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The New Brunswick primary forest products market

March 27, 2020

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Background

Deloitte has been mandated by the New Brunswick Department of Energy and Resource Development to conduct an independent study of the structure and operation of the primary forest products market in New Brunswick. In the context of this study, the primary forest products market means the industry for softwood and hardwood timber and wood fibre used as the primary raw material input for manufactured forest products, i.e., softwood and hardwood lumber, pulp and OSB. The scope of the review consisted of:

(i) a comprehensive review of the structure and operation of the primary forest products market in New Brunswick;

(ii) an analysis of the trends in New Brunswick stumpage fees and a comparison to trends in stumpage fees in other comparable industries; and

(iii) an econometric analysis to understand the determinants of stumpage prices in New Brunswick and to identify whether prices are within the norms of competitive pricing or whether they depart from those norms.

Approach

Our approach to the analysis comprised two phases. The first phase involved a qualitative assessment of the structure of the primary forest products market over time in New Brunswick, including data collection and interviews and the compilation of the electronic database to be used for the statistical analysis. The second phase involved undertaking a detailed statistical analysis to assess the impact of market concentration on stumpage fees and any other sources of price deviations relative to competitive pricing norms for stumpage fees. As part of this statistical analysis, we conducted extensive econometric modelling using the database of stumpage transactions, with the objective of identifying the key determinants of stumpage prices in New Brunswick. We also compared stumpage price deviations found in our analysis to price deviations reported in the academic literature for other industries and economy-wide in Canada and the US, as well as in similar industries from other jurisdictions.

Contents of this report

The report is structured into five chapters.

Chapter 1 is an introduction to the structure and operation of the primary forest products market in New Brunswick. It describes our scope of work and provides necessary background to our analysis, including sources of data and the assumptions made in the course of our analysis.

Chapter 2 is essentially descriptive. It presents a review and assessment of the structure and operation of the New Brunswick primary forest products market. It summarizes the organization of the primary wood product market in New Brunswick, from the forest to pulp and sawmills. The chapter also provides a review of the key participants in the primary forest products market, including the various suppliers and buyers of wood as well as the industry intermediaries, notably independent contractors. It reviews the different types of relevant transactions, including (i) Do-It-Yourself (DIY) sales, where woodlot owners harvest their own wood and then arrange trucking to the mill, (ii) Independent contractor transactions, where woodlot owners negotiate the sale of standing trees with an independent contractor; and (iii) Direct-to-Mill transactions, where the woodlot owner contracts directly with a mill for the sale of standing trees in return for stumpage. Finally, the chapter also presents the key economic concepts used in the report, including: the definition of a

market and the notions of market power, buyer concentration and price deviations. It also reviews the role and impacts of intermediaries (i.e. independent contractors) in relevant markets.

Chapter 3 of this report provides an overview of the primary forest products industries in other jurisdictions that may be considered as comparators to the New Brunswick industry and explains briefly why none of these jurisdictions is a good comparator for primary forest products market conditions in New Brunswick. It covers the supply and demand for primary forest products industries in Nova Scotia, Maine, Quebec and British Columbia.

Chapter 4 provides a description of the data and methods used in the statistical modelling of the New Brunswick primary wood industry. The purpose of the statistical and econometric analysis is to model the factors determining private woodlot stumpage prices across the province in order to identify whether or not there are any deviations in stumpage prices relative to prices prevailing in competitive markets (defined as markets with no concentration, no market power and prices equal to marginal cost) and if so, what the order of magnitude of these deviations may be. First, this chapter presents the analysis of Timber Utilization Survey data over time and across markets, wood species (hardwood and softwood) and product types (sawlog and studwood and pulpwood and roundwood chips). This analysis is intended to provide insights into the market behaviour of different market actors and to identify key market trends over time. The second part of the chapter presents the results of the econometric modelling.

The econometric modelling in Chapter 4 is based on a subset of marketing board transaction-level data which contains recorded stumpage prices paid to private woodlot owners. Most transaction-level data collected by marketing boards (by virtue of the administration fees they are mandated to collect on all private woodlot transactions) contain only mill gate prices. However, over the course of our project, we learned that marketing boards also provide contract administration services to independent contractors. We sought to collect this data as well as all other transaction-level data collected by the marketing boards, which required engaging in discussions with each individual marketing board. Upon acquisition of a marketing board dataset, we assessed, cleaned, standardized and weighted the acquired database to ensure our data was representative of each wood market and that the data was comparable across marketing boards. Details of the techniques used can be found in Appendix A of this report.

Chapter 5 summarizes our analytical findings, provides an interpretation of the results and places them in the broader context of New Brunswick's primary forest industry and other industries.

A. The results of our analysis indicate that there are six distinct marketplaces for private wood across New Brunswick, as defined in Appendix A:

   - North Shore market, primarily a hardwood market;
   - Carleton-Victoria market, a combined hardwood and softwood market;
   - Northumberland market, a combined hardwood and softwood market;
   - Softwood market for the York-Sunbury-Charlotte market area;
   - Softwood market for the Southern New Brunswick market area; and
   - York-Sunbury-Charlotte/Southern New Brunswick market for hardwood.

   We have not come to a view regarding the Madawaska and SENB marketing board areas, given the lack of stumpage price data from these marketing boards.

   The six defined markets for private wood are distinct not only in a geographic sense, but also in the sense of providing a potentially different balance of supply and demand for private wood; different selling choices for woodlot owners; different export markets and different approaches to wood harvesting (e.g., Madawaska has a higher proportion or woodlot owners harvesting their own wood).

Our review indicates that private wood volumes (including exports) in each of the defined markets have tended to be very pro-cyclical over time. Hence, this suggests that private woodlot production is very sensitive to changes in end market demand for wood products. It also implies that market prices for private stumpage are likely to incorporate the impact of changes in end market demand for wood products.

B. Our econometric analysis of private stumpage prices looked at the impact of market concentration, using HHI benchmarks to compare current levels of market concentration in New Brunswick primary wood markets to those in competitive markets (defined as markets with no concentration, no market power and prices equal to marginal cost, i.e. no price deviations). The results of our analysis are put in the context of price deviations found in other markets across North America. This is important because competitive markets are not necessarily common or prevalent in practice.

   The results of our analysis indicate that market concentration levels in excess of those in competitive markets resulted in price deviations for sawlogs and studwood from -2.5% to -11.0%. These price deviations are much lower in magnitude than comparable deviations for the Canadian and US economies overall (i.e. 53% and 78%, respectively), as well as comparable industries globally. In the case of pulpwood and roundwood chips, our analysis shows current levels of market concentration that are considerably higher than those exhibited for sawlogs and studwood. These higher concentration levels – when compared to those in competitive markets – result in larger price deviations (i.e. -14.8% to -38.4%) than for sawlogs and studwood, but these are still within the range of price deviations observed economy-wide in North America. The higher market concentration for pulpwood and roundwood chips can be attributed to the fact that pulp mills have historically been more capital intensive than sawmills, thereby drawing a greater share of wood from their respective market areas. Moreover, the increase in market concentration observed in the Northumberland, York-Sunbury-Charlotte softwood and Southern New Brunswick softwood markets over the 2002/03 to 2017/18 period under consideration was also driven by structural changes in the end-market demand for softwood pulpwood, which led to the closure of pulp mills and thereby higher market concentration in the affected market areas.

C. We developed multiple models to examine whether the relative share of Crown wood volumes in the defined markets had an impact on private stumpage prices. This included using multiple variables for representing the Crown wood share in the defined markets. Nonetheless, we could not find any evidence to the effect that this factor had a clear positive or negative impact on private stumpage prices in New Brunswick. Similarly, the empirical literature on the determinants of private stumpage prices is relatively mute on this issue.

Work assumptions

Deloitte has relied upon the completeness, accuracy and fair presentation of all the financial and other information, data, advice, opinions or representations obtained by it from the Government of New Brunswick, the marketing boards and their consultants and advisors (collectively, the "Information"). The analyses were prepared as at July 31, 2019. In the event that there is any material change in any fact or matter affecting the analyses after the date hereof, Deloitte reserves the right to change, modify or withdraw the report.

Deloitte believes that the analysis must be considered as a whole and that selecting portions of the analysis or the factors considered by it, without considering all factors and analyses together, could create a misleading view of the process underlying the analysis. The preparation of these analyses is a complex process and is not necessarily susceptible to partial analysis or summary description. Any attempt to do so could lead to undue emphasis on any particular factor or analysis.

The analysis is rendered on the basis of economic, financial and general business conditions prevailing as at the date hereof of. In the analyses, Deloitte made numerous assumptions with respect to industry performance, general business and economic conditions, and other matters, many of which are beyond the control of Deloitte.

For the purpose of this report, we used a number of data sources, including administrative data from marketing boards as well as publicly available datasets. It should be noted that the database built as part of this project is unique of its kind. It was the first known attempt at collecting, cleaning, standardizing and weighting all marketing board transactional data for the purpose of econometric modelling. As such, it is a highly informative and valuable tool in New Brunswick's primary wood forest market analysis.

Nevertheless, some limitations may apply to our database, including: missing data points, geographical areas not covered by available data, missing or inconsistent data fields, and other measurement errors and inconsistencies. While we attempted to address possible selection biases by applying generally recognized statistical procedures, it may be the case that this data preparation did not fully mitigate the potential selection bias from issues identified above.

In addition, there were some factors that we were told are significant in determining primary wood market conditions but which are not taken into account in our analysis due to missing data. Among these, the market for hardwood firewood, typically a cash market may significantly influence supply-side market concentration for hardwood by providing additional selling options to hardwood producers. In addition, changes in the incidence of independent contractor activity over the period may have played a significant role in reducing information asymmetry in the market, especially in terms of pricing. Unfortunately, there was no reliable data to quantify this phenomenon.

Despite the caveats listed above, we are generally satisfied with the level of quality achieved for the data we collected, as evidenced by the consistency of econometric results reported as part of Chapter 4, and that are aligned with theoretical expectations in terms of direction and magnitude of the impact the considered variables have on stumpage prices. The results we present in this report are within range of what is feasible and reliable for similar modelling exercises. As such, we reported conclusions that we deemed appropriate to draw given our modelling results and highlighted any limitations to these conclusions in the report.

The fee for our services is not contingent upon the conclusions.

1 Introduction

This chapter is an introduction to an independent study of the structure and operation of the primary forest products market in New Brunswick.

1.1 Background

Deloitte has been mandated by the New Brunswick Department of Energy and Resource Development to conduct an independent study of the structure and operation of the primary forest products market in New Brunswick. In the context of this study, the primary forest products market means the industry for softwood and hardwood timber and wood fibre used as the primary raw material input for manufactured forest products, i.e., softwood and hardwood lumber, pulp and OSB.

The purpose of the review is to provide relevant insights in relation to the New Brunswick primary forest products market structure and interactions between key industry players.

1.2 Scope of services

The scope of services agreed in the mandate letter covers the following elements:

- Perform a comprehensive review of the structure and operation of the primary forest products market in New Brunswick;
- Perform an analysis of the trends in New Brunswick stumpage fees and a comparison to trends in stumpage fees in other comparable industries, through the performance of data analytics, identification of impacts of movements in pricing variables and a qualitative review of public policies and procedures as it relates to stumpage fees in those industries; and
- Perform an econometric analysis to understand the determinants of stumpage prices in New Brunswick and identify whether prices are within the norms of competitive pricing or whether they depart from those norms, which may be a sign of price deviations, as defined in section 2.5.4 below.

1.3 Approach

Our approach to the scope above covered two phases. The first phase involved a qualitative assessment of the structure of the primary forest products market over time in New Brunswick, including data collection and interviews and the completion of the electronic database. The second phase involved undertaking a detailed statistical analysis and modelling exercise to assess the impact of market concentration on stumpage fees and any other sources of price deviations relative to competitive pricing norms for stumpage fees. As part of this statistical exercise, we conducted extensive econometric modelling using the database of stumpage transactions, with the objective of identifying the key determinants of stumpage prices in New Brunswick. We also compared stumpage price deviations found in our analysis to price deviations reported in the academic literature for other industries and economy-wide in Canada and the US, as well as in similar industries from other jurisdictions.

1.4 Contents of this report

The contents of this report are based on the results of our work throughout this project. Specifically, this includes:

- An assessment of the structure of the primary forest products market, as presented in chapter 2 below;
- A review of the key participants in the primary forest products market, including the various suppliers and buyers of wood as well as the industry intermediaries, also presented in chapter 2;
- A review of the market structure of the forest industry in Maine, Nova Scotia, Quebec and British Columbia, as presented in chapter 3;
- A definition of the regional forest products market(s) in New Brunswick, based on a geographic mapping of the marketing board transactions data, for the purpose of executing the econometric analysis. This is also included in chapter 4;
- The results of our quantitative analysis of the data described above, also presented in chapter 4;
- A synthesis of our analytical results and their implications from a market dynamic perspective, especially on private stumpage prices in New Brunswick, presented in chapter 5, and
- A list of acronyms, a glossary, a detailed description of data sources and data preparation tasks performed, as well as a bibliography and a list of all other resources consulted and interviewed as part of this project; as included in the appendices.

1.5 Work assumptions

In accordance with the Engagement Agreement, this analysis has been provided for the use of the Government of New Brunswick for the purpose described above.

Deloitte has relied upon the completeness, accuracy and fair presentation of all the financial and other information, data, advice, opinions or representations obtained by it from the Government of New Brunswick, the marketing boards and their consultants and advisors (collectively, the "Information"). The analysis is conditional upon the completeness, accuracy, and fair presentation of such Information. Except as expressly described herein, Deloitte has not attempted to verify independently the completeness, accuracy or fair presentation of the Information.

The Government has represented and warranted to Deloitte that, other than as specifically disclosed to us in writing or as contemplated in published financial documents, all information concerning the industry provided to us, directly or indirectly, orally or in writing, by the Government and/or its agents and advisors in connection with our engagement hereunder:

- was in the case of all historical financial information and statistical information concerning the industry, at the date of preparation, presented completely and fairly in all material respects; and
- was with respect to any portion of the financial and statistical information (a) prepared on a basis reasonably consistent with government and industry accounting policies; (b) prepared using reasonable assumptions; and (c) the senior officers of the Government have no reason to believe are misleading in any material respect.

No opinion, counsel or interpretation is intended in matters that require legal or other appropriate professional advice. To the extent that there are legal issues relating to assets, properties or business interests or issues relating to compliance with applicable laws, regulations, and policies, Deloitte assumes no responsibility.

The analysis is rendered on the basis of economic, financial and general business conditions prevailing as at the date hereof of. In the analyses, Deloitte made numerous assumptions with respect to industry performance, general business and economic conditions, and other matters, many of which are beyond the control of Deloitte.

The analyses were prepared as at July 31, 2019 and Deloitte disclaims any undertaking or obligation to advise any person of any change in any fact or matter affecting the report, which may come or be brought to Deloitte's attention after the date hereof. Without limiting the foregoing, in the event that there is any material change in any fact or matter affecting the analyses after the date hereof, Deloitte reserves the right to change, modify or withdraw the report.

Deloitte believes that the analyses must be considered as a whole and that selecting portions of the analyses or the factors considered by it, without considering all factors and analyses together, could create a misleading view of the process underlying the analyses. The preparation of these analyses is a complex process and is not necessarily susceptible to partial analysis or summary description. Any attempt to do so could lead to undue emphasis on any particular factor or analyses.

In arriving at our analytical conclusions, we relied upon the following additional major assumptions:

- Acquired data is representative and provide a fair characterization of market dynamics in the markets under review;
- Defined markets are representative of transactions occurring between sellers and buyers of wood products;
- The Ordinary Least Squares (OLS) model, and its underlying assumptions, apply to the data collected; and
- Data acquired is complete, valid and a fair characterization of the underlying transaction.

Should any of the above major assumptions not be accurate or should any of the information provided to us not be factual or correct, our conclusion could be significantly different.

