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Forest-mill integration: a transaction costs perspective

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Forest-mill integration: a transaction costs perspective

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Abstract

In Canada, where public ownership of forestland is prevalent, a central decision facing policy makers is how to allocate timber resources to private forest companies. Debates tend to focus around what proportion of the annual harvest should be devoted to markets opposed to long-term contracts. To give a guide to policy makers, we surveyed forest firms from New Zealand and Sweden where this decision is based purely on a commercial basis. On average, mills source fifty percent of their fibre from the market. However, using a fractional logit model, we test whether theories from transaction cost economics influence this decision. Results are consistent with transaction cost economics; firms decrease the proportion of fibre sourced from a market with increasing fibre specificity, capital intensity, and uncertainty.

Keywords: transaction costs, forest tenure, vertical integration

JEL: D23, K23, L22, L73

Introduction

Fibre is the most important input factor for sawmills and pulp mills. Sawlogs typically represent about 70% of a sawmill's operating costs and pulp logs or residual chips make up between 40 to 60% of operating costs in the production of bleached kraft pulp (Roberts et al. 2004). For this reason, the procurement of fibre is arguably the biggest focus of business strategy and access to reliable and low-cost fibre can represent an enormous competitive advantage to a firm.

In practice, mills can source fibre supplies from their own forest or tenure, through a third party supply contract, or from the open market. In Canada, where the great majority of forest land is owned by the public, an important policy decision is how to allocate public timber resources to private firms. Traditionally, it is fair to say that integration was favoured, as timber tenures throughout Canada have, by and large, been awarded based on the operation of a processing facility and the duration of tenures are for long terms (typically 10-25 years) with renewal clauses. Furthermore, timber was tied to this facility through appurtenance agreements embedded in the tenures.

However, this system certainly has had its critics. Pearse (1976) expressed concern that the tenure system in British Columbia was biased towards a vertically integrated industrial structure and that the full allocation of timber to integrated firms created significant entry barriers. This was echoed by the 1991 Forest Resources Commission which recommended devoting 50% of the annual allowable cut (AAC) to log markets as a means of providing for new entrants and to establish a fair value for

public resources. Studies by Binkley (1997) and Niquidet et al. (2007) highlighted the value destruction associated with rigid processing conditions. Furthermore, softwood lumber producers in the United States have consistently viewed Canadian supply agreements as a subsidy, stressing the need to auction at least 50% of publicly owned timber (Coalition for Fair Lumber Imports 2003). Conversely, industry has expressed the need for a secure, reliable flow of timber to induce investment in efficient, competitive, processing facilities. Also a study undertaken by Globerman and Schwindt (1986) suggests that vertical integration in the Canadian forest sector could be associated with the reduction of transaction costs.

British Columbia made significant changes to its tenure system in 2003 by way of its Forestry Revitalization Plan, increasing the amount of volume sold by auction on a short-term basis to 20% (Niquidet 2008). Similarly, in early 2008 Quebec proposed to re-allocate 25% of its public timber supply to markets (Government of Quebec 2008). Also, for quite some time, in the United States vertically integrated companies have been divesting of forestland and relying increasingly on purchases from independent forest managers (Binkley et al. 1996). However, as noted by Sedjo (2008) it is unclear if this de-integration simply reflects the tax system in the United States rather than a cost minimizing supply chain.

In this paper we seek to explain the forest-mill integration choice from a transaction cost perspective by surveying mill managers in Sweden and New Zealand. In both of these jurisdictions such decisions are made on a commercial basis largely free of

political influence, so they may be useful for comparison with those in Canada where socio-economic factors are often at play. They also do not appear to be as influenced by non-neutral tax regimes which favour one industrial form over the other, as arguably is the case in the United States (Chercover 2005).

In the next section we outline the theory of supply chain integration from a transaction cost economics (TCE) point of view. This is followed by an overview of past TCE research in forestry. After this we outline our research methodology and present the econometric model which we use for testing the integration decision in Sweden and New Zealand. This is followed with the results of our model and the corresponding discussion. The last section sketches a path for future research and presents our conclusions.

