

A gravity model analysis of China's pulp and paper products trade

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ABSTRACT: We used a gravity model to investigate determinants of China's pulp and paper products trade from 1995 to 2005. The results show that an importing country's economy size, forest endowment, distance to China, exchange rate, and membership in Asia Pacific Economic Cooperation (APEC), plus China's accession to the World Trade Organization (WTO) and its forest products policy change implemented in 1998, all significantly affect China's pulp and paper products exports. On the other hand, China's pulp and paper products imports are affected by exporting countries' economic size, forest and capital endowment, APEC membership, China's accession to the WTO, and tariff reductions on forest products.

Application: The factors discussed in this report influence China's pulp and paper products trade. The results can be used to estimate the effects of economic and policy change on China's pulp and paper products trade.

As a result of rapid economic expansion, policy changes, and population growth, China has become a major global producer, importer, and exporter of pulp and paper products in the past decade. Since 1995, the value of China's paper and pulp products imports nearly tripled, from US\$ 3.2 billion in 1995 to US\$ 8.7 billion in 2005 (in 1995 dollars), with an annual growth rate of 11%. Meanwhile, exports of pulp and paper products from China increased from US\$ 952 million to US\$ 3.3 billion, with an annual growth rate of 13%. Yet, other than a few publications from industry and proprietary sources, there is little research on China's pulp and paper products trade.

The purpose of this study was to document trends in China's paper and pulp products imports and exports by product and country over the past 11 years, and to investigate determinants of these imports and exports. In this report, we quantify the contributions of factors influencing China's pulp and paper products imports and exports by using a gravity model, and speculate on the effects of recent policies on exchange rate and trade actions on China's pulp and paper products trade. In this study, pulp and paper products are defined as pulp of wood or other fibrous cellulosic material; recovered (waste and scrap) paper and paperboard; and articles of paper pulp, paper, or paperboard covered in Chapter 47 and 48 of China Customs Yearbooks. We only cover the past 11 years in this study because 1995 was the first year when China Customs fully adopted the global Harmonized Tariff Code.

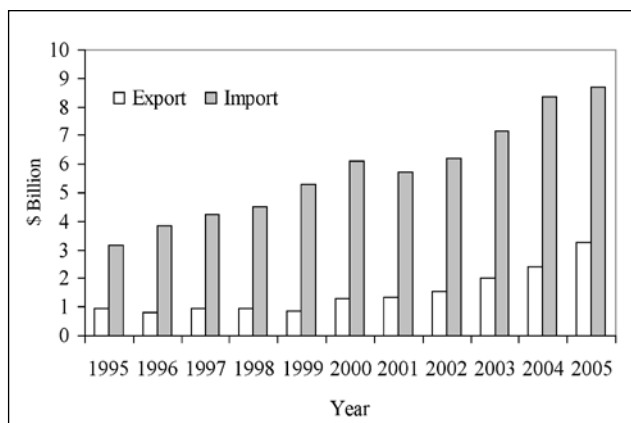
Known as a "workhorse" for empirical studies in international economics, the gravity model has performed remarkably well in empirically explaining bilateral trade flows [1]. Pioneered by Tinbergen [2] and Pöyhönen [3], the gravity model in its most rudimentary form states that bilateral trade increases with economic mass and decreases with commercial distance. Some other explanatory variables – such as pop-

ulation, per capita income, adjacency, common language, trade blocs, and exchange rate – have been added [4]. The next section presents the trends of China's pulp and paper products imports and exports in recent years, followed by model specification and data. The remaining sections present results and conclusions.