For the purpose of this report, we used a number of data sources, including administrative data from marketing boards as well as publicly available datasets. In doing so, we relied on completeness and accuracy of data collected from different sources. It should be noted that the database built as part of this project is unique of its kind: it was the first known attempt at collecting, cleaning, standardizing and weighting all marketing board transactional data for the purpose of econometric modelling. As such, it is a highly informative and valuable tool in New Brunswick's primary wood forest market analysis.

Nevertheless, some limitations may apply to our database, including: missing data points, geographical areas not covered by available data, missing or inconsistent data fields, and other measurement errors and inconsistencies. While we attempted to address possible selection biases by applying generally recognized statistical procedures, it may be the case that this data preparation did not fully mitigate the potential selection bias from issues identified above.

As regards the administrative data used for our econometric analysis, it should be noted that a number of markets were not covered by our analysis, due to missing data (e.g., Madawaska marketing board). In other cases, while data was available, it may not have had all required data fields to perform a full econometric analysis, such as in the case for missing stumpage rates for a significant share of observations, or missing trucking and contractor rates in CV and to a lesser extent NTH. While we attempted to address possible selection biases by normalizing observations with stumpage against the whole database, it may also be the case that this data preparation did not fully mitigate the potential selection bias from unreported stumpage prices. In other cases, we had to restrict the number of years of analysis under review due to data limitations.

In addition, there were some factors that we were told are significant in determining primary wood market conditions but which are not taken into account in our analysis due to missing data. Among these, the market for hardwood firewood, typically a cash market may significantly influence supply-side market

concentration for hardwood by providing additional selling options to hardwood producers. In addition, changes in the incidence of independent contractor activity over the period may have played a significant role in reducing information asymmetry in the market, especially in terms of pricing. Unfortunately, there was no reliable data to quantify this phenomenon.

Despite the caveats inherent in any statistical analysis (see appendix A for more details), we are generally satisfied with the level of quality achieved for the data we collected, as evidenced by the consistency of econometric results reported as part of Chapter 4, and that are aligned with theoretical expectations in terms of direction and magnitude of the impact the considered variables have on stumpage rates. The results we present in this report are within range of what is feasible and reliable for similar modelling exercises. As such, we reported conclusions that we deemed appropriate to draw given our modelling results and highlighted any limitations to these conclusions in the report.

The fee for our services is not contingent upon the conclusions.

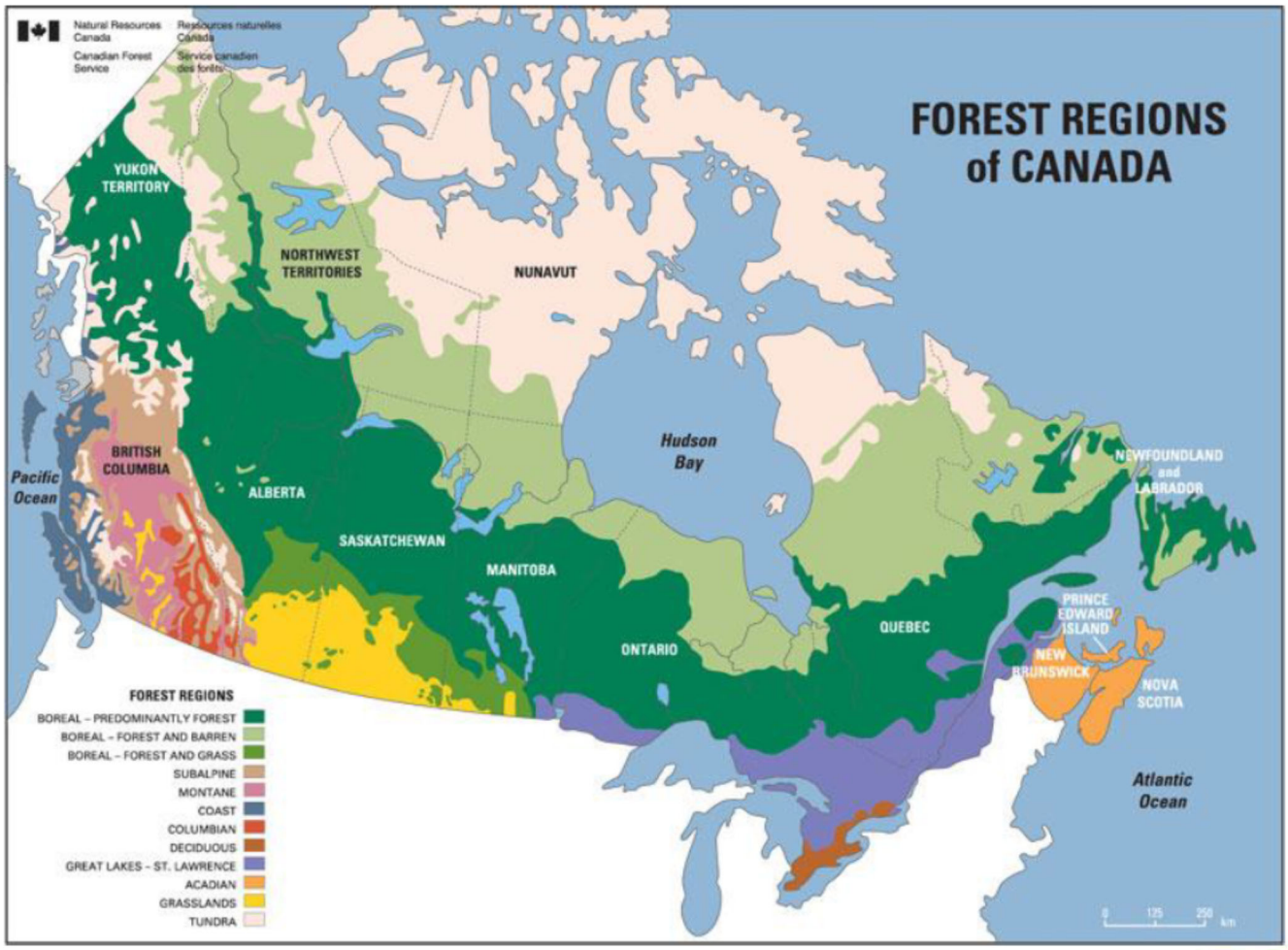
2 New Brunswick primary forest products market

This chapter provides an initial review of the structure and operation of the New Brunswick primary forest products market.

2.1 The Acadian forest of New Brunswick

The Acadian forest is one of Canada's twelve major forest regions. It is also the dominant forest region in New Brunswick.[1]

Chart 1: The Forest Regions of Canada



[1] In addition to the Acadian forest, a small portion of the Boreal forest is also in New Brunswick.

Source: Natural Resources Canada.

Natural Resources Canada defines forest regions as "a geographic zone … whose vegetation cover is characterized by a fairly uniform dominant species and stand type."[2] Indeed, the majority of Canada's regions – from the Boreal to the Coastal Forest – closely align to this classification.

Yet, the Acadian forest is an exception. The Acadian forest does not have a "fairly uniform dominant species and stand type". The Acadian forest is home to a heterogeneous mix of species, which is a result of its unique geographic location.

As explained by Natural Resources Canada researchers, Nadine Ives and Judy A. Loo, the Acadian forest is located between 43 and 48 north latitude and contains elements of the Boreal Coniferous Forest to its north and the Deciduous Forest to its south and west. This latitude, along with variations in topography, geology, and proximity to the Atlantic Ocean, gives rise to the diversity of species present in the Acadian forest.[3]

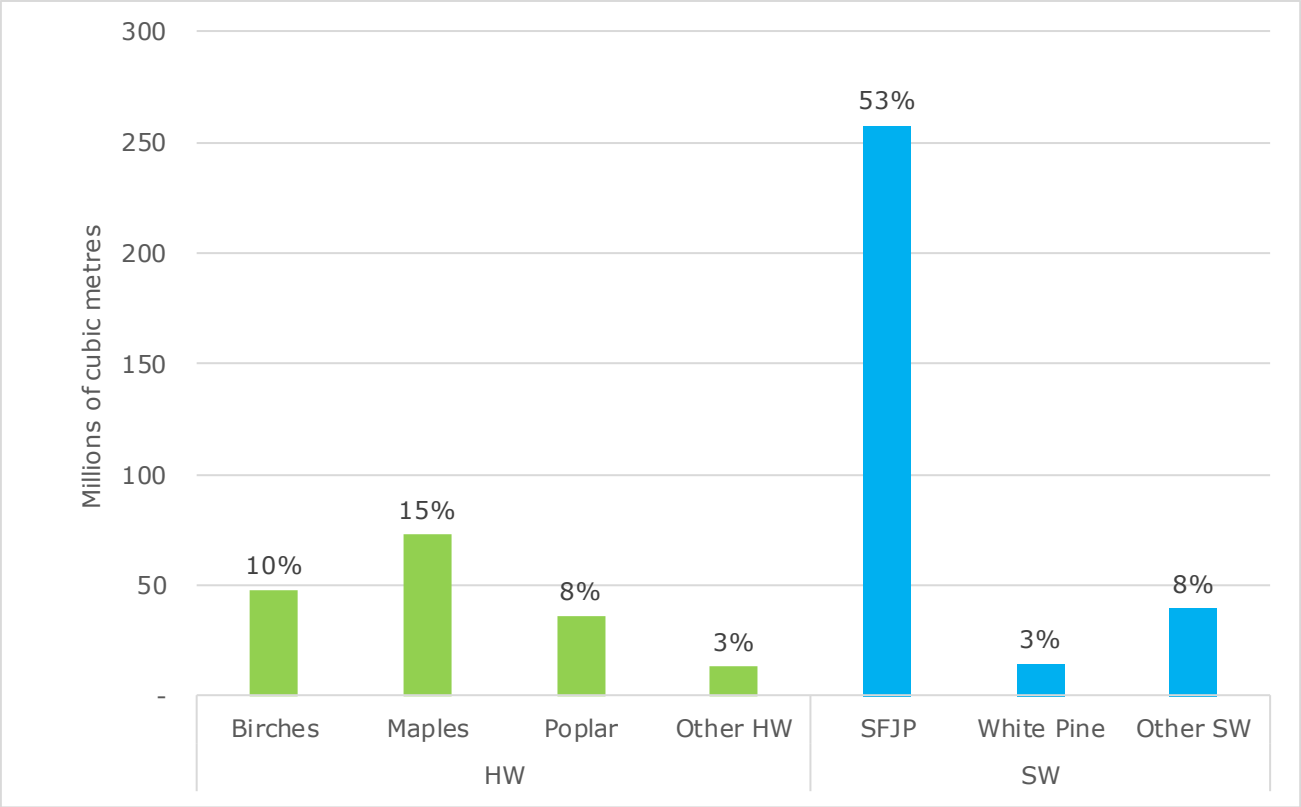
2.1.1 Tree species

There are approximately twenty commercial tree species in New Brunswick's Acadian forest.

Spruce-fir and Jack Pine are the most common species, accounting for 54% of the forest's merchandisable volume. This is followed by maple (15%), birch (10%), poplar (8%), and white pine (3%), among other softwood and hardwood tree species. Approximately 60% of tree species in New Brunswick's Acadian forest are softwood, while the remaining 40% are hardwood.

[2] Natural Resources Canada. Forest Classification. 2017.
[3] Loo J., Ives, N. The Acadian forest: Historical condition and human impacts. The Forestry Chronicle, 79(3), 462-474. 2003.

Chart 2: Major standing tree species in New Brunswick's Acadian forest, total merchandisable volume



Source: 2015 New Brunswick Forest Inventory Report.
Note: Percentages may not add up due to rounding.

Table 1: Softwood and hardwood species in New Brunswick's Acadian mixed forest

Major softwood species	Major hardwood species
• Balsam Fir	• Ash
• Black Spruce	• Beech
• Eastern Cedar	• Grey Birch
• Eastern Hemlock	• Non-Commercial species
• Jack Pine	• Other Tolerant species
• Larch	• Poplar
• Norway Spruce	• Red Maple
• Red Pine	• Sugar Maple
• Red Spruce	• White Birch
• White Pine	• Yellow Birch
• White Spruce	

Source: Canadian Encyclopedia.

2.2 The structure and regulation of the primary forest industry

New Brunswick's primary forest industry features multiple participants that operate under a single regulatory environment.

The transactions in New Brunswick's primary forest industry typically involve a four-phase process:

- Phase One – Stumpage Transaction: In the first phase, the different owners of wood (Crown, industrial freehold, private owners) sell standing trees located on their respective timber growing land in exchange for stumpage, which is the price of a standing tree. Stumpage values can be based on a variety of measurement units (e.g., cord, cubic metre, etc.);
- Phase Two – Harvesting: In the second phase, a contractor (or woodlot owner) harvests (i.e., cuts) the standing trees. The contractor will then bring the timber to a nearby road for transportation;
- Phase Three – Transportation: In the third phase, a trucker collects the timber from the road and transports them to a mill; and
- Phase Four – Milling and end products: In the fourth phase, a mill transforms the timber into converted forest products.

In practice, the flow of goods in New Brunswick's primary forest products market is more intricate. The actual flow takes different forms depending on the type of landowner, which participants are involved and to what extent their operations are integrated. For instance, a woodlot owner may harvest the wood from its land, as opposed to paying a contractor to complete that phase of harvesting.

Moreover, not all the wood supply and purchase transactions are equivalent. The sale of wood from privately-owned woodlots can be treated as *market transactions*, because the vast majority of the transactions occur on an arms-length basis between buyers (e.g., contractors or mills) and sellers (e.g., woodlot owners) representing different and distinct private ownership interests. Hence, the resulting stumpage prices can be viewed as set in a marketplace.

The sale of wood from Crown lands is administered through a system of licensees and sub-licensees, which are forest products companies present in New Brunswick. Generally speaking, licensees are responsible for managing allocated harvesting volumes on the territory they are responsible for, while both licensees and sub-licensees are responsible for harvesting operations. More details on this interaction are laid out in following sections. Sales of Crown wood are not market transactions because these are based on stumpage prices set by the Government of New Brunswick. These Crown stumpage prices are considered administered prices rather than market prices.

The sale of wood from industrial freeholds cannot be considered as market transactions either, because in this case, ownership is vertically integrated between the industrial freeholds and the mills. Hence, the prices, even if available, would be considered transfer prices and not market prices. However, some third-party sales between companies with Crown allocations and mills under different ownership and control can also be considered to take place at market prices, but these prices are closer to mill-gate prices than to stumpage prices.

Once the fourth phase is complete, the end products made in New Brunswick's sawmills, pulp mills and oriented strand board ("OSB") mills are primarily consumed by the construction, paper products and industrial product industries, respectively. Ultimately, market conditions in those industries play an important role in setting the demand conditions and driving the cyclical and structural trends within New Brunswick's primary forest sector.

As this industry has complex arrangements between multiple industry stakeholders, including mills, contractors, truckers and woodlot owners, all of which take place within the regulatory framework set by the Government of New Brunswick, a review of the industry structure may help to better understand the industry dynamics. This section aims at providing the reader with sufficient depth on the industry to appreciate its complexity and the analysis that follows.

