, Zhang and Lahr (2011) used the structure decomposition approach to establish the link between energy intensity and export growth between 1997 and 2007. They showed that growth in China's exports explained more than half of its increase in energy consumption. Similar results were obtained by Li (2010) and Binchang (2006). However, Ackerman (2009) found that China's export success was based on labour costs, not carbon emissions; concluding that there was literally no correlation between carbon intensity and revealed comparative advantage within the Chinese economy.

III. Methodology, Data and Results

(a) Methodology and Data

In this section we outline our methodology for capturing the effects of China's growth on employment and energy consumption using I-O analysis and data for 1995 and 2005. The I-O technique is useful for estimating the impact of exports at a point in time and for capturing flow-on effects. The I-O tables for this study are obtained from the Chinese National Bureau of Statistics (CNBS). To ensure comparability over time, the 1995 table was inflated to 2005 prices using the appropriate price indices obtained from CNBS. Energy consumption data was sourced from the Environmental Statistical Annual Report (Ministry of Environmental Protection) and Chinese Statistical Year Book (CNBS).

(b) Result and Discussion

Table 3 presents employment (e), energy (en) and income (Y) flow-on multipliers for the years 1995 and 2005. There are two parts to each of these multipliers. The first part (PI) includes all of the production induced effects of changes in sales to final demand in each sector. It includes both first round purchases made by each industry sector from all other intermediate sectors and second and subsequent round purchases from intermediate sectors. For example, a one unit direct increase in employment in the export industry would indirectly produce an additional 1.6 jobs in the export support industries in 2005 through the production induced effects.(i.e.2.6 minus 1 initial job gives 1.6 production induced flow-on jobs.) The second part (CI) is the consumption induced effect of local production determining local income which in turn influences the level of local consumption thereby impacting on local

production. For example, a one unit increase in employment in the export industry in 2005 would induce a further rise of employment in the economy of 1.6 jobs as a consequence of higher household incomes inducing higher household consumption. The total flow-on multiplier (TFM) is the sum of production induced and consumption induced multipliers and the multiplier minus 1 show the total additional jobs created in the economy as a result of an increase of one job in the export industry.

As shown in the Table 3, TFM(e), the total flow-on multiplier for employment, rose dramatically over the period (from 3.3 to about 5.2) largely due to an increase in CI(e). The change in CI(e) reflects the enormous increase in household income in the decade under consideration which, notwithstanding the high and rising household savings ratio, has still operated to substantially raise consumption as the marginal propensity to consume is positive (even if less than the average propensity to consume). Although of a slightly smaller magnitude, the change in TFM(en) and TFM(Y) were also significant. Once again this was largely the result of the rise in CI(en) and CI(Y).

Table 3: Multiplier Effects of Exports

	1995			2005		
	PI	CI	TFM	PI	CI	TFM
Employment Multiplier (e)	2.5692	0.775	3.3442	2.551	2.6296	5.1806
Energy Multiplier (en)	1.9058	0.2578	2.1636	2.5576	1.028	3.5856
Income Multiplier (Y)	1.7574	0.2813	2.0387	1.9739	1.7111	3.6850

However, notwithstanding the increase in the values of all TFMs between 1995 and 2005, the economic impact of a one billion *yuan* (1Yb) increase in exports has declined considerably over the period with respect to employment and energy. This is explained in Table 4 where the impact of export expenditure on each of employment and energy is broken down into (1) the Initial affect of export expenditure (IE); (2) the Production Induced effect (PIE) and (3) the Consumption Induced effect (CIE).

With respect to employment, the Initial effect (IE) of 1Yb worth of exports on the number of jobs (employment) created, exhibits a considerable decline from 14,568 in 1995 to 5,966 in 2005. This drop in the initial employment impact of a rise in exports appears to be due to the structural change in Chinese exports previously discussed. China has increasingly moved

away from exports of labour-intensive goods (e.g. garment manufacturing) to assembly items which are relatively less employment intensive (e.g. cars). By 2007, assembly items dominated, accounting for about 70 percent of China's exports (compared with only 25 percent in the 1990s) (UN Comtrade Data base). The initial impact on employment of this change was so powerful that it could not be offset by the rise in CI(e) and the constancy in IS(e) (and, by implication, the rise in TFM(e)). When all of IE(e), PIE(e) and CIE(e) are considered, the total effect (TE) of 1bY of exports is a decline between 1995 and 2005 in the potential impact on employment of about 42 percent (from 63,288 jobs down to 36,873 jobs).

