Forest Policy and Economics 61 (2015) 113–121

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

An investigation of China's import demand for wood pulp and wastepaper

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ARTICLE INFO

Article history:
Received 9 December 2014
Received in revised form 10 June 2015
Accepted 3 October 2015
Available online 6 October 2015

Keywords:
Demand system
Differential production model
Elasticity
Environmental impacts

ABSTRACT

Wood pulp and wastepaper are all essential inputs in making paper and allied products. China has been the leading participant in the global fiber trade in recent years. In this study, China's import of wastepaper and wood pulp by supplying source was assessed through a two-stage differential production model. The analyses revealed that wastepaper imports were inelastic in both expenditure and price, the magnitude of price elasticity estimates became larger after considering the variation of total expenditure, and the substitution between wastepaper and wood pulp imports was limited. Rising imports of wastepaper had small effects in reducing the rapidly growing imports of wood pulp by China. Thus, the concern over environmentally detrimental effects of importing virgin wood pulp from countries with poor forest management practices will likely continue.
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1. Introduction

Fiber is an essential production input for the paper industry. Global fiber markets have become more closely connected with increasing international trade. From 1999 to 2011, the ratio of trade over production worldwide increased from 23% to 31% for wood pulp and from 16% to 28% for wastepaper (Food and Agriculture Organization, 2013). China has become the leading participant in the global fiber flow over the last decade. In 2011, 34% of wood pulp and 59% of wastepaper traded in the international market were sent to China. Annual spending by China on papermaking fiber imports has reached $18 billion in recent years. Major suppliers of papermaking fiber to China included the United States, Canada, Indonesia, and Brazil.

Large import demand on fiber by China is directly related to several features of its fiber and paper products market. Increasing domestic paper consumption and packaging needs for its booming export-oriented manufacturing industries are the major drivers of fiber demand in China (He and Barr, 2004). Domestic fiber supply is limited as China has been poor in forest resources (Sun et al., 2004). Existing forest stands often have low productivity, and historically wood pulp has not been a large component of China's fiber supply. Consequently, there has been a rising demand of high-quality papermaking fiber in China to produce paper and paperboards, and that demand has largely been met by imports of wood pulp and wastepaper. Stafford (2007) estimated that 46% of fiber used by China in 2006 was imported, and in turn, close to 47% of final paper products (mainly export-grade paper and corrugated shipping boxes) were made of imported fiber. To sum, China is short of papermaking fiber and there has been an alignment between high-quality fiber imports and paper products exports.

A number of studies have analyzed China's large imports of papermaking fiber. He and Barr (2004) assessed the growth of China's pulp and paper sector and concluded that the rapid growth in pulp demand had far-reaching implication for forest sustainability and rural livelihoods within China and throughout the world. For Southeast Asian countries (e.g., Indonesia), China's large imports of timber and pulp have often been perceived as rapidly increasing, unsustainable, and illegal (Lang and Chan, 2006). Stafford (2007) also noted that China sourced a substantial amount of virgin wood pulp from countries where good forest management could not be assured, and at the same time, China's large import of wastepaper could benefit environment by saving forests and reducing landfills. Given the simultaneous large imports of both virgin and secondary fiber by China, there has been a need for more systematic analyses of China's import market.

The objective of this study was to assess China's import demand for papermaking fiber by product type and source. More specifically, this study sought to analyze the impact of economic factors (i.e., fiber price and expenditure) and non-economic factors (e.g., seasonality) on the demand for source-differentiated fiber products, and furthermore, the substitution between wastepaper and wood pulp products. The model employed was a differential production model. The main features of this model were that demand for fiber was differentiated by product and source, theoretical properties of the demand system were tested and imposed during the estimation, and economic and non-economic variables were considered simultaneously in the system. The data used were China's monthly imports of fiber by product and source between 1999 and 2013. Papermaking fiber was classified into wastepaper and wood pulp. The top four supplying countries were considered for each product type.

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http://dx.doi.org/10.1016/j.forpol.2015.10.001
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This study makes several contributions to the literature related to papermaking fiber trade. First, demand elasticities for wastepaper are estimated and they can reveal whether China's import of wastepaper is sensitive to price changes. As China has emerged as the largest wastepaper importer in recent years, these findings from the perspective of international fiber trade will be helpful for trade policy design. Second, both conditional and unconditional estimates of price elasticities are estimated through the two-stage differential production model. The unconditional estimates will allow a more comprehensive assessment of import competition by type and source in China. Finally, substitution and linkage between wastepaper and wood pulp imports will be assessed through cross-price elasticities. Wastepaper recycling has been promoted extensively with the expectation that it can substitute for wood pulp to a large degree, and thus, generate environmental benefits (Stafford, 2007). As China has been a large importer of both wastepaper and wood pulp, the findings from this study will provide empirical evidence about their relation from the perspective of global fiber trade.

2. Methodology

Various methods have been employed to examine trade and market competition of paper and wood commodities. For example, Buongiorno and Uusivuori (1992) used cointegration techniques to examine the exports of pulp and paper from the United States to six European countries and Japan. Uusivuori and Kuuluvainen (2001) employed a cost–function approach to evaluate the substitution in global wood imports in the 1990s. Turner and Buongiorno (2004) derived the empirical model from a production function and estimated the price and income elasticities of forest products import demand with a panel dataset. In this study, the differential production model (Theil, 1980) was used to analyze China's import demand for wastepaper and wood pulp, given their intermediate nature as inputs in paper production. Several past studies have adopted this approach to assess demand for source-differentiated products (e.g., Liu et al., 2007; Muhammad et al., 2010; Muhammad et al., 2012).