2.3 The structure and regulation of the primary forest industry

2.3.1 The ownership structure of forest lands

The New Brunswick forest serves a wide array of purposes. The multiple uses of the forest range from recreational and tourist uses, to industrial and conservation or preservation uses. A study commissioned in 2007 by Natural Resources Canada surveyed over 1,500 randomly selected New Brunswick residents. The study's findings revealed that different uses of the forest were supported by different population segments. For example, the respondents living in the forest-dependent regions had a more positive view on the economic uses of the forest, compared to more urban areas, where a higher value was placed on the protected areas and public management of the forest.[4]

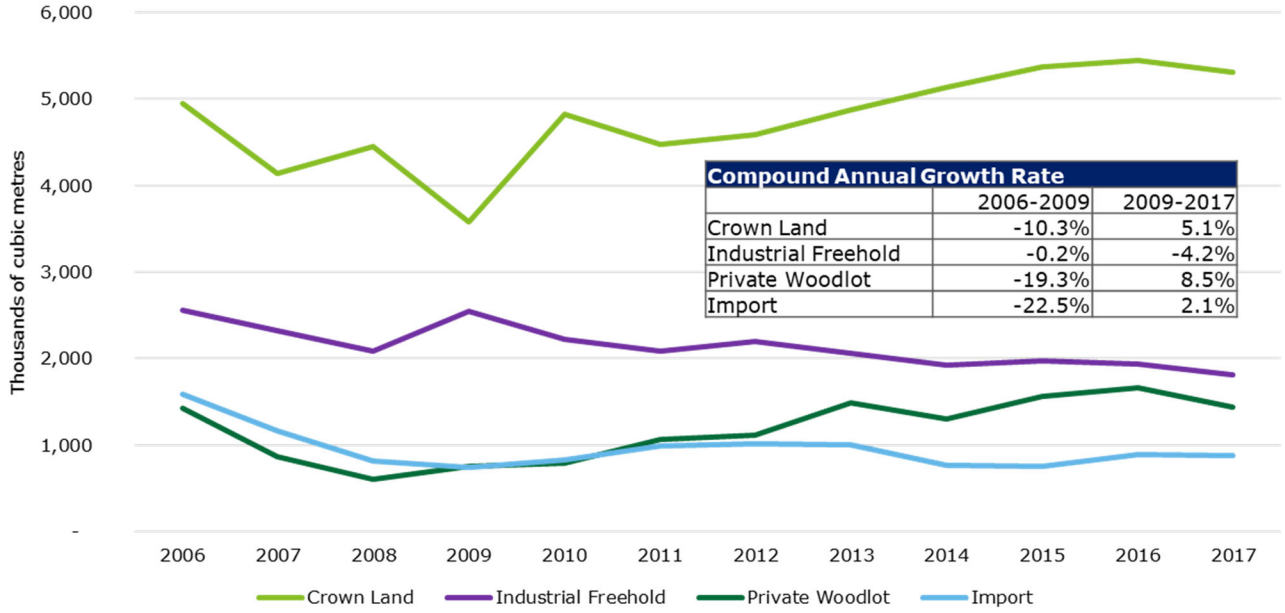
The survey also highlighted the population's expectations for conservation strategies and policies that promote biodiversity in New Brunswick's forest. This Forest Management Survey reported that the protection of water, air, and soil for a variety of animal and plant life species was ranked as the most important forest value for the people of New Brunswick. In a 2011 submission to the New Brunswick Crown Land Task force, these views were also supported by environmental groups which expressed interest in an increase in Protected Natural Areas (PNAs).[5]

Regardless of the use they make of the forest, landowners are a key industry participant in the New Brunswick forest industry. It is worth noting that their use of the forest may change, in response to a change in market conditions or regulations that impact business decisions. For the purpose of this report, however, our analysis will be focused on timber extraction activities. From this perspective, New Brunswick landowners represent the main sources of wood supply in New Brunswick, which are complemented by imports from neighbouring jurisdictions. They own the raw product – standing trees – that is harvested and purchased for manufacturing in New Brunswick's forest products industry. There are five key categories of landowners in New Brunswick:

- Private woodlot owners;
- Industrial freehold;
- Crown Land;
- Federal Crown Land; and
- First Nations Land.

[4] Public Views on Forest Management in New Brunswick: Report from a Provincial Survey. 2007.
[5] New Brunswick Crown Land Task Force. A path for a sustainable economic forest in New Brunswick: Report by New Brunswick Crown Land Task Force. October 13, 2011.

Chart 3: Annual timber supply to New Brunswick mills, by source[6]



Source: Timber Utilization Survey.
Note: In this chart, Federal Crown Land supply is omitted because of the small volume supplied relative to other sources. While imports are not a landownership type, imported volumes are added because they account for a significant share of timber supply.

Private woodlot owners

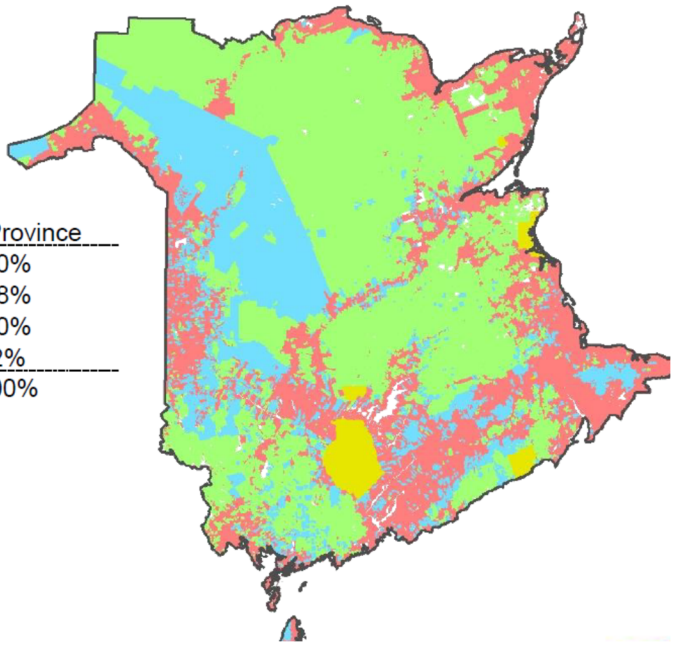
Private woodlot owners refer to private owners of productive land that is suitable for forestry (i.e., woodlots). In New Brunswick, there are more than 40,000 private woodlot owners. Collectively, woodlot owners hold approximately 30% of New Brunswick's forest lands (1.8 million hectares). Private woodlot owners are defined as those who own between 10 to 10,000 hectares and whose principle business is not the operation of a wood processing facility.

In 2017, private woodlot owners provided 15.2% of the timber supply from New Brunswick. This follows a period of 8.5% growth (CAGR) in supply between 2009 and 2017. The share of wood supplied by private woodlot owners reached a trough at 9.8% in 2009, after a drop in volumes of 19.3% (CAGR) from 2006 to 2009, due to the 20082009 recession.

[6] For a detailed breakdown of timber production, by source (e.g., production of each product/species by each license) please see the appendix.

Chart 4: Landownership of New Brunswick forest lands

Ownership	Area ('000 ha)	% of Province
Crown Land	3,085	50%
Industrial Freehold	1,093	18%
Private Woodlots	1,814	30%
Federal	136	2%
Total	6,129	100%



Source: Government of New Brunswick, Department of Energy & Resource Development.

Industrial freehold

Industrial freehold refers to land that is productive, suitable for forestry and owned by private forest product manufacturers or companies that sell their wood to such manufacturers. In New Brunswick, there are five major holders of industrial freehold land:

- Acadian Timber;
- AV Group;
- Fornebu Lumber;
- H.J. Crabbe & Sons; and
- J.D. Irving.

Most of these entities are typically large-scale and control many aspects of the forest product production operations, from owning parcels of land, to harvesting and manufacturing wood products. Acadian Timber does not own timber converting facilities. Collectively, industrial freehold land accounts for approximately 18% of New Brunswick's forest areas (1.1 million hectares). Industrial landowners are defined as private entities owning more than 10,000 hectares of land or whose principle business is operating one or more wood processing facilities.

Wood harvested from industrial freeholds in New Brunswick decreased by 4.2% between 2009 and 2017 (CAGR), from 2,500 thousand cubic metres to 1,800 thousand cubic metres. This has resulted in a decline in the share of wood harvested from industrial freeholds from 33.4% in 2009 to 19.1% in 2017.

Crown Land

Crown Land refers to land that is productive, suitable for forestry, and owned by the Province of New Brunswick. As outlined in the next section, it is managed by licensees and operationalized by sub-licensees under provincial government oversight. A number of these licensees are forest product manufacturers that

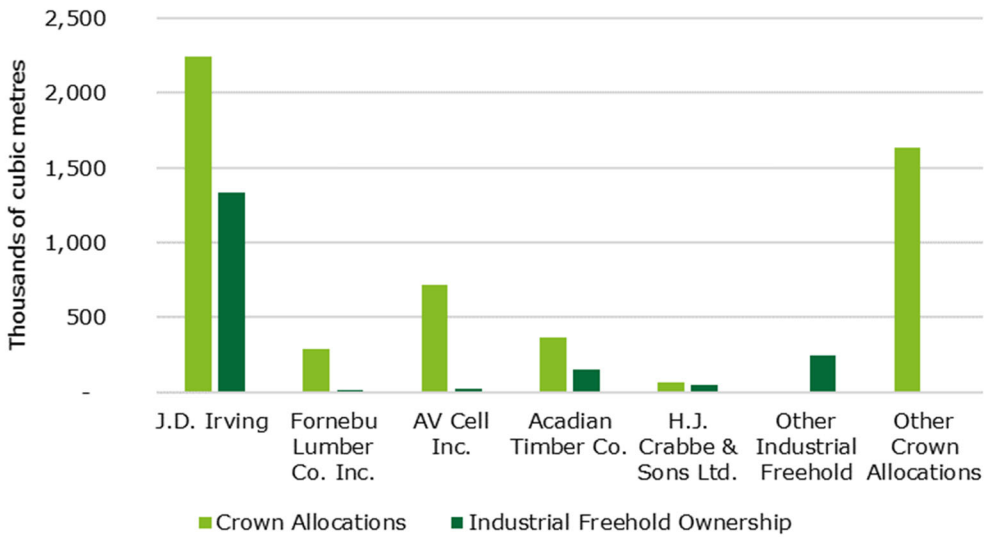
also own industrial freehold land. Crown Land accounts for 50% of New Brunswick forests (3.1 million hectares).

Wood supply from Crown Land in New Brunswick grew steadily at 5.1% average annual growth between 2009 and 2017. This growth is in part due to an increase in the Annual Allowable Cut ("AAC") levels in 2014. Between 2009 and 2017, the Crown Land share of wood harvested increased from 50.0% to 56.2%

Federal Crown Land

Federal Crown Land refers to land that is productive, suitable for forestry, and owned by the Government of Canada. Federal Crown Land accounts for just 2% of New Brunswick forests (0.1 million hectares) and it supplies less than 1% of wood in New Brunswick. For the purpose of this report, Federal Crown Land and First Nations Land wood supply will not be examined further, given its marginal impact on the overall industry.

Chart 5: Production on industrial freehold and Crown Land by major forest product producers – consumed wood (2017)



Source: Timber Utilization Survey.

2.3.2 The regulatory framework

The Government of New Brunswick sets and enforces laws, regulations and policies that apply to the forest products industry.

New Brunswick's forestry policies are based on sustainable forest management principles (also known as the "forest management model"), scientific research and stakeholder consultations. The different regulations pursue objectives related to environmental protection, public safety, and data reporting, in addition to general forest sustainability oversight. Overall, there are several key laws that apply to New Brunswick's forest products industry:

- Crown Lands and Forests Act;
- Forest Products Act;
- Transportation of Primary Forest Products Act;
- Forest Fires Act;
- Clean Water Act;
- Heritage Conservation Act;
- Parks Act; and

- Scalers Act;
- Natural Products Act;
- Protected Natural Areas Act.

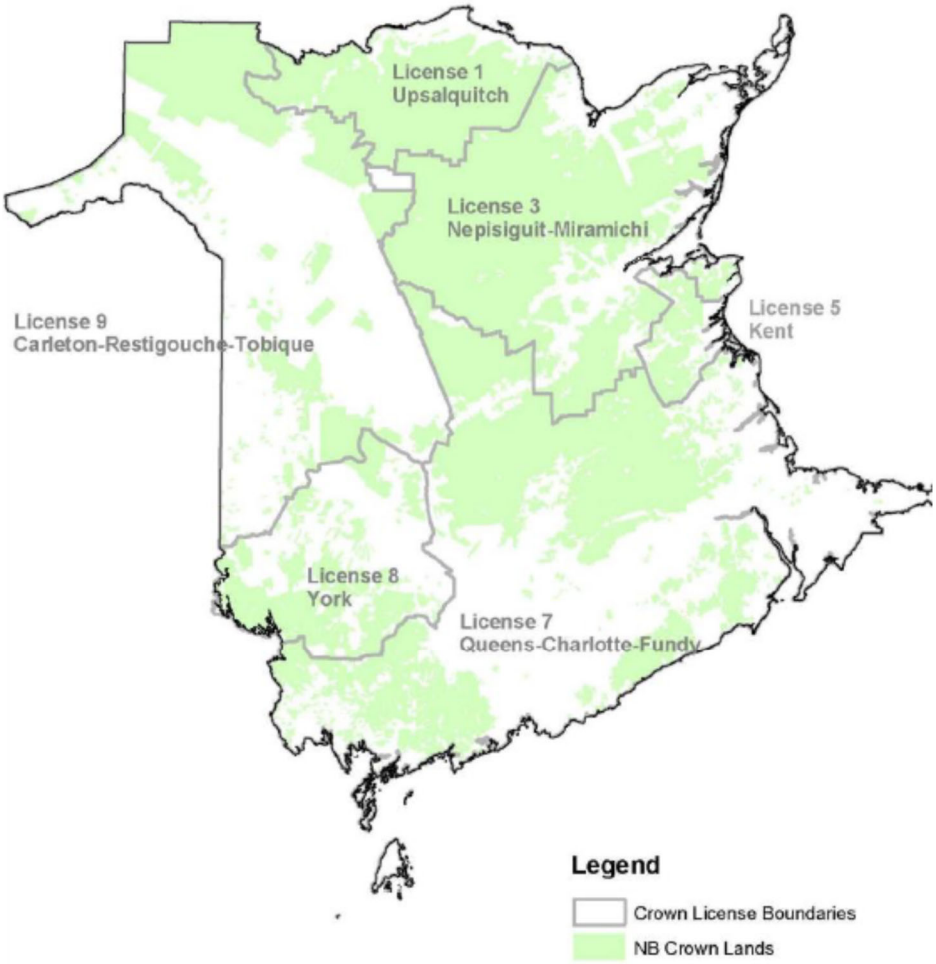
The remainder of this section provides a brief summary of selected legislation and key terms used in the industry.

Crown Lands and Forests Act

The Crown Lands and Forests Act (1982) plays an important role in governing Crown Land. The Act allows the Minister of Energy and Resources Development to set goals and objectives for the management of Crown Lands. It also allows the Government to allocate an area of the Crown Lands to a Licensee, generally a forest products company, which in turn must manage the land in line with a 25-year management plan. These responsibilities include silviculture and other land management activities as well as harvesting wood in line with the AAC. The harvesting responsibilities can also be assigned by the Licensee to a Sub-licensee. However, each Sub-licensee must own a forest products mill which will convert the timber from the License area.

Specifically, the act divides Crown Lands into six (originally ten) License Management Areas – known as Crown Licenses. These Licenses are granted to forestry products companies – known as Licensees – based on a standard Forest Management Agreement ("FMA") between the Crown and the licensee. First Nations communities have been allocated 5% of the provincial Crown allowable harvest level. Sub-licensee mills have defined timber allocations under each License.

Chart 6: New Brunswick Crown Land and License management areas



Source: Government of New Brunswick, June 2017.

Through this structure, both the Licensee and the Sub-licensee interact with the government. However, their roles are technically separate: both have rights to harvest timber from Crown land, but licensees have additional responsibility to manage the license area.

The government receives compensation from licensees via levying royalties (or Crown stumpage) on the timber harvested from Crown Land. Section 59(1) of the *Crown Lands and Forest Act* requires that stumpage charged for timber harvested from Crown Land be based on the fair market value of the standing timber. In order to achieve this goal, Crown stumpage rates are based on a fair market value survey which was historically performed every three to five years by a third-party. The results of these surveys were then used as the basis for setting the Crown stumpage rate for each species and class of timber. For the years between surveys, the base rate was indexed using a pre-determined set of market prices applicable to each species/product combination. Before the adjusted rates can be applied, they must be approved by the Lieutenant Governor-in-Council, and Schedule A (Regulation 86-160 of the *Crown Lands and Forests Act*) must be amended to reflect the new rates.