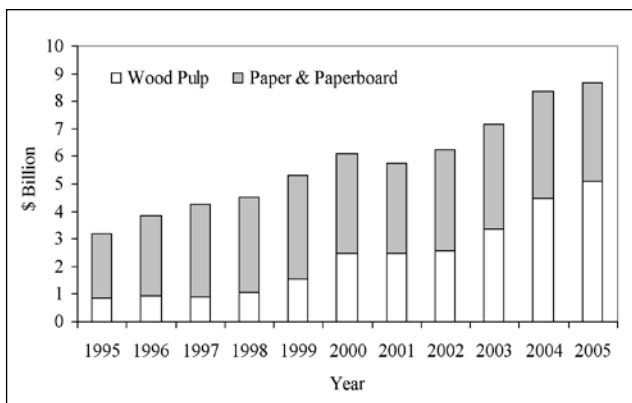
CHINA'S PULP AND PAPER PRODUCTS TRADE

Figure 1 presents the value of China's imports and exports of pulp and paper products from 1995 to 2005. Pulp and paper exports grew fast after 1999, coinciding with the successful bilateral negotiations of China's entry to the World Trade Organization (WTO) with the European Union and the United States by the end of 2000. The difference between imports and exports narrowed in recent years.

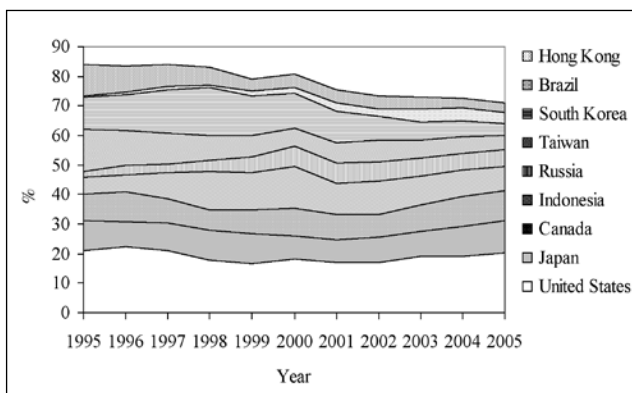
Figure 2 shows the trend in China's pulp and paper products imports by product. Imports of wood pulp and other fi-



1. Value of China's pulp and paper products imports and exports, in 1995 U.S. dollars.



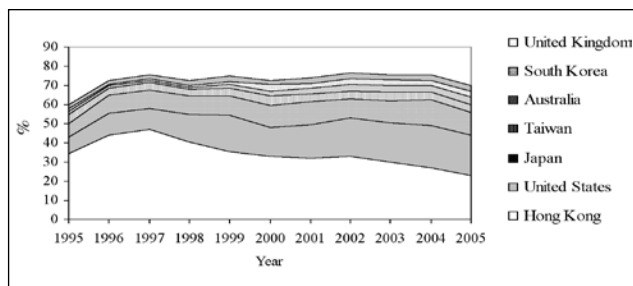
2. Value of China's pulp and paper products imports by major product, in 1995 U.S. dollars.



3. Share of China's pulp and paper products imports by source.

brous cellulose material grew almost 20% annually during the study period. The imports of wood pulp and other fibrous cellulose material were valued at US \$845 million in 1995. By 2005, the imports increased to US \$5.1 billion (in 1995 dollars). According to Sun et al. [5], this is mainly because China was moving away from straw-based pulp toward greater use of wood-based fiber. Meanwhile, imports of paper and paperboard grew moderately, with an annual growth rate of less than 5%. China exports mainly paper and paperboard, with wood pulp accounting for an insignificant percentage of total pulp and paper exports.

Although the number of source countries and regions exporting pulp and paper products to China increased from 76 to 106 during the study period, some remained as the major sources. **Figure 3** shows China's paper and pulp products imports by major trading partners. The United States has long been the top country from which China imported some 20% of pulp and paper products. Japan, Canada, and Indonesia are in the second tier of the largest source countries, each accounting for about 10% of the imports. The shares of China's pulp and paper products imported from South Korea, Taiwan, and Hong Kong declined from around 10% in 1995 to less than 5% in 2005. Pulp and paper products imports from Brazil and Russia have gradually increased since the late 1990s, accounting for about 5% of China's pulp and paper



4. Share of China's pulp and paper products exports by destination.

imports in 2005.