Table 4 exhibits a similar pattern with respect to energy consumption. With regard to energy consumption the impact of a 1 Yb increase in exports in 2005 would have resulted in a rise in energy consumption which was 32 percent less than would have been the case in 1995. The decline in energy consumption impact of a rise in exports is consistent with the overall improvement in energy efficiency in China as shown in Appendix 1 where in 1995 $1 billion of GDP on average required 1.8 million tons of SCE while in 2005 it only required 1.05 million tons of SCE. This has been achieved by new investment both foreign and domestic and as a response to the increasing price of energy and pressure for higher environmental standards both domestically and internationally.

Table 4: Economic Impact per 1Yb of Exports

		IE(1)	PIE(2)	CIE(3)	TFE (2 + 3)	TE (1 + 2 + 3)
Employment per Yb Exports	1995	14,568	37,429	11,291	48,720	63,288
	2005	5,966	15,219	15,688	30,907	36,873
	Change%	-59.04	-59.34	39.94	-36.56	-41.73
Energy per Yb Exports	1995	5.47	10.43	1.41	11.84	17.31
	2005	2.60	6.60	2.70	9.20	11.80
	Change%	-52.72	-36.53	92.85	-22.03	-31.79

While there have been improvements in energy efficiency they do not fully offset the improvements in labour productivity. This trade-off is important for China in terms of its policy of using export growth to increase employment in the modern economy while at the same time minimising the additional energy consumption and resulting pollution associated with the increased employment.

Table 5

Export energy consumption (Tons of SCE) per unit of employment

	IE	PIE	CIE	TE
1995	375.4	278.6	124.8	273.5
2005	435.8	433.6	172.1	320.0

Table 5 shows energy consumption associated exports for the 2 periods including the production induced and consumption induced multiplier effects. The table shows that energy consumption per employee is highest in the exporting industries themselves (IE) and that energy consumption per employee has risen between the 2 periods. This is consistent with relatively more capital investment in the exporting industries and these industries becoming less labour intensive over time. In 1995 the production induced flow-on industries (PIE) that supply inputs into the export industries required less energy per worker than the export industries. However by 2005 energy consumption per worker in PIE was almost as high as IE. This result is consistent with technology and investment trickling down from the export industries to the rest of the Chinese economy. In both periods the consumption induced flow-on industries (CIE) require less than half the energy per employee that is required by IE and PIE. This is partly due to less investment in these industries as they are further removed from the export industries. More importantly the CIE have a much greater concentration of service industries which for the most part require far less energy per employee than the goods sectors.

This analysis has important implications for China's management of the trade-off between employment growth and energy consumption growth. Specifically the larger the CIE component of any increase in total employment including flow-on effects from an increase in exports the smaller will be average energy required for the new employment created. The CIE component of employment associated with exports has increased from 18% in 1995 to 42% in 2005. This is the consequence of higher wages for workers resulting in workers spending more in the domestic economy. This trend can continue if wages continue to increase which is possible through increasing the skill intensity of Chinese workers and investing in human capital. Thus increasing human capital in China is part of the answer to achieving rapidly increasing employment in the modern economy, which is moving away from traditional unskilled labour-intensive sectors (such as textile, toys) to assembly line activities dominated by ICT products, without excessive damage to the environment.

However investment in human capital is only part of the answer to the dilemma between employment and environmental standards. As international pressure for China to address environmental standards has been applied, China has responded by putting in place a number of policies. In 1998 the Chinese government changed the name of the State Environmental Protection Bureau to the State Environmental Protection Administration (SEPA), and elevated it to the ministerial level where it was given responsibility for exercising overall supervision and management of China's environmental protection strategies. By the end of 2005, the State had promulgated over 800 national environmental protection standards. There are now 3,226 environmental protection administration departments at different levels across China, with 167,000 people engaging in environmental administration, monitoring, scientific research, publicity and education. Between 1996 and 2004, China's investment in environmental pollution control reached 952.27 Yb, amounting to one percent of that period's GDP. In 2006, expenditure on environmental protection has been formally itemized in the State's financial budget. On November 26, 2009，the Chinese government formally announced its goal of controlling the greenhouse gas emissions, and decided that, by 2020, the GDP/unit carbon dioxide emissions should drop by 40-45 percent from its 2005 level. The "Outline of the 12th Five Year Program (2011-2015)" set a controlling target of energy consumption, for the first time, of 4.1 billion tons of SCE for 2015 This would mean an annual increase of 4.8 percent during the 12th Five Year period, compared with an average of 5.8 percent since 1980.