This survey's methodology has also evolved over time, but its latest iterations collected information on a number of transaction parameters, including: transportation certificate and scale bill, geographical source of

wood, species, wood products, volume of wood, unit of measurement, destination mill, stumpage paid and marketing board region from where the timber was harvested.

The Crown also establishes the License Management Fees (LMFs) by which the Crown compensates Crown licensees for the forest management activities that licensees are required to perform on behalf of the Crown. LMFs are set by the New Brunswick Department of Energy and Resource Development ("ERD").

The table below shows the list of Crown licenses, licensees and sub-licensees, where relevant.

Table 2: Licenses and Sub-licenses of New Brunswick Crown Land

No. – License	Licensee	Sub-licensees
1 – Upsalquitch	AV Cell Inc.	• Chaleur Sawmills Associates • Clair Industrial Development • Groupe Savoie Inc. • J.D.I. (Baker Brook) • J.D.I. (Doaktown) • J.D.I. (Kedgwick) • Junction Lumber Products Inc. • Kedgwick Lumber Co. Ltd. • Les Cèdres Balmoral Ltée • Marwood Ltd. (Nasonworth) • Twin Rivers Paper Company • Riverstone Plywood Inc., and • York North Veneer Products Inc.
3 – Nepisiguith-Miramichi	Fornebu Lumber	• Arbec Forest Products • AV Cell Inc. • AV Nackawic Inc. • Chaleur Sawmills Associates • Delco Forest Products Ltd. • Goguen Lumber • Groupe Savoie Inc. • J.D.I. (Baker Brook) • J.D.I. (Doaktown) • J.D. Irving, Limited • Junction Lumber Products Inc. • Kedgwick Lumber Co. Ltd. • Leger Firewood Ltd. • Les Cèdres Balmoral Ltée • Marwood Ltd. (Nasonworth) • Miramichi Lumber Products Inc. • Miramichi Timber Frames • R. F. Sadler Ltd. • Riverstone Plywood Inc. • SBC Cedar Inc. • Seacoast Fishing Supply Ltd. • Stewart Lumber Products (2010) • Twin Rivers Paper Company, and • York North Veneer Products Inc.
5 – Kent	ERD – Kent License Management Team	• Arbec Forest Products • Delco Forest Products Ltd. • Goguen Lumber

No. – License	Licensee	Sub-licensees
		• J.D.I. (Doaktown) • Junction Lumber Products Inc. • Les Cèdres Balmoral Ltée, and • Riverstone Plywood Inc.
7 – Queens - Charlotte-Fundy	J.D. Irving, Limited	• Ashmore Ltd • CANUSA Cedar Inc. • Clair Industrial Development • Devon Lumber Co. Ltd. • Flakeboard Co. Ltd. • Goguen Lumber • Groupe Savoie Inc. • J.D.I. (Baker Brook) • J.D.I. (Doaktown) • J.D.I. (Veneer) • Marwood Ltd. (Nasonworth) • R. F. Sadler Ltd. • Riverstone Plywood Inc. • SBC Cedar Inc. • Seacoast Fishing Supply Ltd. • William F. Tompkins & Sons Ltd., and • York North Veneer Products Inc.
8 – York	AV Nackawic	• Ashmore Ltd. • AV Cell Inc. • CANUSA Cedar Inc. • Clair Industrial Development • Delco Forest Products • Devon Lumber Co. Ltd. • Flakeboard Co. Ltd. • Fornebu Lumber Company Inc. (Bathurst) • Garant, Div. of Hanson Kidde Canada Inc. • Groupe Savoie Inc. • H. J. Crabbe & Sons Ltd. • J.D.I. (Baker Brook) • J.D.I. (Veneer) • J.D.I. (Doaktown) • John W. Jamer Ltd. • Marwood Ltd. (Nasonworth) • R. F. Sadler Ltd. • Riverstone Plywood Inc. • Twin Rivers Paper Company • William F. Tompkins & Sons Ltd., and • York North Veneer Products Inc.
9 – Carleton-Restigouche-Tobique	Twin Rivers	• Ashmore Ltd. (Harvey) • AV Cell Inc. • AV Nackawic Inc. • CANUSA Cedar Inc. • Clair Industrial Development • Flakeboard Co. Ltd. • Garant, Div. Of Hanson Kidde Canada Inc. • Groupe Savoie Inc.

No. – License	Licensee	Sub-licensees
		• H. J. Crabbe & Sons Ltd. • Harvey Farm & Forest Ltd. • J.D.I. (Baker Brook) • J.D.I. (Veneer) • J.D.I. (Doaktown) • J.D.I. (Kedgwick) • J.D.I. (St. Leonard) • John W. Jamer Ltd. • Kedgwick Lumber Co. Ltd. • Lattes Waska Laths Inc. • Marwood Ltd. (Nasonworth) • R. F. Sadler Ltd. • Riverstone Plywood Inc. • William F. Tompkins & Sons Ltd., and • York North Veneer Products Inc.

Source: Government of New Brunswick.
Note: In addition to sub-licensees, First Nations communities also have Annual Allocation of Timber in each license region. The non-consecutive nature of licenses numbering is a legacy from the original ten licenses and subsequent changes.

Historically, Crown allocations are one of the sources of wood that contributes to security of supply. The Crown allocation is intended to provide long-term security of wood supply to the mills, thereby contributing to align the wood supply available to mills with the extended useful life of the mill's productive capacity. It is difficult to attract investment in new or refurbished mill productive capacity without a security of wood supply from Crown lands and other wood sources over the relevant investment horizon. In 2011, the Crown Land Task force acknowledged that the security of supply from Crown wood is crucial to attracting private investments and that this also benefits the private woodlot sector in terms of additional demand for private wood.[7]

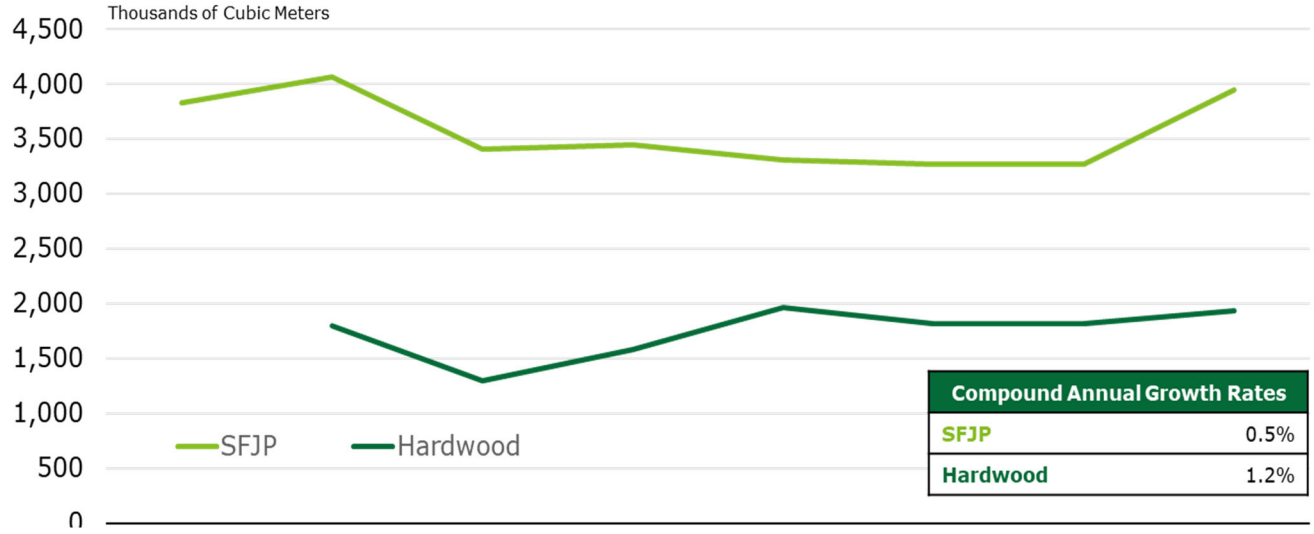
[7] New Brunswick Crown Land Task Force. A path for a sustainable economic forest in New Brunswick: Report by New Brunswick Crown Land Task Force. October 13, 2011.

Annual Allowable Cut

In addition to managing licenses, the *Crown Land and Forests Act* sets management goals and regulations, such as the AAC. The AAC designates the amount of timber in cubic metres that can be harvested from each Crown License annually. The objective of the policy is to ensure long-term timber supply sustainability. The sustainable yield of a given forest is the extraction rate of the resource which does not exceed the growth rate of the resource, i.e., the sustainable yield aims at preserving the renewable nature of the resource.

The AAC is set for five-year periods and allows for +/- 10% variations in annual harvests around the average annual AAC rate, so that licensees and sub-licensees may be responsive to many factors, including: harvesting capacity, weather, variations in demand, etc. Supply may exceed average AAC in one year, so long as it is reduced proportionately over subsequent years in the five-year term.

Chart 7: Annual Allowable Cut, SFJP and hardwood, 1982-2018



Source: Government of New Brunswick.

From an enforcement perspective, the ERD monitors compliance with the *Crown Lands and Forest Act* (including the AAC) through continuous assessments of the planning, harvesting, accessing, and silviculture practices of licensees. The ERD's operational expectations are outlined in the *Forest Management Manual* ("FFM") for New Brunswick Crown Lands. Licensees that do not meet the province's standards are mandated to work with the ERD to develop action plans to improve their outcomes. With respect to the AAC, licensees that are non-compliant with the AAC by the conclusion of each five-year period are at risk of their license not being renewed.

Proportional supply

Finally, the Crown Lands and Forest Act article 3(2) mandates ERD, through its minister, to *"encourage the management of private forest lands as the primary source of timber for wood processing facilities in the Province consistent with subsection 29(7.1)"*. While Crown wood supply has increased over time, it is not clear what the driving forces are behind such a change. The 2011 Private Forest Task Force reports that the share of wood supplied by private woodlots fell from thirty-eight per cent in 1990-1991 to nine percent in 2010-2011[8].

[8] Private Forest Task Force Report. A Snapshot of New Brunswick non-industrial forest owners in 2011: Attitudes, behaviour, stewardship and future prospects.

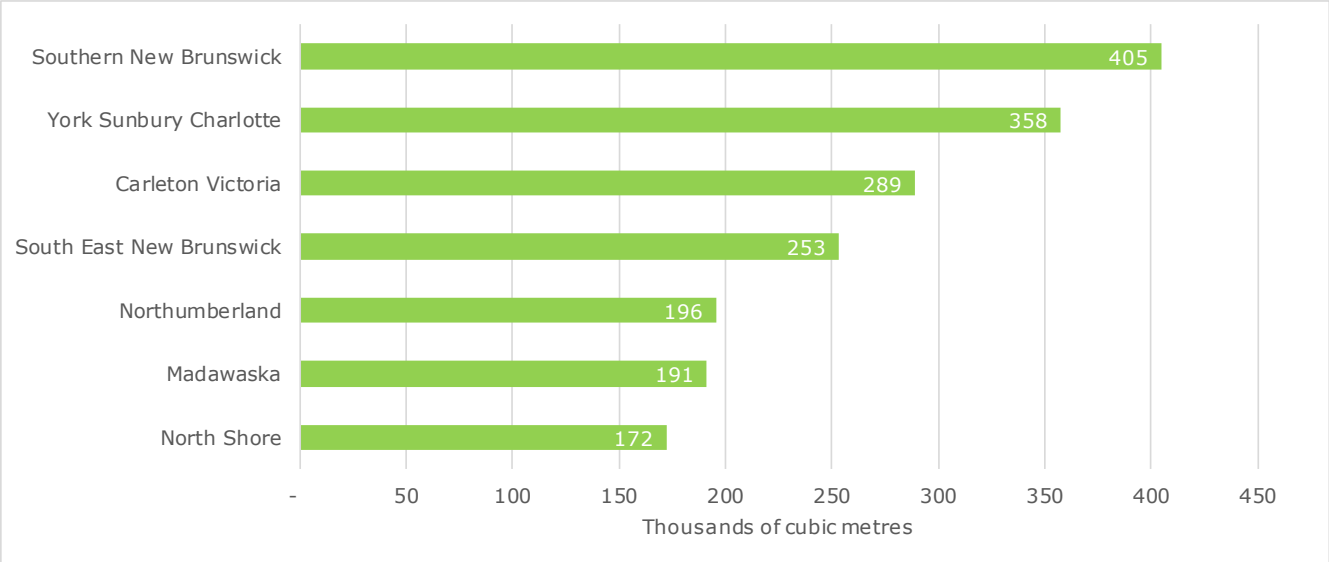
Natural Products Act and the New Brunswick forest products marketing boards

The *Natural Products Act* sets up the seven marketing boards which represent private woodlot producers in their respective geographies. In practice, these marketing boards offer financial and technical services to private woodlot owners, which tend to be small-scale and without significant resources. There are seven marketing boards, each of which represent a region of New Brunswick:

- North Shore Forest Products Marketing Board (NSH);
- Northumberland Woodlot Owners Association (NTH);
- South Eastern NB Forest Products Marketing Board (SENB);
- Southern New Brunswick Forest Products Marketing Board (SNB);
- York Sunbury Charlotte Forest Products Marketing Board (YSC);
- Carleton-Victoria Wood Producers Association (CV); and
- The Office de vente des produits forestier du madawaska (Madawaska).

It should be noted that the origin of several of the marketing boards dates back to the 1960s and 1970s, when these were set up via a plebiscite of owners in each region – i.e., prior to the board implementation period in the early 1980s (e.g., Madawaska, 1962; North Shore, 1973; Northumberland 1974).[9]

Chart 8: Wood harvested by marketing board region (2017)



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database. Data includes wood supplied for domestic use as well as exports.

[9] SNB. Challenges Facing New Brunswick Woodlot Owners: What are the possible solutions? Slide presentation to Deloitte Team. September 2018.

The legislation and regulations underpinning the New Brunswick marketing boards would suggest that the marketing boards have the power to control the supply of wood from private woodlots in their respective areas and thereby influence (if not set) the stumpage prices which woodlot owners receive for their wood.[10] However, in practice, this does not appear to be the case because woodlot owners are not required to sell their wood through their local marketing board (although they are required to pay the marketing board an administrative fee for each wood sale).