Transaction cost theory

The theory of TCE is well developed and has been applied to a wide range of disciplines where problems of contracting and economic organisation appear. This includes economics, law and public policy as well as business strategy (Carter and Hodgson 2006; Stuckey and White 1993). Its origins are owed to Coase (1937) who questioned the emergence and boundaries of firms. Such questions remained relatively un-researched until the ground breaking TCE studies of Williamson (1975; 1979); Klein et al. (1978); Grossman and Hart (1986); Joskow (1985) and Hart and Moore (1990) among others.

In short, TCE theory holds that exchange agreements must be governed, and that the exchanging parties will try to adopt governance forms that minimise transactions costs. Often the choice of governance form can be simplified to the "make versus buy" decision, meaning the choice between market and hierarchical governance. However, a range of intermediate solutions can exist between buying on the spot market and full integration, including long-term contracts, strategic alliances, and joint ventures (Williamson 1991; Menard 2004).

A key determinant of transaction costs is the risk of hold-up. This is opportunistic behaviour by one party in the transaction to their own advantage, and to the disadvantage of the other party. Two important factors determining the risk of hold-up are the level of asset specificity and the level of uncertainty (Stucky and White 1993). Asset specificity impacts the size of "appropriable quasi-rents"; which is defined as the potential gain available through the hold-up. In simple terms, these rents are equal to the difference between the value of the asset in its specific use and that in its next best alternative (Klein et al. 1978). For example, if a buyer's asset is highly specific to a particular input, the asset's value would be greatly diminished if the supply of that input was disrupted. Therefore the appropriable quasi-rents are large, and the supplier could gain considerably by threatening to cease supply. Common forms of asset specificity include the proximity of the supply source to the processing asset, the customization of the asset and human resources to the supply source, and supplier concentration (Joskow 1985; Fink et al. 2006).

High levels of uncertainty in a market can also increase the risk of hold-up due to the need for frequent re-negotiation of terms. Alternatively, uncertainty can increase the costs of preventing hold-up by making the process of designing comprehensive contracts more complex, and the required price premium higher (Klein et al. 1978).

An additional TCE factor that is not directly related to the risk of hold-up is transaction frequency (Williamson 1979). This can also influence the choice of exchange governance form, because total transactions costs are a function of costs per transactions and the number of transactions. For example, parties with a large-volume of transactions could conceivably have a greater incentive to lower their transaction costs through integration.

Forestry and transaction cost economics

TCE theory has already received some attention in the forestry literature. Ohanian (1994), Melendez (2002) and Wang (2005) have all shown that transaction cost factors have an important role in determining the degree of integration between pulp and paper producers. Furthermore, Wang and van Kooten (1999) and Wang et al. (2000) revealed that TCE factors help to explain forest companies' choice of contractual forms and payment for silvicultural operations.

While not tested explicitly, previous research on the factors that influence the forest-mill integration decision have also cited TCE factors. Somewhat anecdotally, Globermann and Schwindt (1986) suggest that transaction costs are the reason for finding

that all but one of the largest 30 companies owned timberland cutting rights. They proposed that sawmills and pulp mills are dedicated to a specific forest basin defined by the economic transport radius for logs because mills are not easily relocated (salvage values are low compared to the cost of initial construction). They argue that forests are not as dependent on a particular mill because standing forest is not a wasted asset; meaning that in the event of no transaction, forest owners have the alternative of letting the forest continue to grow. Yin et al. (2000) studied the effect of forest ownership on operating decisions for a paperboard mill. They presented three key features of the pulp and paper industry, which make integration attractive: the industry has (1) high capital intensity, and (2) a high degree of asset specificity, which together yield a lack of flexibility and vulnerability to the (3) highly cyclical markets. Furthermore, Yin and Izlar (2001) cite supply uncertainty and price volatility associated with spot markets as a rational for entering into long-term supply agreements. Finally, Lonnstedt (2003, 2007) identifies several TCE factors in his case studies of timberland ownership in Sweden and the United States respectively. However, none of the above studies formally tested the forest-mill integration decision with empirical data from a TCE perspective. The next section outlines our method of modelling this decision.

Methodology

Several econometric methods can be used to explore TCE theories. Researchers have used varying dependent variables to measure the integration decision. Binary (integrated not integrated) models were initially used with standard probit or logit models (Monteverde and Teece 1982; Ohanian 1994). However, the drawback of such an

approach is that in many cases firms choose to have some degree of integration rather than choosing to be fully integrated or not integrated. Wang (1999) and Wang et al. (2000) incorporate this third 'combination' by the use of an ordered probit model. Nevertheless, this option does not distinguish between a continuous set of alternatives within this category. For example, under this technique firms who outsource 85% of their supplies are treated the same as those who outsource 15%. To allow for a wider range of options, a more flexible method is to allow the dependent variable to be a proportion; such as the fraction of the firm's supply coming from the market, this is the approach we take in this paper.