Figure 4 shows the major destinations for China's pulp and paper products exports. Hong Kong, the United States, and Japan have been the leading importers. On average, these three accounted for about 62% of China's annual pulp and paper products exports during 1995-2005. The UK, South Korea, Taiwan, and Australia each accounted for about 2% of China's pulp and paper products exports. A sizeable share of forest products imported to Hong Kong were re-exported to the United States, Japan, and the UK.

MODEL SPECIFICATION AND DATA

Following Zhang and Li [4], this study models China's pulp and paper trade as a function of factors that might create trade resistance or promote such trade between China and other countries. We apply the gravity model separately to the imports and exports. Trade flow is modeled as:

$$T_{it} = e^{\alpha_i} \prod_m X_{imt}^{\beta_m} \prod_k e^{\gamma_k P_{ikt}} \varepsilon_{it} \quad (1)$$

Or, in its log-linear form:

$$\ln T_{it} = \alpha_i + \sum_m \beta_m \ln X_{imt} + \sum_k \gamma_k P_{ikt} + \ln \varepsilon_{it} \quad (2)$$

where, T_{it} is the value of pulp and paper products exports/imports between China and its trading partner ($i \in M$, M is the number of China's pulp and paper products trading partners) in year t ($t = 1, 2, \dots, 11$). X_{imt} is the m th explanatory variable for country i in year t , and P_{ikt} is the k th dummy variable. Eq. (2) is a fixed-effects (random-effects) panel data model if the intercept is assumed to be fixed (random). ε_{it} is the error term and β and γ are parameters to be estimated.

Our data cover the pulp and paper products trade between China and its 24 major importing and exporting partners from 1995 to 2005. These exporting partners are Hong Kong, United States, Japan, Taiwan, South Korea, Australia, United Kingdom, Germany, Malaysia, Canada, Indonesia, India, Thailand, Russia, Iran, Netherlands, France, Vietnam, Philippines, Saudi Arabia, Italy, Spain, New Zealand, and Turkey. The importing partners are United States, Japan, Canada, Indonesia, Russia, Taiwan, South Korea, Brazil, Chile, Germany, Sweden, Hong

Kong, United Kingdom, Netherlands, Finland, New Zealand, Australia, Thailand, France, Belgium, Spain, Italy, Norway, and Malaysia. Although Hong Kong and Taiwan belong to China, they are administered autonomously and are treated as individual importing and exporting partners in this study.

Exporting and importing partners are not necessarily the same. Exports to the major 24 partners accounted for 89% of total China's pulp and paper products exports in 2005 and 84% in 1995. Imports from its major 24 importing partners accounted for 98% of China's pulp and paper products imports in 2005 and 97% in 1995 [6].

The dependent variables are export or import value of pulp and paper products by country and year. Independent variables include trading partner's economic size, per capita income, distance to China, resource endowment, exchange rate, and three dummies (two policy and one regional).

We initially tried to use gross domestic product (GDP). However, the correlation between GDP and per capita resource endowment is high for both the export and import models (all above 0.5). We therefore used national population as a proxy for a trading partner's economic size to avoid multicollinearity. Larger countries are expected to export more and absorb more imports. We also tried to use GDP per capita as a measure of exporter's capital labor endowment and importer's per capita income. However, GDP per capita is highly correlated with resource endowment and exchange rate. We did not include it in the final models.

Distance between China and its trading partner is measured in great circle distance between their capitals. Data were obtained from the trade resources web site maintained by Robertson [7]. As Loungani et al. [8] note, distance captures more than transportation costs. It is also associated with information and search costs. Longer distance suggests higher transportation costs, and greater information and search costs. Distance is expected to have a negative value in the model.

Wood pulp production per capita is used as a proxy of a country's forest resource endowment. We expected it to be positively related to China's pulp and paper products imports and negatively related to China's pulp and paper products exports. In addition, real interest rate is used as an indicator of capital endowment because the pulp and paper industry is capital intensive. We expected it to be positively associated with China's pulp and paper products exports and negatively associated with its imports. Real exchange rate is in trading partner's currency per Chinese yuan. An increase in the value implies an appreciation of the Chinese yuan, which we expected to have a negative effect on China's pulp and paper products exports and positive effect on imports.