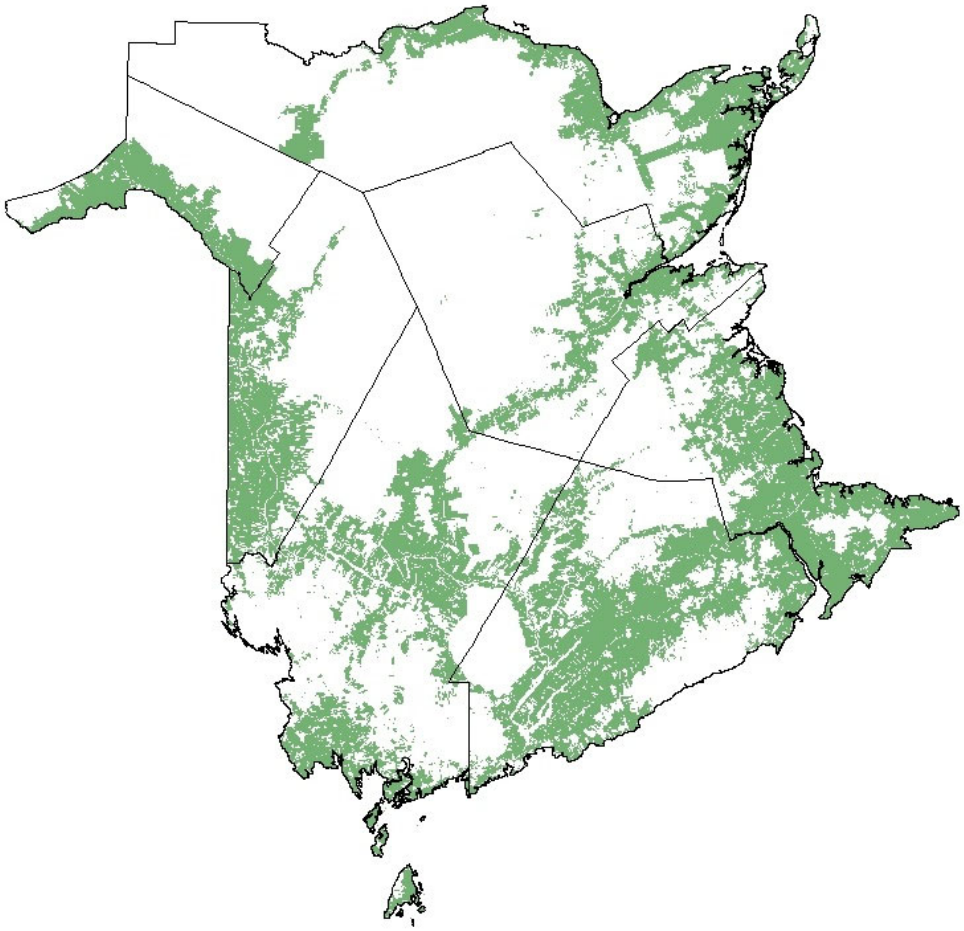
Some marketing boards negotiate contracts to supply wood to certain mills in their vicinity. These contracts set the mill gate prices for the wood product and in some cases also set the volume of wood to be delivered. However, marketing boards do not control the volume of wood sold through these contracts, let alone the volume of wood sold in their marketing board area. Once the marketing boards negotiate the contracts, it is up to the woodlot owners to decide on the volume of wood to be delivered to each specific mill under the terms of the contract. Woodlot owners can choose to sell their wood through a marketing board contract, if available, but they can also choose instead to sell their wood to a number of independent contractors (who may then arrange to harvest, transport and sell the wood to mills). In some areas, they can also sell the wood directly to mills (or to contractors harvesting wood on behalf of local mills). Hence, it is not clear that the marketing boards have any power to set or even influence stumpage prices, despite the fact that they may bundle a number of wood sales under a single contract. Additionally, marketing boards do not appear to restrict entry of new landowners to the market.

The marketing boards provide a number of valuable services to woodlot owners (e.g., management advice, scientific evaluation and support, and other technical information services, including silviculture) as well as to independent contractors. For example, we learned that many marketing boards provide contract administration services to independent contractors, who have entered into contracts with individual woodlot owners to harvest their wood and sell it to mills. In these cases, the marketing board collects the revenue paid by the mill (for the wood purchased); pays the agreed stumpage to the woodlot owner; takes its administration fee as stipulated by regulation; pays off any other contractors involved in getting the wood to the mill gate (e.g., trucker) and remits the remainder to the independent contractor.

[10] See Appendix IV of Report of the Auditor General – 2015 Volume II, Ch. 4, p. 232, which states that "Section 9 and 10 of regulation 2014-1 details many specific powers of marketing boards. Among these are [the power] …

- to market the regulated product
- to prohibit the marketing or the production and marketing, in whole or in part, of the regulated product
- to regulate the time and place at which, and to designate the body by or through which, the regulated product shall be marketed or produced and marketed."

Chart 9: New Brunswick marketing boards



Source: New Brunswick Forest Product Commission.

Forest Products Act and the New Brunswick Forest Products Commission

In 1971, the Forest Products Act created the New Brunswick Forest Products Commission, which is an "*independent Commission overseeing the marketing relationships involving forest industries (pulp mills and sawmills); forest products marketing boards (private woodlot owners and producers) and the provincial government*".[11] The Commission draws its authority, duty and responsibilities from the Natural Products Act, which also created the New Brunswick Forest Products Marketing Boards.

[11] Natural Resources and Energy Development. Forest Products Commission.

The Commission is composed of seven members: a chairman, two representatives from the industry (one from pulp mills and one from sawmills), two representatives of woodlot owners and two representatives from ERD. It reports directly to the Minister of Energy and Resources Development.

Overall, the Commission is responsible to oversee the "*conduct of the regulated forest products marketing system for private lands in New Brunswick. It is responsible for ensuring that the Boards exercise the powers granted to them in the manner intended."* It does so by encouraging and facilitating the expansion of wood markets, fair pricing for both wood producers and consumers as well as "optimizing the utilization of private woodlot resources".[12]

2.3.3 Mills

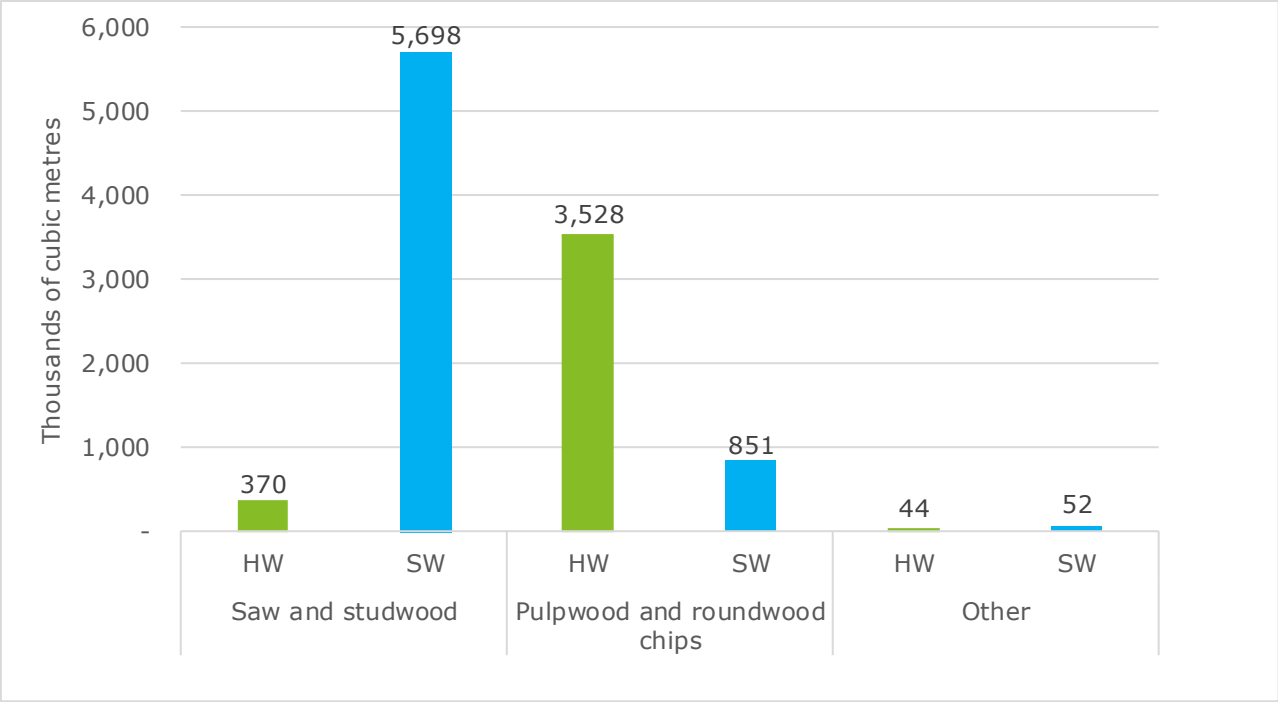
Mills, most of which are owned by large forest products companies, set the demand for timbers in New Brunswick. They use timbers as an input to manufacture wood products. The demand for timbers in New Brunswick is largely driven by five forest products companies. In addition, mills in neighboring jurisdictions in Canada (e.g., Nova Scotia and Québec) and the US (e.g., Maine) also contribute to the demand for New Brunswick timber.

In 2017, J.D. Irving, Limited ("JDI") represented the largest forest products company manufacturing wood products, with mills under its ownership consuming 53% of timber supply (5,000 thousand cubic metres). Other notable manufacturing groups are AV Group (11%; 1,000 thousand cubic metres), Arbec Forest Products (6%; 600 thousand cubic metres), Chaleur Sawmills Associates (6%; 600 thousand cubic metres), Twin Rivers (6%; 600 thousand cubic metres), Groupe Savoie Inc. (5%; 500 thousand cubic metres), and Fornebu Lumber (4%; 400 thousand cubic metres). Independent mills, not owned by a forest products company, account for about 10% of timber consumption.

The mills operating by these forest products companies typically specialize in operating either pulp mills or sawmills. Pulp mills require the pulp portion of a tree, while sawmills require the saw materials (sawlogs and studwood) to produce manufactured products.

[12] Natural Resources. New Brunswick Forest Products Commission: Annual Report 2013-2014. April 1, 2015.

Chart 10: Annual volume of wood harvested in NB by product categories in 2017



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.

The logs and studwood from New Brunswick sawmills are primarily sold to the construction industry. The end product prices are typically determined by (i) the type of product and (ii) the type of tree species used in manufacturing. Ultimately there are two price categories that are relevant to logs and studwood:

- Lumber – SPF stud; and
- Panel – OSB, softwood plywood.

Lumber and panel wood product prices tend to follow construction cycles and, as such, were especially impacted by the last recession that was largely driven by the collapse of the US housing market. These prices declined from their peak in 2004 to the recessionary trough of 2009, with Panel prices showing the sharpest decline at -17.4% (CAGR) and Lumber – SPF stud prices experiencing a decline of 12.5%. However, prices have recovered over the post-recession period, from 2010 to 2018, with increases of 7.5% (Panel) and 4.4% (Lumber – SPF stud).

With respect to pulpwood, New Brunswick experienced a structural change in the utilization of this product which began a few years before the economic downturn. This structural change occurred as a result of significant mill closures brought about by reduced demand for publishing. These closures began in 2004, and New Brunswick's last newsprint mill closed in 2008.

Markets and uses for softwood and hardwood pulpwood in New Brunswick today are very different than they were prior to the economic downturn. The industry is far less dependent on the printing and publishing demand than it was. The majority of pulpwood from New Brunswick is now sold to companies that manufacture tissue products, OSB, dissolving pulp, particleboard, fibreboard, and specialty printing and packaging papers.

This reduction in overall pulp fibre demand has allowed pulp and paper mills to source more sawmill chips which may negatively impact demand and value of softwood pulpwood in the stumpage market.

There are two price categories that are relevant to pulpwood:

- Northern Bleached Softwood Kraft pulp; and
- Bleached Hardwood Kraft pulp.

On average, Bleached Hardwood Kraft Pulp prices are 6.8% lower than Northern Bleached Softwood Kraft Pulp over the 2007-2018 period. Nevertheless, the two price categories generally show a similar growth pattern.

A lack of data prevented us from calculating the pre-recession price changes for Kraft Pulp. However, Northern Bleached Softwood Kraft pulp showed muted growth over the 2010-2018 period, at 1.4% (CAGR), while prices for Bleached Hardwood Kraft pulp stagnated at -0.1% (CAGR) over the same period.

Table 3: Key end product prices (2000-2018)

Year	Lumber – SPF stud (US$ per thousand board feet)	Panel – OSB, softwood plywood (C$ per thousand sq. ft.)	Northern Bleached Softwood Kraft pulp (US$)	Bleached Hardwood Kraft pulp (US$)
2000	256	341		
2001	270	308		
2002	311	335		
2003	268	440		
2004	371	525		
2005	366	397		
2006	293	307		
2007	265	279		
2008	212	193	662	698
2009	190	202	561	508
2010	253	283	774	755
2011	252	255	769	701
2012	310	319	653	644
2013	335	348	674	663
2014	341	323	726	602
2015	272	337	622	616
2016	240	393	598	527
2017	353	489	683	594
2018	357	503	867	748
CAGR 2004-2009	-12.5%	-17.4%		
CAGR 2010-2018	4.4%	7.5%	1.4%	-0.1%

Source: Madison's Canadian Lumber Reporter and Brian McClay & Associates.

2.3.4 Contractors and other industry participants

Forest product manufacturers are often supported by contractors and truckers, both of which are important participants in New Brunswick's forest product industry. Contractors harvest the timbers and truckers bring the primary forest products to the mill on behalf of the forest product manufacturers. Truckers load the wood from the roadside onto their vehicles and deliver it to the mill gate, where it is scaled.

Contractors do the initial transformation by cutting stumpage and producing timbers that will then be the raw input to the value chain of the whole industry. As such, contractors perform the first value-added operation in the industry. In terms of transactions, they may initiate it by contacting woodlot owners and offering to harvest their wood, or they can be hired by another industry player (marketing board, licensee/sub-licensee or industrial freehold owner) to come and harvest their wood. It should also be noted that individual contractors may play both roles – i.e., contractors for industry groups and independent contractors – although usually at different times of the year. Generally, once they cut the trees, contractors will bring the produced timbers by roadside.

There are at least two types of contractors in the New Brunswick forest products industry:

- Contractors who carry out harvesting, forwarding and perhaps other functions (e.g., trucking) on behalf of industry groups. These contractors work on Crown Lands and industrial freeholds.
- Independent contractors who serve as intermediaries between private woodlot producers and mill owners. These independent contractors often provide harvesting, forwarding and sometimes trucking services to the woodlot owners in order to ship their wood to the mill gate. In some cases they may hire truckers or other service providers as sub-contractors.

The independent contractors are the group of particular interest to this analysis, because they play a potential arbitrage role in the forest products industry and may thereby affect the level of competition and prices in the private stumpage market. By virtue of negotiating with woodlot owners and selling to various mills on a regular basis, they have valuable market intelligence regarding mill gate prices, stumpage prices, harvesting/trucking rates; and how these prices are determined and how they vary. This market intelligence can be used to take advantage of any differences in the above prices and rates in order to earn margins which exceed the going market rates for harvesting, trucking or any of these other services. This arbitrage activity also has the beneficial effect of contributing to a uniformity of stumpage prices and other rates in the relevant local stumpage markets.

As an administrative duty, the trucker produces and delivers the Transportation Certificate (TC) to the mill, as all primary forest products transported within New Brunswick must contain a TC. The TC must be completed to include the source of timber, date and time loaded, products, species, destination, license plate number, and the name and signature of the trucker, before the trucker gets on the road. When the trucker arrives at the mill, the trucker must present the TC to the owner or person in charge at the mill. The offload date and receiver signature must then be included on the TC. The owner or person in charge of the mill who receives the TC must collect, keep and remit the TC and any other prescribed documentation or information.

Different classifications of TCs are used depending on the source of timber:

- For wood harvested on Crown Land, licensees print pre-numbered TCs to identify each load of Crown wood;
- For wood harvested on large industrial freehold tracts of land, forestry companies prepare their own TCs; and
- For wood harvested on private woodlots, TCs are supplied by the marketing boards.