The assumptions of normality and linearity associated with the classical regression model estimated by Ordinary Least Squares (OLS) do not hold when dealing with proportions as the dependent variable. Consequently, several alternate econometric models have been developed and applied, but each has their own potential drawbacks. Traditionally, a log-odds ratio conversion was done, however this transformation, along with a model based on the beta distribution are incapable of dealing with extreme points at 0 and 1 (Kieschnick and McCullough 2003; Wagner 2001). Another alternative is a two limit tobit model, where 0 and 1 are treated as lower and upper limits (i.e. censoring points). This two-limit tobit model has been applied in previous TCE problems (Hobbs 1997). However, proportions of 0 or 1 under this model are assumed to represent missing (censored) variables, whereas in fact they are real observations and not missing or censored per se (Maddala 1991). Instead we adopt a fractional logit model (FLOGIT) which was developed by Papke and Wooldridge (1996) specifically for data on

proportions. As they describe, this approach is consistent in the face of alternative distributions and can accommodate boundary cases (0 and 1).

The FLOGIT model is an extension of the logit model and is given by:

(1) $$E(y_i|x_i) = G(x_i\beta)$$

Where G is the logistic cumulative distribution function, y is the proportion of firm i's supply which is procured from the market, x is a vector of TCE co-variates and β is a vector of parameters to be estimated by maximizing the following Bernoulli log-likelihood function:

(2) $$l_i(b) \equiv y_i \log[G(x_i b)] + (1 - y_i)\log[1 - G(x_i b)]$$

The choice and measurement of *x* has also been a challenge for empirical TCE studies. There is no universal way to measure asset specificity and uncertainty so instead various proxies are used which can very much depend on the industry being studied (Joskow 1993). Furthermore, good measures of TCE factors are seldom available from public sources so suitable data typically needs to be recovered by surveying individual firms (Boerner and Macher 2001).

From mill lists provided by the Swedish Forest Agency and the New Zealand Ministry of Agriculture and Forestry we identified the population of primary mills (pulp mills and sawmills) in the two countries as being 456. We then randomly selected 30% of these mills (136 mills) for our survey. In order to ascertain the most appropriate mill employee to survey and to obtain buy-in from participants, all mills sampled were called

and spoken to directly. 88 mills indicated a willingness to participate and subsequently filled in our internet based survey.[3]

The survey collected information on the proportion of each mill's fibre supply that was met from spot markets (*fibrem)*, from long-term contracts (*fibrec*) and from their own land (*fibreo*).[4] It also retrieved TCE information by collecting the following from each of the firms:

- Fibre specificity (*fibrespec*) – a ranking of how specific the fibre consumed is to the mill's particular operations. Utilizes a five level Likert scale ranging from 1 = not at all specific → 5 = highly specific. Our prior expectation, given TCE theory, is that firms with greater fibre specificity will source less fibre from the market.
- Supplier concentration – the three firm forest ownership concentration ratio in the mill's fibre basin (120 km radius) was grouped into three categories: 1) low concentration (concentration ratio 0 to 0.3), 2) moderate concentration (concentration ratio 0.31 to 0.6) and 3) high concentration (concentration ratio > 0.6). The moderate concentration (*mod_con*) and high concentration (*high_con*) categories were assigned dummy variables with low concentration treated as a reference contained in the constant of the model. As the ownership of the forest becomes more concentrated the potential for opportunistic behaviour (quasi rent extraction) is expected to increase. Therefore, prior expectation is that the sign on these variables will be negative.

[3] We utilized the following survey service: http://www.surveymonkey.com
[4] Spot markets were defined as any wood supply coming from a contract that was less than a year in duration. Fibre included both chips and roundwood for pulp mills.