While China’s reliance on energy consumption is growing due to the rapid economic growth experienced over the past few decades, its export sector—which is largely dominated by manufacturing (including textiles, machinery and equipment, and other manufacturing) and agriculture—is in fact less energy intensive than the construction industry(see, Appendix II) which is also part of China’s growth.

V. Conclusion

China’s rapid economic growth over the past four decades has lifted millions of people out of poverty and it is now viewed as a major economic power in the global economy. While some attribute this impressive growth performance to lower labour and environmental standards, there is now sufficient evidence to suggest that its superior growth performance was largely due to trade liberalisation attempts that began in the late 1970s (Athukorala, 2008). China’s accession to the World Trade Organisation further enhanced its growth performance by

providing most-favoured nation (MFN) status in major markets and building its image as a credible nation for investment.

China has now moved away from the exports of traditional labour-intensive exports (such as, agricultural products, toys and garments) to electrical and electronics products which require relatively semi-skilled rather than unskilled labour. In this paper we have focused on how the change in the structure of China's exports has impacted on both employment and energy consumption. Our findings indicate a considerable fall in both employment and energy intensity. The fall in employment intensity appears to be mainly due to an increase in the production of assembly items for export which are relatively less unskilled employment intensive. By 2007, assembly items dominated, accounting for about 70 percent of China's exports compared to only 25 percent in the 1990s. The decline in energy consumption per Yb worth of exports appears to be due to increased use of energy saving technology as the price of energy rises and the pressure for higher environmental standard grows as well as a switch to the production of exports that are less energy intensive.

While a fall in energy consumption is a welcome development, overall environmental standards in China remain a major concern. Policy makers therefore need to focus on policies (such as taxes and incentives) that will result in a lowering of energy consumption without hindering China's competitive advantage in labour intensive production. Declining employment per unit of exports has raised some concern among Chinese policy makers that employment growth required to maintain jobs for an ever increasing labour supply, will be less likely to be generated through export growth unless China places a heavy emphasis in developing its human capital. As China continues to move increasingly towards processing trade and is playing an important in global production sharing, there is a need to increase skill intensity among the Chinese unskilled labour. In turn this will increase wages and induce domestic spending that creates jobs requiring much less energy per job than does the export sector.

Appendix I: Key Economic Performance, China: 1990-2010

Year	GDP (Billion USD)	Export (Billion USD)	Import (Billion USD)	Balance (Billion USD)	Reserve (Billion USD)	FDI Inflow (Billion USD)	Energy Consumption (Million Tons of SCE)	Employ-ment (Million Persons)
1990	390.28	62.09	53.35	8.74	11.09	3.49	987.03	567.40
1995	727.95	148.78	132.08	16.70	73.60	37.52	1311.76	623.88
2000	1198.48	249.20	225.09	24.11	165.57	40.72	1455.31	711.50
2001	1324.81	266.10	243.55	22.55	212.17	46.88	1504.06	730.25
2002	1453.83	325.60	295.17	30.43	286.41	52.74	1594.31	737.40
2003	1640.96	438.23	412.76	25.47	403.25	53.51	1837.92	744.32
2004	1931.65	593.32	561.23	32.09	609.93	60.63	2134.56	752.00
2005	2256.92	761.95	659.95	102.00	818.87	60.33	2359.97	758.25
2006	2712.92	968.94	791.46	177.48	1066.34	63.02	2586.76	764.00
2007	3494.24	1217.78	955.95	261.83	1528.25	74.77	2805.08	769.90
2008	4519.95	1430.69	1132.56	298.13	1946.03	92.40	2914.48	774.80
2009	4990.53	1201.61	1005.92	195.69	2399.15	90.03	3066.47	779.95
2010	5878.26	1577.93	1394.83	183.10	2847.34	105.74	3250.00	

Source: Compiled by the authors based on data is from the IMF Database (GDP figures) and the National Bureau of Statistics of China.