2.4 The upstream wood supply chain and commercial decision points

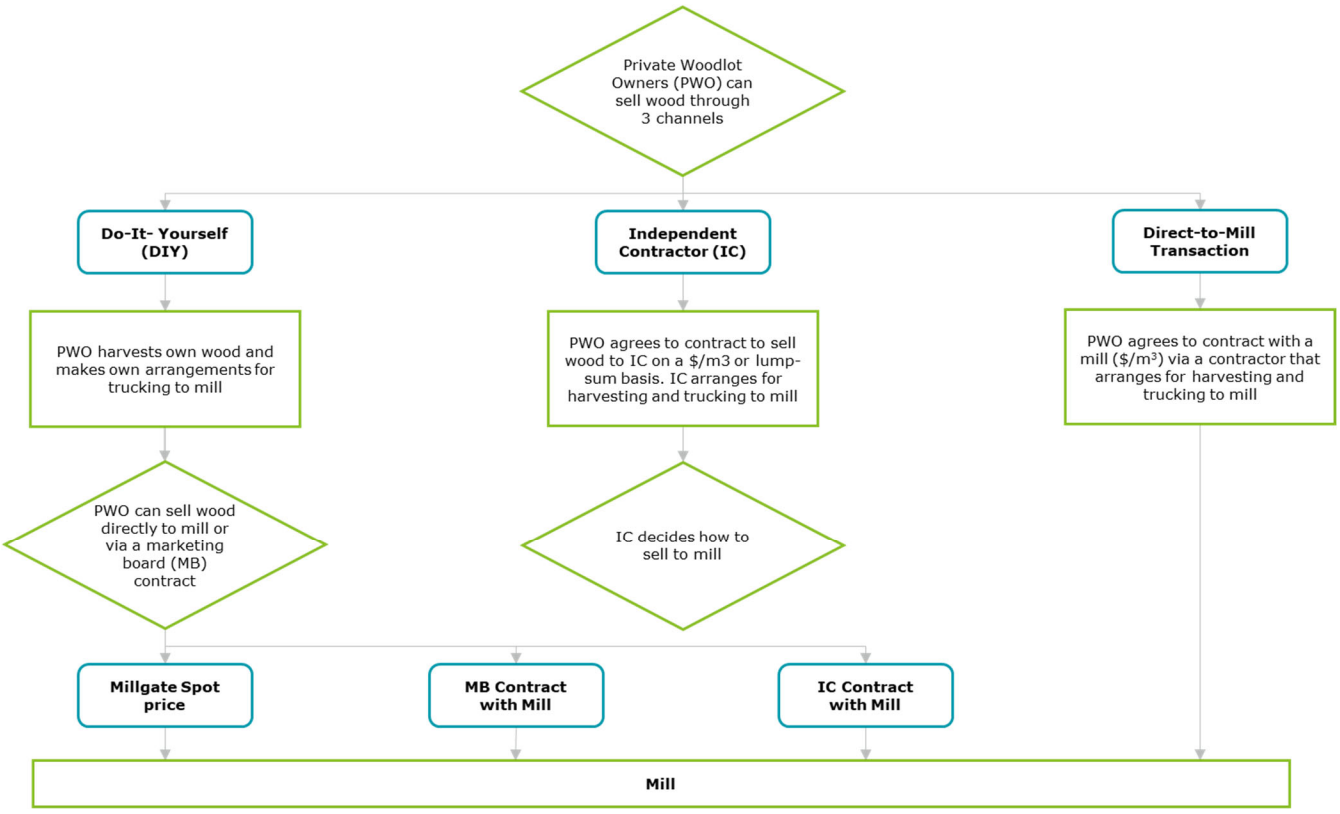
2.4.1 Private woodlot owners

Private woodlot owners tend to have three choices in how to sell their wood:

- Do-it-Yourself (DIY) sales;
- Independent contractor (IC) transactions; and
- Direct-to-Mill Transactions.

The flow chart below illustrates the three different sales channels usually available to a private woodlot owner. The first channel involves a DIY sale, whereby private woodlot owners (PWO) harvest their own wood and then arrange trucking to the mill. The other two sales channels involve transactions with an independent contractor (IC), who in turn arranges to sell the wood to one or more mills; or a Direct-to-Mill transaction in which the PWO agrees to contract directly with a mill. It is important to note that every private woodlot transaction is subject to a marketing board levy and is reported as a specific marketing board source of timber in the annual timber utilization report, irrespective of whether the marketing board is directly involved with the transaction.

Chart 11: Flow of wood and funds – Private woodlot owners



Source: Deloitte analysis.
Note: 1. Marketing board collects appropriate levies on all transactions. 2. In some cases, the marketing board will manage the transactions on behalf of the independent contractor, which means taking payment from the mill, paying the stumpage to the PWO, paying for trucking and remitting what is due to the IC

In relative terms, under current market conditions, the Independent Contractor stream is the largest, accounting for 60% of the wood harvest from private woodlots, while Direct-to-Mill transactions are relatively new and account for only 13% of wood from private woodlots. The Do-It-Yourself stream represents the remaining 27% of wood from private woodlots, but is more common in some areas such as the Madawaska Marketing Board area. This dynamic among private woodlot owner streams to supply wood to mills has evolved over time. Specifically, Do-It-Yourself used to represent a larger share of transactions in the past, while the transactions conducted by Independent Contractors has grown over time.

Do-It-Yourself (DIY) sales

The DIY channel, whereby PWOs harvest their own wood and then arrange trucking to the mill, was the traditional channel to market for individual owners. It is still common in some parts of the province, such as Madawaska. However, it is becoming less common as woodlot owners rely increasingly on other sources for their primary income (and on non-forestry occupations). Once DIY woodlot owners harvest their wood and arrange for trucking, they can choose to sell their wood directly to the mill (at the spot price posted at the mill gate) or alternatively, sell through a marketing board contract with the mill (where these are available) or via any independent contractor who has their own contract with the relevant mill(s). The DIY owners would likely be selling their wood to more than one mill, given the likelihood of harvesting sawlog, studwood and pulpwood at any one time.

Independent Contractor (IC) transactions

In the case of the IC channel, the PWO negotiates the sale of standing trees with an independent contractor. Once the sale occurs, the IC will (i) harvest the standing trees: and (ii) hire and make the payment to the trucker for transportation of the timbers to the mill. Typically the contractor will have the operating capability to harvest the timber and transport it roadside in the forest. The contractor could be integrated and have both harvesting and forwarding capabilities as well as the truck transportation capability from the forest roadside to the mill. Some contractors are also woodlot owners in their own right.

The flow of funds in IC transactions includes: negotiating and paying the land owner for stumpage (the tree on the stump); paying a rate per cubic metre to harvest and forward the wood to the roadside (or have own crew and equipment complete this phase); pay a variable rate based on distance to load and transport the wood to the mill (or have own crew and equipment complete this phase); and negotiate and sell the wood to a mill for a mill gate price. While these steps embed all the intermediary actions that lead to the conclusion of a transaction, and their associated cost, it potentially excludes an allowance for the risks taken by the contractor through negotiating and executing all phases of this transaction from the stump to the mill. One key example is the risk of changes in mill gate prices between the time of the contract negotiated with the PWO (usually at the start of the season) and the timing of the wood deliveries to the mill gate. As such, the IC needs to factor in an allowance for the risk it takes during the transaction. This allowance is not evident in the transaction flow, but it is included in the price paid by the mill owner at the mill gate. It is also worth noting that the IC is likely to negotiate contracts with the mills for the delivery of a certain volume of wood during a given season – typically a volume of wood that would cover deliveries from multiple PWOs during the season.

Direct-to-Mill transactions

In some regions of the province, the PWO may also have the option of contracting directly with one of the mills. In this type of transaction, which has been introduced more recently by some mills, the PWO enters a direct agreement with a mill for the sale of standing trees in return for stumpage. The mill owner then arranges for a contractor to (not an IC) to harvest the wood and for transportation of the wood to the mill gate. It would seem that the introduction of, and increase in the number of, this type of transaction is to assist the mill owners in improving on a secure supply of wood for the mills. From a PWO perspective it adds another channel to the market for timber.

Marketing boards

PWOs often seek the assistance of their local marketing board when selling their wood, even if the marketing board has no contract in place with the relevant mills. Marketing boards represent individual PWOs in their region, but they do not have the authority to require a woodlot owner to deliver wood to a mill. In other words, marketing boards cannot control wood volumes sold, nor select mills that transact with woodlot owners in their areas. The sale decision rests solely with the PWO.

In some regions of the province, the marketing boards are very involved in the sale of wood through the DIY and IC channels. For example, in some cases, ICs rely on marketing boards for the contract administration. In such cases, the marketing boards take payment from the mills and then disburse the agreed stumpage to the PWO as well as making payments to the trucker and any other contractor before providing the remaining funds to the IC (less the administration fee due on the transaction due to the marketing board). As a result of these marketing board practices, we have been able to collect transaction-level data from marketing boards which include stumpage fees paid to PWOs. The marketing board fee can either be a fee per unit (e.g., cubic metre) of wood sold or a flat fee.

Commercial transactions

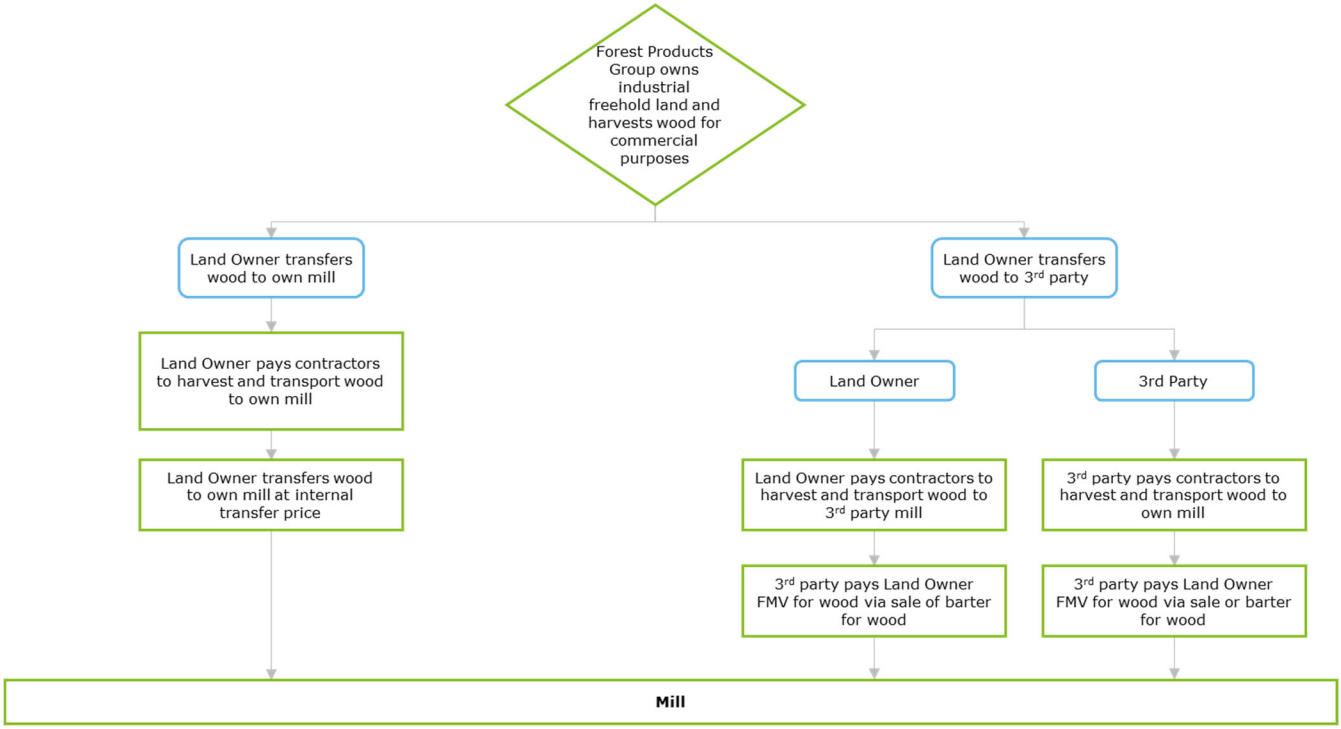
In summary, it is worth noting that a transaction between the mill and the IC; the mill and the marketing board; the IC and the PWO; as well as the DIY sale to the mill; and the Direct-to-Mill transaction with the PWO are all commercial transactions which yield market prices. However, only two of these include explicit stumpage prices: (i) the contract between the IC and the PWO and (ii) the Direct-to-Mill transaction with the PWO.

2.4.2 Flow of goods and funds – Industrial freehold Land

There are two typical value chains associated with industrial freehold wood. Owners of industrial freehold lands can harvest wood for their own mills or transfer some or all of the harvested wood to other industry groups. Hence, there are two parts to the value chain, as follows:

- Single industry group transfer; and
- Multiple industry group transaction.

Chart 12: Flow of wood and funds – Industrial freehold



Source: Deloitte analysis.
Notes: 1. The Landowner manages the freehold land and pays all costs of land ownership. 2. Generally a barter transaction is exchanging wood with a third party for an alternative wood specie or wood at a lower cost.

Single industry group transfer (Transfer of wood to own mill)

In a single industry group transfer, an industry group harvests standing trees that it possesses for its own milling purposes. Because the owner of the land and trees is the same that owns the mill, i.e., they are vertically integrated, there is no commercial transaction at the mill gate and the price is fixed through the company's internal accounting (transfer pricing). As such, there is no commercial transaction (and no market price) between the tree owning part of the organization and the mill, but rather the transaction is reflected on each entity's books.

The industry group may hire and make payments to a contractor for harvesting and a trucker for transportation of the timbers to the mill.

Multiple industry group transactions (Transfer of wood to third party)

In a multiple industry group transaction, an industry group sells timber to a mill owned by another industry group in exchange for a mill gate price. This exchange is a commercial transaction and does yield a market price at the mill gate, provided the parties can be considered independent from an ownership and control perspective.

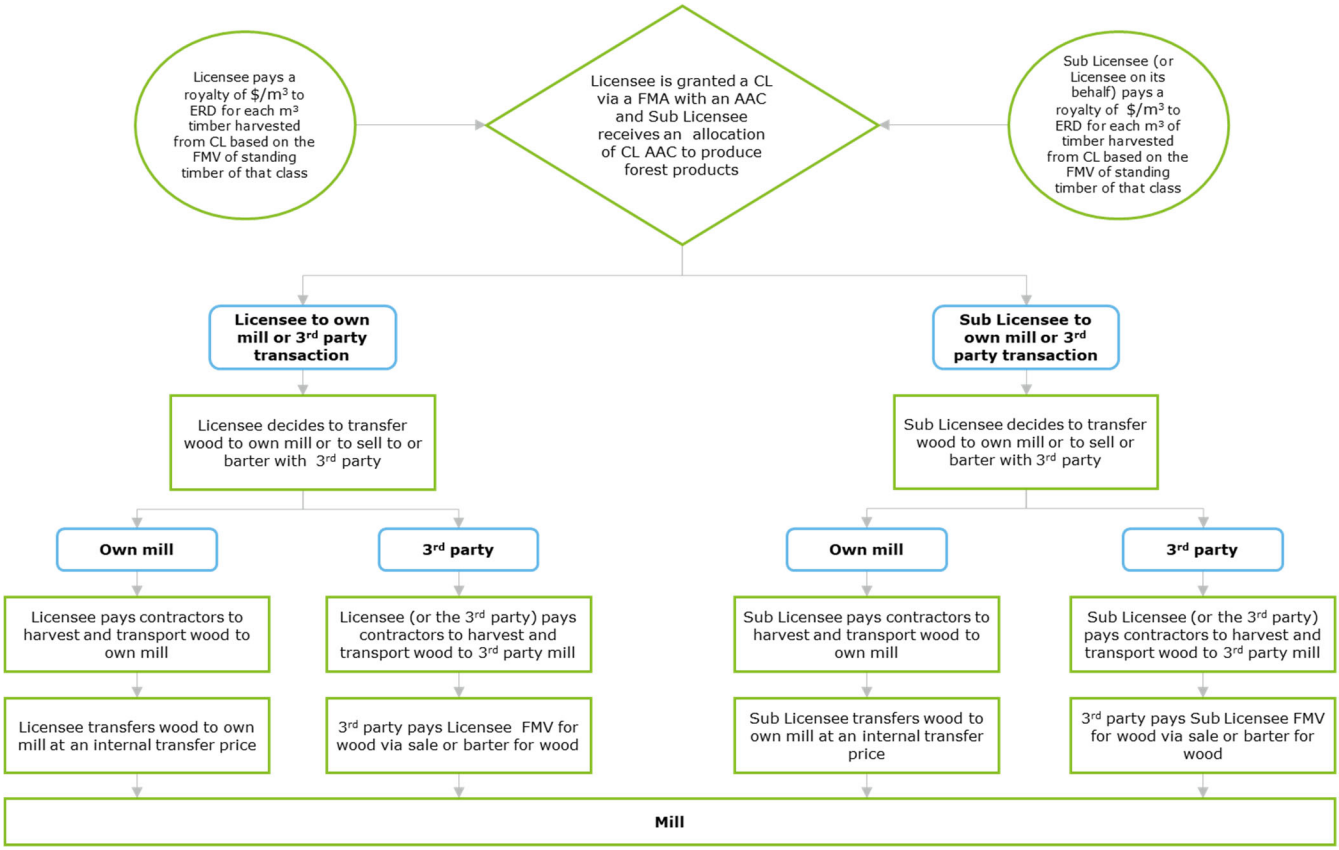
The industry group that owns the standing trees may hire and make payments to a contractor for harvesting and a trucker for transportation of the timbers to the mill. Payments to the contractor and trucker may be made instead by the third party mill purchasing the wood.