Because China belongs to the Asia-Pacific Economic Cooperation (APEC), we used a dummy variable to see the effect of the trade bloc to China's pulp and paper products trade. The dummy equals to 1.0 if the country is also a member of APEC and zero otherwise. We expected it to have a positive effect on China's pulp and paper products trade. A policy dummy is used to capture the effect of China's accession to

the WTO. It equals to 1.0 when the trading partner was a member of WTO in 2002 or later. Finally, a policy dummy is used to capture the effect of 1998's logging ban and the tariff reduction on forest products imports. It is expected to promote China's pulp and paper products imports and exports.

RESULTS

To account for individual country effect, we used a one-way fixed effects model (FEM) and a one-way random effects model (REM) to estimate Eq. (2). The Hausman statistic for the import and export models are not computable because the covariance matrix for the Hausman test is not positive definite. This suggests that ordinary least square estimates are not better than generalized least square estimates. Further, REM is weakly preferred for both models [9].

Table I shows the REM results for China's pulp and paper products imports. The estimation results show that most of the independent variables are statistically significant. As expected, the positive coefficient of wood pulp production per capita suggests that China imports more pulp and paper products from countries with relatively abundant forest endowment. Also, China imports more pulp and paper products from countries with larger economies, and China's accession to the WTO helped its pulp and paper products imports. The negative coefficient of real interest rate indicates that China imports more pulp and paper products from countries with lower interest rates, and thus richer capital endowment. The 1998 logging ban and tariff reduction on forest products imports promoted China's pulp and paper imports.

Table II shows the results for China's pulp and paper exports. The significant negative coefficient on wood pulp production per capita suggests that China exports its pulp and paper products to trading partners with less abundant forest endowment. The significant positive coefficient of importer's population suggests that trading partners with larger economies accepted more Chinese pulp and paper products. As

Variable	Coefficient
Constant	0.99
Wood pulp production per capita	0.10***
Exchange rate	0.05
Distance	-0.44
Real Interest Rate	-0.10**
Exporter population	0.44***
APEC	1.16***
WTO	0.29***
Policy	0.54***
No. of Observations	240
Degree of Freedom	231
R ²	0.56
LM Test Ratio	597.14***

* significant at 10% level, ** significant at 5% level, ***significant at 1% level.

I. Gravity model for China's pulp and paper products imports (1995-2005).

Variable	Coefficient
Constant	-4.60
Wood pulp production per capita	-0.50***
Exchange rate	-0.28***
Distance	-0.02***
Real interest rate	-0.64
Importer population	0.57***
APEC	1.85***
WTO	0.58***
Policy	0.33***
No. of observations	240
Degree of freedom	231
R ²	0.44
LM test ratio	359.18***

* significant at 10% level, ** significant at 5% level, ***significant at 1% level.

II. Gravity models for China's pulp and paper products exports (1995-2005).

expected, exchange rate is negatively associated with China's pulp and paper products exports. China's pulp and paper products are relatively cheaper when the exchange rate is lower, thus increasing China exports. Distance to the trading partners is negatively associated with China's pulp and paper exports. APEC membership and the 1998 policy reform (logging ban and tariff reduction) are shown to have a significant

positive effect on China's pulp and paper products exports. Finally, China's accession to the WTO promoted its pulp and paper products exports.

CONCLUSIONS

This study documents the trend and investigates the determinants of China's pulp and paper products trade from 1995 to 2005. The exports and imports gravity models are estimated by using panel data models. Random-effects models are shown to be a better fit than fixed-effects models.

The imports model results suggest that exporting partner's economy size, forest and capital endowment, APEC membership, and China's tariff reduction on forest products imports and its accession to the WTO all significantly affect China's pulp and paper products exports. The exchange rate and distance are not shown to significantly affect China's pulp and paper products imports.