2.1. Differential production model

The differential production model is derived from production theory where firms maximize profit in a two-stage procedure (Davis and Jensen, 1994). In the first stage, firms make a decision of total expenditure on a specific commodity (i.e., papermaking fiber in this study). In the second stage, the total expenditure is allocated among source-differentiated products. A Rotterdam demand system has been developed to analyze the competition among these products. The Rotterdam demand system is advantageous in several aspects (Marsh et al., 2004). Variables used in the system are derived through profit maximization and thus consistent with economic theories. It can be estimated using linear estimation procedures, and theoretical restrictions can be tested and imposed.

The derivation of the two-stage differential production model was detailed in the literature (e.g., Theil, 1980; Barnett and Serletis, 2008). For the research issue in this study, the model can be represented by the following total expenditure equation and demand system:

$$\Delta\log(Q_t) = \varphi\Delta\log(z_t) + \sum\nolimits_k \lambda_k \Delta\log(h_{kt}) + \sum\nolimits_j \sum\nolimits_s \pi_{js} \Delta\log\left(p_{js,t}\right) + \zeta_t \tag{1}$$

$$\overline{w}_{ir,t}\Delta\log\left(q_{ir,t}\right) = \alpha_{ir} + \sum\nolimits_m \delta_{ir,m} x_{mt} + \beta_{ir}\Delta\log(Q_t) + \sum\nolimits_j \sum\nolimits_s \gamma_{ir,js} \Delta\log\left(p_{js,t}\right) + \varepsilon_{ir,t} \tag{2}$$

where the Divisia volume index (Q_t) represents total import expenditure on fiber by China over time, and $q_{ir,t}$ is China's import quantity of fiber by supplying source and product. The indexes are t for time, k for production input prices in China, i and j for different fiber products, r and s for supplying sources (country of origin), and m for dummy variables. In the total import expenditure equation for China, the price of domestic fiber (z_t), production input prices (h_{kt}), and the import prices of fiber by source and product ($p_{js,t}$) are included. In the Rotterdam demand system, the explanatory variables are a set of dummy variables (x_{mt}), the Divisia volume index (Q_t), and China's import prices of fiber ($p_{js,t}$). The parameters to be estimated are φ, λ, π, α, δ, β, and γ. The error terms are ζ_t and $\varepsilon_{ir,t}$.

In the total expenditure equation, the coefficient for fiber price in China is expected to be positive since a higher domestic fiber price should lead to a greater expenditure on fiber imports. The coefficients for the prices of production inputs and fiber imports should be negative as higher prices lead to a decrease in total import expenditure. In the Rotterdam demand system, several variables are derived from production theories and defined in particular formats (Theil, 1980; Muhammad et al., 2012). They need to be constructed from source-differentiated data of price ($p_{ir,t}$) and quantity ($q_{ir,t}$) for product i from source r at period t. Specifically, the relations are as follows:

$$w_{ir,t} = p_{ir,t}\, q_{ir,t} / \sum\nolimits_i \sum\nolimits_r p_{ir,t}\, q_{ir,t} \tag{3}$$

$$\overline{w}_{ir,t} = \left(w_{ir,t} + w_{ir,t-1}\right)/2 \tag{4}$$

$$\Delta\log(Q_t) = \sum\nolimits_i \sum\nolimits_r \overline{w}_{ir,t}\Delta\log\left(q_{ir,t}\right) \tag{5}$$

$$\Delta\log\left(p_{js,t}\right) = \log\left(p_{js,t}\right) - \log\left(p_{js,t-1}\right) \tag{6}$$

where $w_{ir,t}$ is the budget share of product i from source r at period t in China's total import expenditure; and $\overline{w}_{ir,t}$ is the average budget share over two adjacent periods. The log-difference operator for other variables in both the total expenditure equation and demand system is similar to that for $\Delta\log(p_{js,t})$. As a result of the log-difference treatment, the transformed data are stationary. The stationarity property of these variables used in this study was also confirmed by unit root tests.

Three fiber products were defined in this study (i.e., $i, j = 1, 2$, and 3): wastepaper, wood pulp, and others (as detailed later). There were five supplying sources in each of the first two categories and one aggregate source in the third. In total, there were 11 combinations of different products and supplying sources. The data used were monthly price and quantity series between January 1999 and March 2013 ($t = 1, \ldots, 171$). In the total expenditure equation, two inputs were included: one for labor cost and the other for fuel and electricity in China (i.e., $k = 1, 2$). In the demand system, two sets of dummy variables (x_{mt}) as demand shifters were included. Eleven monthly dummy variables from January to November were included to consider the possible impact of seasonality. In addition, the model was augmented with a dummy variable related to the 2008 financial crisis that might have an impact on China's import demand of fiber. Preliminary analyses revealed that the import of wastepaper and wood pulp by China declined sharply over the period between November 2008 and February 2009. Thus, the dummy variable was added in the demand system, with the value of one over the period and zero otherwise.

According to Theil (1980), the error terms in Eqs. (1) and (2) are statistically independent if the parameters are assumed constant and the errors are normally distributed. This allows for separate estimation of the total expenditure equation and demand system. Demand restrictions can be derived from economic theory and imposed on the second-stage demand system using the following parameter constraints (Davis and Jensen, 1994; Liu et al., 2007):

$$\sum\nolimits_i \sum\nolimits_r \alpha_{ir} = 0;\ \ \sum\nolimits_i \sum\nolimits_r \delta_{ir,m} = 0;\ \ \sum\nolimits_i \sum\nolimits_r \beta_{ir} = 1;\ \ \sum\nolimits_i \sum\nolimits_r \gamma_{ir,js} = 0 \tag{7}$$

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