2.4.3 Flow of goods and funds – Crown Land

There are two typical value chains associated with Crown Land. For the purpose of this report, we labelled these three value chains:

- Crown to Licensee transaction;
- Licensee to Sub-licensee transaction; and
- Sub-licensee to third party.

Chart 13: Flow of wood and funds – Crown Land



Source: Deloitte analysis.
Notes: 1. The Licensee manages the Crown Lands on behalf of ERD and receives fees for completing these functions and duties. 2. Generally a barter transaction is exchanging wood with a third party that the Licensee or Sub-Licensee controls via the CL AAC for an alternative wood specie or wood at a lower cost.

Licensor to Licensee transaction

The Licensor/Licensee transaction consists of an industry group (or Licensee), in this case the mills, paying a royalty to the province (or Licensor) for the timber harvested on a Crown-granted License. In exchange for a royalty paid to the provincial government (Crown stumpage), the industry group purchases the timber from the Crown from one of six areas of Crown Land (Crown Licenses). In addition, the Licensee manages the Crown Land and receives a fee for the land management services it is required to provide as a Licensee to the province. The Licensee also has to submit industrial plans to the Department of ERD every five years. A Sub-licensee may or may not be part of the same industry group as the Licensee.

In a Licensor to Licensee transaction, a License is owned by the same industry group, which harvests standing trees from the Crown Land for its own milling purposes and manages the timberlands on behalf of the province.

The Licensee hires and make payments to contractors for harvesting and transporting timbers to the mill. However, this exchange of funds will not occur if the contractor and trucker work for the same industry group as the Licensee.

Finally, the government charges the Licensee a royalty on the stumpage for standing trees on Crown Land within its License area.

Licensee to Sub-licensee transfer

In a Licensee to Sub-licensee transaction, a Licensee owned by one industry group transfers timber to a Sub-licensee owned by another industry group.

The Sub-licensees are granted an annual timber allocation by the province from the six Crown Licenses. The Sub-licensee is granted an allocation based on the consideration by the province of the amount of timber necessary to supply the forest products converting facility. Typically the Licensee harvests the wood from the License and recovers its costs for doing so. The Sub-licensee pays the province the same stumpage prices by species and by quality of wood as the Licensee.

Sub-licenses are typically associated with a certain mill capacity. In 2014, new Sub-licenses and the associated AACs were allocated to industry groups in exchange for specified commitments to invest in additional mill productive capacity. These commitments are contained in a memorandum of understanding between the province and the Sub-licensee.

Sub-Licensee to 3rd Party Transfer

In a sub-licensee to 3rd party transfer, a licensee owned by one industry group allocates timber harvesting capacity to a Sub-licensee owned by another industry group. The sub-licensee then transfers the harvested wood to a 3rd party, an independent mill or another market player not party to the upstream transaction, in exchange for fair market value payment or barter of wood.

Crown Land stumpage prices

Crown stumpage rates are based on a fair market value survey which was historically performed every three to five years by a third-party. The results of these surveys were used as the basis for setting the Crown stumpage rate for each species and class of timber. For the years between surveys, the base rate was indexed using a pre-determined set of market prices applicable to each species and product combination. The Crown rates must be approved by the Lieutenant Governor-in-Council before they are published.

Across most timber classes, Crown Land stumpage prices for saw products generally decreased between 2006 and 2011 following the economic downturn and recovered post-recession. They remained stable since 2015. Sawlog prices for spruce fir and jack pine decreased from CAD 22.0 per cubic metre in 2006 to CAD 17.2 per cubic metre in 2011. They then recovered during the post-crisis period, from their low of 2011 to a high of CAD 31.1 per cubic metre in 2015. They have remained at that level since then. The same pro-cyclical pattern is shown for Maple sawlog, which went from CAD 19.0 in 2006 to CAD 12.2 per cubic metre in 2012, before recovering to CAD 14.4 per cubic metre by 2015. It has remained at that level since then.

On the other hand, pulpwood Crown royalties were most likely more impacted by the pulp and paper global trends rather than by the Great Recession of 2008-09. As such, the royalties showed a steady decline over the period considered. SFJP pulpwood went from a high of CAD 13.6 in 2006 and decreased steadily since then to reach CAD 7.3 per cubic metre in 2014. It is stable at CAD 7.6 per cubic metre since 2015. The same pattern is showed by hardwood pulpwood, which went from CAD 9.6 per cubic metre and reached CAD 5.8 per cubic metre in 2015.

There is one notable exception. The royalty rates for cedar sawlogs increased during the 2006-2018 period, from CAD 13.3 per cubic metre in 2006 to CAD 17.5 per cubic metre in 2011. It was somewhat impacted by the recession and reached a low at CAD 13.5 per cubic metre in 2013, but quickly recovered. However, it is worth noting cedar sawlogs is a small and niche market that may not respond to economic cycles the same way other wood products do.

Table 4: Crown Land stumpage prices of selected species and products

Crown royalty stumpage rate (CAD per cubic metre)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Hardwood:													
Sawlogs - Sugar Maple	19.0	27.4	13.7	13.3	12.6	12.6	12.2	13.4	10.5	14.4	14.4	14.4	14.4
Pulpwood - Other Hardwood, OSB - Any Hardwood Species	9.6	9.3	8.2	8.2	8.2	8.2	8.0	7.5	5.8	5.8	5.8	5.8	5.8
Softwood:													
Sawlogs - Spruce, Fir, Jack Pine	22.0	22.6	19.7	17.6	17.2	17.2	20.4	23.1	28.5	31.1	31.1	31.1	31.1
Sawlogs, Studwood and Lathwood - Cedar	13.3	18.2	17.7	20.6	17.5	17.5	13.7	13.5	17.0	18.6	18.6	18.6	18.6
Studwood and Lathwood - Spruce, Fir, Jack Pine	22.0	22.6	19.7	17.6	17.2	17.2	17.4	19.7	22.9	25.0	25.0	25.0	25.0
Pulpwood - Spruce, Fir, Jack Pine	13.6	9.9	9.6	11.2	10.6	10.6	10.1	10.3	7.3	7.6	7.6	7.6	7.6

Source: Crown Lands and Forests Act Regulations.
Note: The CAGR calculations take into account the differences in dates at which Crown Stumpage prices were changed.

2.5 Key economic concepts

The measurement and analysis of market power has been a prominent component of empirical industrial organization for years, starting from the seminal work of Lerner.[13] Market definition is the first step in the assessment of market power and it is central to competition economics.

2.5.1 Market definition[14]

Market definition involves defining the set of products and geographical areas that exercise some competitive constraint on each other. A market definition exercise usually proceeds along two dimensions: a product market definition dimension (i.e., which products to group together) and a geographical market definition dimension (i.e., which geographic areas to group together). Product market substitution and geographic market substitution are examined on both the demand and supply side.

Demand substitutability describes the extent to which buyers respond to a price increase by substituting away from a given product/location to alternative products or alternative locations. Supplier substitutability describes suppliers' response to an increase in a product's price. There might be substitutability from the supply side when producers that are currently supplying a different product possess the skills and assets that make it possible to switch production relatively quickly to the given product if a price rise occurs. In this case, the competitive constraint would not come from the fact that a considerable part of demand could be addressed by competing products when the price rises, but rather that the price rise attracts producers that are currently selling other products (or same products but to other markets).

A firm whose product faces close competing substitutes only has a limited ability to raise its price above that of these substitutes. Hence, the market definition for competition policy purposes is closely related to the concept of market power. A common description of a relevant market is one which is "worth monopolizing".

The test that guides the analysis of market definition in both the product and the geographic dimensions is the so-called "small but significant and non-transitory increases in prices" (SSNIP) or hypothetical monopolist test. It provides a conceptual framework for analysis of market definition and it is used by antitrust authorities worldwide. The test seeks to identify the smallest relevant market within which a hypothetical monopolist could impose a profitable small but significant and non-transitory increase in price (typically 5-10%).

[13] A.P. Lerner. The Concept of Monopoly and the Measurement of Monopoly Power. Review of Economic Studies, 1(3), pp. 157-175. 1934.
[14] Based on the following sources: M. Motta. 2004. Competition Policy, Theory and Practice, Cambridge University Press and P. Davis and E. Garcés. 2010. Quantitative Techniques for Competition and Antitrust Analysis, Princeton University Press.

In the present case, the SSNIP test applied to product market definition could provide insights into whether hardwood and softwood are different product markets. This would mean assessing whether a hypothetical monopoly seller of softwood would find it profitable to increase stumpage prices by 5-10%.

The SSNIP test applied to geographical market definition in the present case would involve asking the following question: would a hypothetical monopoly seller of wood covering a given marketing board area find it profitable to increase the stumpage price by 5-10%? If the answer is affirmative, then the geographic market would be defined within this area. If not, for instance because one expects imports from another marketing board to render such a price increase unprofitable, the test should be repeated including other marketing board areas, and so on. In the definition of geographic markets, the importance of transportation costs relative to the price of a given product can provide useful information. The study of movement of products to and from other geographical areas can also provide useful information. Even in the absence of trade between two geographic areas, it does not mean that there is no competition between these areas. For example, if prices are similar in the two areas and transport costs are significant, the two areas have no incentive to trade.

Timber markets are inherently local because standing timber are natural resources that cannot be transported and logs have high transportation costs relative to the value of the underlying resource. As a matter of economics, stumpage prices in each local market reflect supply and demand conditions in the relevant local area (harvesting costs, demand for wood from nearby mills, transportation costs, marketability, etc.), the composition of the forest as well as other factors specific to that locality.[15] Stumpage prices can be influenced by a wide range of industrial, market and regulatory factors. The literature on the topic highlights the importance of input prices, such as logging, transportation and manufacturing costs (and associated profits), in determining stumpage prices. However, it also emphasizes that national and even global macroeconomic factors, such as the economic and housing cycles, also impact stumpage prices. In terms of regulatory factors, the literature mentions: environmental and land preservation policies, the land ownership structure and sales mechanisms. The authors also list a number of characteristics specific to wood sales that are likely to influence stumpage price, including: grade of wood sold, ease of harvesting and extraction, volume of wood transacted and specific landowner characteristics. The literature also enumerates a number of local characteristics that may impact stumpage, including local and regional market conditions (e.g., inventories held at nearby mills), local organizational and operational policies and access to technology and the degree of competition.[16]

2.5.2 Market power

Market power is defined as the ability of a firm to raise the price of a given product above the marginal cost of producing that product, which is equivalent to raising prices above the level that would prevail in a highly competitive setting. The key factors that limit market power are the extent of demand substitutability and the extent and nature of the supply response. If a firm has many substitutes for its products, the market power of the firm would be limited. On the contrary, if the firm does not have any substitutes for its product, it will be able to set higher prices. Firms that have market power have the ability to raise prices without losing too many customers and they are sometimes called price makers. Firms which do not have market power are called price takers since they have no control over prices. The exercise of market power by sellers leads to higher prices, reduced output and a loss of economic welfare. On the other hand, a large number of competing suppliers offering a non-differentiated good facing a limited number of buyers may in fact be "price takers", i.e., they have such limited market power that they have to accept the prices offered by the buyer.

[15] J. Asker. Economic Analysis of Factors Affecting Cross Jurisdictional Stumpage Price Comparisons. 2017.
[16] Klepacka, A.M., Siry, J.P. and Bettinger, P. Stumpage prices: a review of influential factors. 2017

In the industrial organization literature, price distortions (referred to as price deviations in this report) refer to the fact that prices depart from the prices that would prevail under perfect competition. In this context, price deviations reflect the presence of market power and they are measured using the Lerner index.[17] However perfect competition is rarely, if ever, observed in practice, because almost all markets are characterized by varying degrees of externalities, economies of scale, information asymmetries, imperfect competition and other frictions or sources of market power.[18] In this context, interpreting price deviations as departures from perfect competition would mean that all prices differ to some extent from the perfectly competitive ideal.

In the industry studied, mills buy wood directly from private woodlot owners or from contractors, who act as intermediaries between private woodlot owners and mills in the vertical supply chain. However, private woodlot owners retain the decision whether to sell their wood or not, independently of their decision to sell directly or through an intermediary. Private woodlot owners are very numerous (40 000 individuals in 2004[19]). They each hold a tiny share of the market. Hence on the supply-side, the market is very fragmented, which suggests that small private woodlot owners enjoy little or no market power.

Marketing boards may play a role in the marketplace by pooling together several individual woodlot owners in order to increase their negotiation power and offset any market power enjoyed by mills. However, in the case of New Brunswick, several factors prevent marketing boards from playing this role. Marketing boards are generally unable to directly manage the selling decisions (quantities, timing, etc.) of private woodlot owners. Hence, the marketing boards have little if any control over the supply of wood in their designated area. This is also reflected in the fact that woodlot owners can transact directly with mills and thereby circumvent the capacity marketing boards to control wood supply conditions, even on a given territory. As a result, marketing boards have limited market power in setting stumpage prices, because they have little or no influence on private woodlot owners' decisions to sell their wood.

2.5.3 Buyer concentration

Buyer concentration measures the extent to which a large percentage of a given product is purchased by relatively few buyers.[20] At the extreme, a single purchaser of all the production for a good would give rise to a situation of monopsony. An oligopsony is a situation where there are only a small number of buyers in a market.

Buyer concentration results in buyer market power, which refers to the circumstance in which the demand side of a market is sufficiently concentrated that buyers can exercise market power over the transacted price. A buyer has market power if it can force sellers to reduce prices below the level that would prevail in a competitive market (defined as a market with no concentration, no market power and prices equal to marginal cost).[21] A buyer with considerable market power can make use of its bargaining power to stimulate competition among sellers. It can exert pressure on suppliers to get them to provide higher quality products, better customer service and lower prices. Buyer power is likely to be strong in the following situations: buyers are more concentrated than sellers; buyers can easily backward integrate or begin to produce the seller's product themselves; buyers are subject to low transaction costs when changing suppliers; buyers are price sensitive and well educated about the product; buyers purchase large volumes of standardized products from the seller; substitute products are available on the market and buyers' purchases comprise a large portion of seller sales.

[17] J. Schroeter. Estimating the Degree of Market Power in the Beef Packing Industry. The Review of Economics and Statistics, 70(1), pp. 158-162. 1988.
[18] S. Athey. British Columbia's Market-Based Pricing System for Timber. 2017.
[19] M. Stone, B. Macgregor and Phelps S. Timber markets in New Brunswick and Nova Scotia and their use in assessing stumpage prices in other Canadian provinces. Canadian Forest Service, Natural Resources Canada. 2004.
[20] OECD. Glossary of industrial organisation economics and competition law. 1993.
[21] R. Noll. Buyer Power and Economic Policy. Antitrust Law Journal, 72(2), pp. 589-624. 2005.