The export models show that China's pulp and paper products exports are affected by the importing partner's economy size, distance to China, exchange rate, forest endowment, APEC membership, and China's tariff reduction on forest products imports and its accession to the WTO.

China's pulp and paper products exports are significantly affected by China's exchange rate relative to the trading partner's currency. When the Chinese yuan is appreciated, Chinese manufactured products are relatively more expensive, and thus China will export less pulp and paper products. Between the

INSIGHTS FROM THE AUTHORS

China has become a major global producer, importer, and exporter of pulp and paper products in recent decades. Yet, other than a few publications from industry and proprietary sources, there is little research on the China's pulp and paper products trade.

In this study, we wanted to document trends in China's paper and pulp products imports and exports by product and country over the past 11 years, to investigate determinants of these imports and exports quantitatively, and to speculate on the effects of recent policy on exchange rate and trade actions on China's pulp and paper products trade.

This is the first research quantifying the factors affecting China's pulp and paper products imports and exports by using a gravity model. The most difficult aspect of this research was to choose appropriate independent variables. We chose those based on our hypotheses, econometric techniques, and literature sources.

We found it interesting that China's pulp and paper products exports are significantly affected by its exchange rate to trading partner's currency. Between the beginning of 2006 and the end of 2007, China's currency has increased in value against the U.S. dollar and other major currencies by about 11%. The U.S.

Congress and Department of Commerce have called on China to increase its currency value by at least another 5% within a year. China's pulp and paper exports are expected to slow their rate of growth if the appreciation of the Chinese yuan continues.

This study addresses the factors influencing China's pulp and paper products trade. The results can be used to estimate or speculate the effects of economic and policy change on China's pulp and paper products trade and the market. As a next step, we may want to look at the same aspect of other forest products.



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Trade restrictions, such as U.S. and Canadian antidumping and countervailing duties, also affect certain Chinese pulp and paper products imports. These actions will influence China's pulp and paper products exports in the coming decades, which could in turn bring down China's rate of increase in its pulp and paper products imports. **TJ**

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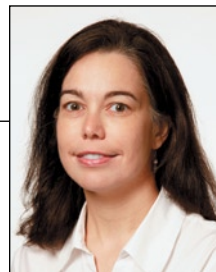
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Editor's Note

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Standing-room-only at Portland conferences

The opening session of TAPPI's International Bioenergy & Bioproducts Conference (IBBC), August 27 – 29, in Portland, Ore., USA, was packed like a proverbial sardine can, with attendees from both IBBC and TAPPI's Engineering, Pulping & Environmental (EPE) Conference at the special Wednesday afternoon "bridge" session. Speaking to a standing-room-only crowd, keynote speaker Denny Hunter of Catchlight Energy (Chevron and Weyerhaeuser joint venture company) explored the driving forces behind biofuel developments in today's forest industries, and John Cowie of AF&PA presented the official Agenda 2020 position paper for the U.S. pulp and paper industry.

Held in conjunction at the Doubletree Hotel and Executive Conference



Center, EPE and IBBC drew increased attendance over last year's events. A total of 538 people registered for EPE, an increase of 16% over 2007, with the highest proportion of mill attendees in many years. IBBC had some 260 registrants, more than double that of prior TAPPI renewable energy conferences, with attendees from pulp and paper mills, research and engineering compa-

nies, energy groups, renewable energy operations, financial and legal firms, environmental groups, academia, etc.

The 2008 EPE program included a broad spectrum of pulping, power, chemical recovery, and environmental papers, all which are published in the conference proceedings (now for sale at www.tappi.org). TAPPI members can download individual papers from the TAPPI e-library. IBBC highlighted the latest technologies and approaches for producing biofuels from cellulosic sources, including case studies from several key projects around the world.

For 2009, EPE and IBBC will again be held back-to-back in Memphis, Tenn., October 11-16. A call for EPE papers has already been issued (see www.tappi.org/epe).

— By Ken Patrick, for Jan Bottiglieri