- Fibre balance – firms operating in a fibre basin where there was a net export of logs were assigned a dummy variable (*net_export*). This variable proxies for supply abundance and indicates regions where fibre is not as specific geographically. Our prior expectation for the sign on this coefficient is positive.
- Uncertainty (*uncert*) – firms were asked to specify the level of supply uncertainty in their fibre basin according to a five level Likert scale (1 = very reliable → 5 = highly uncertain). Given TCE theory, our prior expectation for the sign on this variable is negative.
- Transaction frequency (*size*) – mill fibre consumption in thousand metric tonnes. As described earlier, based on TCE our prior expectation for the sign on this variable is negative.
- Economies of scope (*mills*) – number of mills in the fibre basin owned by the organisation. We hypothesized that this variable is also related to specificity. Instead of the fibre being specific to a single mill this variable attempts to capture the degree to which timber is specific to a collection of mills (e.g. multiple mills can utilize the various grades flowing from a timber stand). Therefore, prior expectation for the sign on this variable is negative.
- Mill type – mills were differentiated into sawmills and pulp mills. Pulp mills were assigned a dummy variable (*pulp*). Pulp mills are known to be more capital intensive, with larger sunk costs and therefore greater potential for a hold up problem. Prior expectation for the sign on the variable is also negative.
- Region – a dummy variable was also created to denote firms in New Zealand (*NZ*). We had no prior expectations for the sign on this variable.

Results

Descriptive statistics for both the dependent and explanatory variables coming from the survey can be found in Table 1. For interest sake, we also report summary statistics for the variables *fibrec* and *fibreo*, although these variables were not incorporated explicitly in the model.

Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
fibrem	0.50	0.39	0	1
fibrec	0.37	0.37	0	1
fibreo	0.13	0.26	0	1
NZ	0.38	0.49	0	1
pulp	0.32	0.47	0	1
fibresp	3.25	1.36	1	5
uncert	2.93	1.36	1	5
mills	2.24	2.09	1	13
size	224.53	279.22	1	1250
Mod_con	0.41	0.49	0	1
high_con	0.30	0.46	0	1
net_export	0.34	0.48	0	1

The main source of fibre is the spot market, representing 50 % of consumption on average (44 % in Sweden and 58 % in New Zealand). Long term contracts were used in greater proportion than outright forest ownership. Furthermore, of the 88 mills, 22 sourced all fibre from the market and 12 sourced no fibre from the market.

To detect any potential issues with collinearity, prior to modelling we checked the correlation matrix associated with the explanatory variables. This matrix is reported in Table 2. With the possible exception of pulp mills and *size* the correlation coefficients

suggest that collinearity is not an issue. We then ran the fractional logit integration decision model; these results are reported in Table 3.

Table 2. Correlation matrix for right hand side variables

	NZ	*Pulp*	*fibresp*	*uncert*	*mills*	*size*	*low_con*	*med_con*	*net_export*
NZ	1.00								
Pulp	-0.28	1.00							
fibresp	0.20	-0.18	1.00						
uncert	0.13	-0.04	0.19	1.00					
mills	-0.22	0.09	0.06	-0.02	1.00				
size	-0.31	0.71	-0.17	-0.03	0.24	1.00			
low_con	-0.45	0.25	-0.29	-0.34	0.12	0.28	1.00		
med_con	-0.02	-0.07	0.02	0.15	-0.10	-0.07	-0.54	1.00	
net_export	0.14	-0.03	0.01	-0.13	-0.11	-0.08	-0.10	-0.01	1.00

Table 3 – Fractional logit model results. Dependent variable proportion of firm's supply sourced from market.

Variable	**Coef.**	**Std. Err.**	**P value**
constant	3.213	0.760	0.000
NZ	1.132	0.478	0.018
pulp	-1.518	0.460	0.001
fibresp	-0.540	0.145	0.000
uncert	-0.285	0.127	0.024
mills	-0.171	0.075	0.023
size	0.001	0.001	0.040
net_export	0.336	0.347	0.333
mod_con	-0.804	0.445	0.071
high_con	-0.986	0.648	0.128
Log pseudo-likelihood = -40.61			
# of observations: 88			

Excluding *net_export* and *high_con*, all of the variables are significant at the 10% level or better. All else equal, firms in New Zealand source more of their fibre requirements from the market than firms in Sweden and pulp mills source less fibre from a market than sawmills. Consistent with TCE, firms that view their fibre supplies as being highly specific to their operation or view market supplies as being an uncertain

source, tend to procure less fibre from markets. The number of other mills in the fibre basin owned by the firm also leads to less market procurement. The coefficients on *med_con* and *high_con* suggest that firms will gradually move away from markets as forest ownership becomes more concentrated, although high_con fell short of being significant at the required 10% level. Also with the expected sign but not significant was *net_export*.