Appendix II: Trade Structure and Energy Co-efficient 2005

Sector	% of Export	% of Import	Energy Co-efficient
Agriculture	0.9	2.9	1.9
Mining and Quarrying	1.2	10.6	5.1
Foodstuff	2.3	1.6	1.6
Textile, Sewing &	14.4	3.4	1.9
Other Manufacturing	6.2	3.6	2.5
Production and Suppl	0.1	0.0	8.8
Coking, Gas and Petrol	1.0	2.3	8.1
Chemical Industry	7.5	12.7	5.8
Building Materials	1.3	0.5	12.0
Metal Products	7.0	7.1	9.8
Machinery and Equip	42.2	47.9	0.7
Construction	0.3	0.2	0.8
Transportation, Post	4.6	1.7	4.6
Wholesale and Retail	7.3	1.6	1.4
Real Estate, Leasing	0.9	1.7	0.3
Banking and Insurance	0.1	0.6	0.6
Other Services	2.7	1.6	1.5

Source: Result of IO9 software processing based on 2005 IO table with sector energy consumption data from the NBS of China.

Reference

Ackerman (2009), 'Carbon Embedded in China's Trade', Stockholm Environment Institute Working Paper, WP-US-0906, June 16, 2009

Athukorala, P. (2008), 'Singapore and ASEAN in the regional division of labour', *The Singapore Economic Review*, Vol. 53 (3), pp. 479-508.

Binchang, X. (2006), The Relationship between Export Trade and Energy Consumption: An Empirical Study in China, *Journal of Guangxi University of Finance and Economics*, May 2006

China Statistical Yearbook, National Bureau of Statistics of China, Various Years.

Dean, J. M., Lovely, M. E. and Mora, J. (2009), Decomposing China-Japan-US trade: vertical specialisation, ownership and organisational form, Paper presented at *China, Japan and the US: Deeper Integration Conference*, Tokyo, Japan, May 28.

Feenstra, R. C and Hong, C. (2007), China's Exports and Employment, Paper presented at the NBER conference *China's Growing Role in World Trade*, August 3-4, Bejing.

Fu, X. and Balasubramanyam, V. N. (2005), *Exports, Foreign Direct Investment and Employment: The Case of China*, UK: Blackwell Publishing Ltd.

Guo, H. and N'Diaye, P. (2009), Employment Effects of Growth Rebalancing in China, IMF Working Paper, WP/09/169, August.

Hao, C. (2011), 'Trade Surplus Decreases Employment? *The Journal of Quantitative and Technical Economics*, June.

Wei, H. (2011), 'Empirical Analysis on Relationship between China's Textile Industry's Export and Employment', *Journal of International Trade*, January.

Information Office of the State Council, The People's Republic of China, Environmental Protection in China 1996 – 2005.

Jiang, N., Wang, LP and Sharma, K. (2009) 'Trends and patterns of FDI in China's economic boom' in PK Basu and Y. Bandara (eds.) *WTO Accession and Socio-economic Development in China*, Oxford: Chandos Publishing.

Juan, M., Xiao-bing, X. and Jian-wu, Z. (2010), 'Effects of International Trade on Manufacturing Employment: An Empirical Study Based on Dynamic Panel Data Model', *Finance and Trade Research*.

Li, L. (2010), 'An Empirical Analysis of Relationship between Export and Energy Consumption in Shandong Province', *International Journal of Business and Management*, March.

Rui, N. (2010), 'A Case Study of Relations between China s Domestic Demand, Export and Employment: Empirical Analysis Based on the Data of 1997-2007', *Journal of Capital University of Economics and Business*, April.

Zhang, H. and Lahr, M. L. (2011), China's Energy Intensity Change from 1997 to 2007: A Structure Decomposition Analysis, IIOA Conference Alexandria, June 13-17, USA.

Zhang, C., and Chen, W. (2009), Empirical Study on the Relationship between Energy

Consumption and Export Trade in China, World Economy Study, August 2009