Conversely, and in contrast to TCE theory, mills with more frequent transactions (as measured by annual mill consumption) tend to source more fibre from the market as a proportion of their needs. This result may not be all that surprising given that transaction frequency has not received empirical support in several other empirical studies (Anderson and Schmittlein 1984; Maltz 1994, Hölmstrom and Roberts 1998). Furthermore, other research has provided evidence of a positive relationship between increasing firm size and outsourcing due to managerial diseconomies of scale (Levy 1985, Abraham and Taylor 1996), a phenomenon that was also discussed by Williamson (1975). Finally, as pointed out earlier in Table 2, the correlation between *size* and mill type could be affecting this result.

Discussion

While the results of this study support the broad target of 50% market procurement recommended by the 1991 British Columbian Forest Resource Commission, we find significant evidence for transaction cost factors in the forest-mill integration decision. In our opinion, this means that the characteristics of the fibre supply basin and the assets

involved should be considered in any policy decision rather than a hard 'one size fits all' target.

For example, the capital intensive pulp sector can be expected to have legitimately greater demands for long-term secure supplies. This might be met either by directly holding tenure with the provinces or by entering into supply agreements with other tenure holders and/or sawmills. Further, in regions where small numbers bargaining is prevalent, prospective investors can be expected to be hesitant to invest in processing facilities without entering into some longer term contractual arrangement. Tenure diversification therefore may encourage greater trust and use of markets in fibre procurement, if this is a desired objective. Though, any diversification strategy will need to consider the potential tradeoffs associated with any economies of scale in forest management (Niquidet et al. 2007).

The results also suggest that to gain support for an expanded market for timber in Canada, reducing supply uncertainty could be critical. Indeed, most of the complaints from timber manufacturers in British Columbia since the 2003 tenure reallocation have been associated with the uncertainty surrounding the supply coming from the provincial timber auction agent (BCTS) and from independent tenure holders such as First Nations groups (Vancouver Sun 2008).[5] Also prior and pending land-use decisions in Canada have contributed to an uncertain supply situation overall. This has arguably led to an increased demand for longer term, secure wood supply agreements as offered by tenure.

[5] This fibre supply is infamously dubbed the 'black hole'.

Conclusions

In this paper we investigated the fibre procurement decisions of primary manufacturing facilities in New Zealand and Sweden. In general, our empirical model supports theories of TCE which suggests to us that policy makers face a balancing act when choosing how to allocate public timber resource to private processing facilities. The right balance between markets and long term agreements depends very much on the characteristics of the supply, which will vary regionally, as well as the type of processing facilities involved. Nonetheless, the reforms in British Columbia which have generated markets for about 43% of the annual harvest[6] and the proposed shift of 25% of the public allowable cut to markets in Quebec do not seem to fall within an unreasonable range.

However, before we make any specific policy recommendations we feel much more research is needed to gain a greater appreciation of these issues. This research could proceed by investigating both more regions and variables. Indeed, part of the integration decision may fall outside of the realm of TCE. For in our discussions with survey participants, factors such as capital constraints and company tradition were also noted as being drivers of backward integration or lack thereof. Also, gaining market power is widely suspected to be a rationale for vertical integration (Bhuyan 2005). Furthermore, future research could explore the integration decision more from the forest

[6] The number from BC is based on the proportion of the Interior harvest coming from BCTS, woodlots, private lands, non-replaceable forest licenses (NRFLs) and community forests in 2007. However, the NRFL volume is held by a mix of First Nations groups, independent forest managers, and timber processing companies. Also in some cases, the remaining replaceable license volume (Tree Farm Licenses and Forest Licenses) is held by independent forest managers who do not process timber.

owner's perspective. Do factors such as growth rates, mill concentration and possibilities for alternative land uses (e.g. agriculture, residential real estate) affect forest owner's willingness to enter into longer term agreements? Finally, additional research needs to be done on how and why long term fibre agreements are structured in the commercial forest sector. This will include items such as contract duration and pricing adjustments; both being crucial parameters in the design of forest tenure in Canada.

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