Murray[22] explains that "*the exchange of many commodities, such as agriculture products and natural resources, is often characterized by many atomistic sellers and few concentrated buyers, often due to transportation and storage factors. This situation suggests that these markets may be subject to monopsony or oligopsony power, which is likely to depress the price of the affected input*". In the specific case of wood, Murray further explains that "*because transport costs are a large component of the delivered cost of wood, the markets for wood inputs might be best described as localized or spatially differentiated in the tradition of Hotelling (1929)"*[23]*.* Importantly, Murray indicates that the oligopolistic structure of the market generated by the existence of transportation costs is offset to some extent by the incentive of mills to compete by operating at high rates of capacity utilization. He investigates in his paper whether the localized nature of these inputs provides some degree of market power for the wood processing mills by estimating the degree of market imperfection and the magnitude of price deviations resulting from market power (measured by the Lerner index). Using data on the two largest wood processing sectors in the United States (sawlogs and pulpwood) covering the period 1958-1988, he finds that the average degree of oligopsony power in the sawlog market is relatively low for the entire period and that it is higher for pulpwood than for sawlogs. He finds these results not surprising given the presence of larger and relatively isolated mills in the pulp and paper sector and smaller, more densely distributed sawmills in the sawlogs sector.

In the case of the New Brunswick wood industry, wood products companies have two ways of exercising potential market power from buyer concentration. They can either exercise it directly through mill gate prices paid to woodlot owners or indirectly through mill gate prices paid to contractors. In the first instance, mills may be able to impose lower mill gate prices to captive sellers. Sellers' captivity may originate from their incapacity to sell to another mill to due to: (1) high transportation costs, (2) lack of competing mills (other accessible mills are owned by the same company) or (3) accessible mills are not equipped to process the product they offer. In this case, specific mills would be able to enforce their market power.

The other, indirect, way wood products companies may exercise their market power is through their wood purchases from contractors. They may put downward pressure on prices offered to contractors who then transfer the price decrease, fully or in part, to other parties upstream in the wood supply chain, up to the woodlot owner. In this case, contractors may absorb some of the price decrease through lower margins, but they may also pass on the lower prices through to woodlot owners.

2.5.4 Price deviations

As explained above, we use the term price deviations to refer prices that depart from the prices that would prevail in a competitive market, which is an indicator of market power held by sellers or buyers.[24]

One important potential source of price deviations in the literature is government policies and related interventions,[25] which can influence or interfere with market prices and supply and demand conditions in the market. Such policies include taxes, subsidies, tariffs and exchange rate controls affecting the producers and consumers of goods which are traded (or even non-traded) on international markets. Agricultural price deviations have been studied extensively in the economic literature.[26]

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[22] B. Murray. Measuring oligopsony power with shadow prices: US markets for pulpwood and sawlogs, The Review of Economics and Statistics, 77(3), pp. 486-498. 1995. See also: R. Rogers and Sexton R. Assessing the Importance of Oligopsony Power in Agricultural Markets, American Journal of Agricultural Economics, 76(5), pp. 1143-1150. 1994.

[23] H. Hotelling. Stability in Competition. The Economic Journal, xxxix, pp. 41-57. 1929.
The literature on spatial competition was initiated by Harold Hotelling's seminal article. In Hotelling's model, identical goods offered by firms located at different points in the landscape are not perfect substitutes because travel to and from firms to buy their goods is costly for their customers. Consequently, with respect to customers that are located closer to it than to any other firm, every firm is in a position that is something like a natural monopoly. This is especially true when the typical customer's transportation cost is a significant portion of the total cost of the good to the customer.

[24] "Price deviations", as defined here, are also referred to in the literature as "mark-ups" or "price distortions".

[25] J. Anderson, J. Bannister and Neary J. Domestic Distortions and International Trade. International Economic Review, 36(1), pp. 139-157. 1995.

[26] M. Bale and Lutz E. Price Distortions in Agriculture and Their Effects: An International Comparison. American Journal of Agricultural Economics, 63(1), pp. 8-22. 1981.

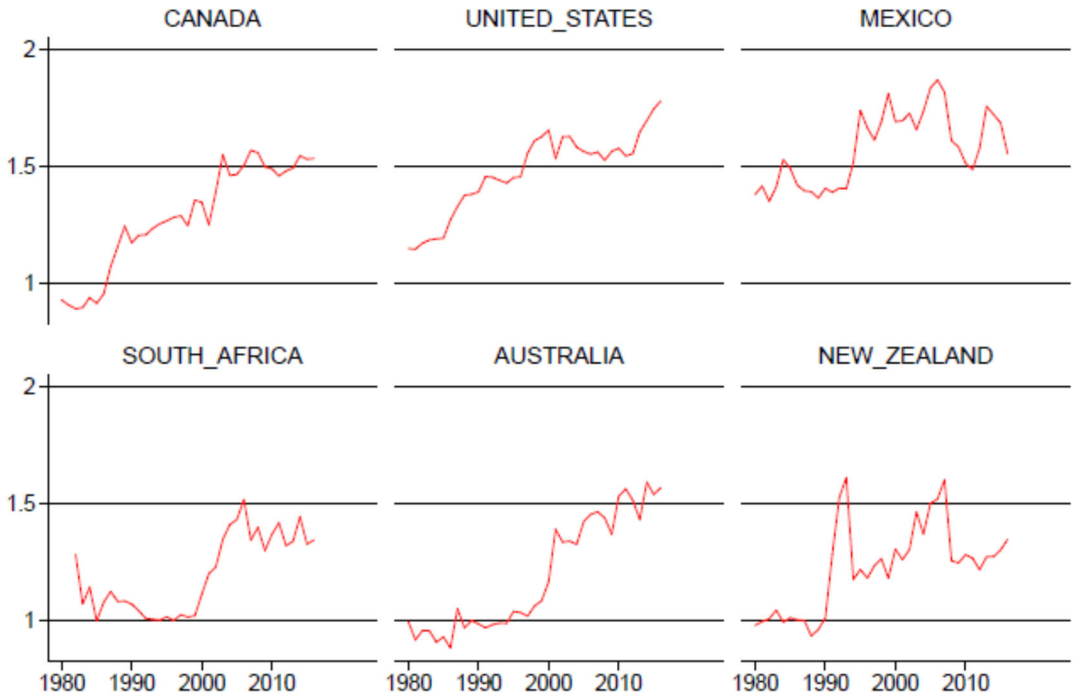
Another source of price deviations is the degree of competition in markets, which can be measured by the Herfindahl-Hirschman Index (HHI). The HHI is a commonly accepted measure of market concentration in an industry.[27] The index measures the size of firms relative to the industry and market in which they operate. A highly concentrated industry is one in which there are few market players which account for a large share of the transactions in the market – a quasi-monopoly or oligopolistic market structure. A low degree of concentration is closer to a competitive market and refers to an industry where there are many firms with a very small share of the market. The HHI is calculated as the sum of squares of the market shares of firms within the industry and it ranges from 0 (least concentrated) to 10,000 (most concentrated). One common threshold for identifying competitive markets is 1,500 (0.15), and many sources refer to the U.S. Department of Justice's guidelines on mergers and acquisition as the key source for this threshold.[28, 29] The literature also suggests that there is no universal threshold and supports instead a range interpretation of the HHI. An HHI between 0 and 2,000 (0-0.2) is indicative of a competitive market, with prices close to marginal cost and few or no barriers to entry or exit. An HHI between 2,000 and 4,000 (0.2-0.4) is indicative of what is known as "monopolistic competition", where there are many buyers and sellers, but the market is characterized by product differentiation. An HHI between 4,000and 7,000 (0.4-0.7) is indicative of an oligopolistic market. Lastly, an HHI between 7,000and 10,000 (0.7-1.0) is indicative of a monopoly-type market structure.[30]

The ranges of HHI values above and the literature on the topic of optimal pricing imply that there is a range within which prices are considered optimal (i.e., where price deviations are not material), even if they are not exactly at the marginal cost. This implies that prices may deviate from slightly from marginal cost, without this necessarily being indicative of problematic market conditions. In fact, most industries in most economies see prices that diverge from those that would prevail in competitive markets, as shown by the evidence below.

De Loecker and Eeckhour define price deviations as the ratio of price to marginal cost of production. In their 2018 study, De Loecker and Eeckhour extract data from the financial statements of over 70,000 firms in 134 countries to assess the evolution of price deviations over the last four decades. The study shows that there has been a rise in global price deviations from an average of +10% in 1980 to an average of +60% in 2016. The magnitude of price deviations is comparable in Europe, North America, Asia, and Oceania. The 2016 average value of price deviations for the United States and Canada was +78% and +53%, respectively. The authors suggest that the more developed economies have had larger increases in price deviations over the past decades.[31] In a separate paper, the same authors find that price deviations in the US rose over time as well – from 18% in 1980 to 67% in 2014.[32]

[27] Djolov, G. Business concentration through the eyes of the HHI. International Journal of Economic Sciences and Applied Research. 2014.
[28] The United States Department of Justice. Horizontal Merger Guidelines. August 19, 2019.
[29] For recent examples, see: Cheung, S.O., Shen, L. Concentration analysis to measure competition in megaprojects. Journal of Management in Engineering. O'Shaughnessy, E. The Effects of Market Concentration on Residential Solar PV Prices: Competition, Installer Scale, and Soft Costs. National Renewable Energy Laboratory. 2018.
[30] Djolov, G. Business concentration through the eyes of the HHI. International Journal of Economic Sciences and Applied Research. Some papers, like this one, refer to a market with a 0-2,000 HHI as a perfectly competitive market. We take this to mean a competitive market with no concentration or market power and prices equal to marginal cost. A perfectly competitive market is more of a theoretical reference point (e.g. requires market participants to have full information, no uncertainty, etc.).
[31] De Loecker, J., Eeckhour, J. Global Market Power – National Bureau of Economic Research. 2018.
[32] De Loecker, J., Eeckhour, J. The Rise of Market Power and the Macroeconomic Implications. 2017.

Chart 14: Domestic price deviations in North America, Africa and Oceania



Source: Jan de Loecker and Jan Eeckhour, 2018

Price deviations may also vary by industry. Amountzias used the markup formulation developed by De Loecker and Warzynski to estimate the dynamics of the price-to-marginal cost ratio for 19 EU manufacturing industries disaggregated into 10 sectors over 1995-2014.[33] Summary statistics of the constituent 19 EU manufacturing industries show that all countries have a price-to-marginal cost ratio higher than unity in their manufacturing sectors, indicating that prices were generally higher than marginal cost. Results also show that the price-to-marginal cost ratio is higher than unity across every sector within the manufacturing industry in all of the EU countries included in the study. For example, the price-to-marginal cost ratio for the wood, paper products, and printing sector of the manufacturing industry points to price deviations of 20% in France, 138% in Ireland, 67% in Italy, and 23% in the UK.

The main hypothesis we examine in this report is whether or not stumpage prices in the private woodlot sector deviate from the levels that would prevail in a competitive market. This is not only a binary (yes/no) analysis, and accordingly we assess the order of magnitude of the price deviations in order to assess whether these are in line with price deviations prevailing elsewhere in the economy (i.e., in other sectors). As described in Chapter 4, we assessed price deviations from a competitive market (defined as a market with no concentration, no market power and prices equal to marginal cost) as indicated by an HHI value between 0.15 and 0.2. We also assessed the order of magnitude of those price deviations in comparable industries and economies listed above, i.e. where prices are roughly 20% to 75% above marginal cost.

[33] Amountzias, C. Pricing Decisions and Competitive Conduct across Manufacturing Sectors. 2019.

2.5.5 Role of intermediaries/middlemen

Intermediaries play a role in the process by which demand and supply meet. One rationale for the presence of middlemen is offered in Rubinstein and Wolinsky (1987)[34]: middlemen can facilitate the searching and matching between trade parties in decentralized markets in which the matching process is time-consuming.

The role of trade intermediaries has been studied in the context of developing countries and the liberalization of trade. This literature suggests that only a small fraction of the benefits of export growth in developing countries following trade liberalization trickle down to farmers and workers, while intermediaries appropriate a large share of the margins.[35] Mitral et al (2018)[36] shows that farmers that cannot directly access wholesale markets sell most of their crop to middlemen, who aggregate purchases and then resell them at wholesale markets. In this context, farmers are unaware of the prices that the middlemen sell to and they lack direct access to wholesale markets. The result is that middlemen earn large margins and do not pass through price changes to farmers.

Even in developed countries, there is a role for middlemen due to information asymmetry between agents. As argued by Biglaiser (1993)[37] and Lizzeri[38] (1999), middlemen can serve as information intermediaries in markets where there are selection issues (adverse selection). The idea is that middlemen have a more advanced technology and experience to distinguish product quality, so goods traded through them are of higher quality than those traded directly between sellers and buyers. They alleviate information asymmetry in the market by acting as guarantors of quality.

In the stumpage market in New Brunswick, independent contractors harvest timbers and put them by the road so that transportation providers pick them and deliver them to the mills, which then transform them. These independent contractors are the main purchasers of private stumpage. The mills obtain wood from private woodlots primarily by buying logs from these contractors rather than directly from woodlot owners.[39]

These contractors interact repeatedly with private woodlot owners and mills. Their role as intermediaries can contribute to ensuring competitive market conditions, for any attempt by the mills to artificially depress stumpage prices can be partly counteracted by higher prices offered by contractors selling to other mills. In this context, the presence of contractors would reduce asymmetries between buyers and sellers.

This role played by contractors may be significant to the dynamic between the buyers and sellers of wood, since woodlot owners are much less likely to be as involved as contractors in the industry. The 2011 Private Forest Task Force reports that thirty-two percent of their respondents claim to harvest some wood every year, and an additional eighteen per cent harvested at least once in the last five years.[40] By way of consequence, this implies that half of woodlot owners were not involved in the industry in the five years leading to the survey. As such, contractors may help spread information on the current state of the primary wood industry among less informed woodlot owners, in addition to playing a significant arbitrageur role across local markets.

[34] A. Rubinstein and Wolinsky A. Middlemen. The Quarterly Journal of Economics, 102(3), pp. 581-593. 1987.
[35] P. Bardhan, D. Mookherjee and Tsumagari, M. Middleman Margins and Globalization. American Economic Journal: Microeconomics, 5(4), pp. 81-119. 2013.
[36] S. Mitra, D. Mookherjee, M. Torero and Visaria S. Asymmetric information and middleman margins: an experiment with Indian potato farmers. The Review of Economics and Statistics, 100(1), pp. 1-13. 2018.
[37] G. Biglaiser. Middlemen as experts. The RAND journal of Economics, 24(2), pp. 212-223. 1993.
[38] A. Lizzeri. Information revelation and certification intermediaries. The RAND Journal of Economics, 30(2), pp. 214-231. 1999.
[39] B. Kelly. An Analysis of the New Brunswick Private Woodlot Survey and the New Brunswick Private Timber Market.
[40] Private Forest Task Force Report. A Snapshot of New Brunswick non-industrial forest owners in 2011: Attitudes, behaviour, stewardship and future prospects: Private Forest Task Force Report.

2.6 Forest product manufacturing and downstream demand

The end products made in New Brunswick's sawmills and pulp mills are primarily consumed by the construction and paper products industries, respectively. As such, both products respond to different market conditions.

Sawmills are directly impacted by the home construction cycle, characterized by peaks and troughs in single-detached and multi-family home construction. As such, sawmills were especially hit by the 2008-2009 recession, which was mainly driven by the US housing construction market. Demand for sawmill products is North American, which implies that the New Brunswick lumber industry is greatly influenced by economic conditions south of the border. This explains the cyclical pattern observed in Lumber and Panel prices described in section 2.2.4 above. This is also true for OSB and hardwood end products, which will be analyzed further in the next steps of the project.

The wood pulp industry is more global in nature, with New Brunswick pulp being shipped as far as Asia. In 2017, the top destination of wood pulp exports from New Brunswick was the US (CAD 219M). Other large destinations included Asian countries: India (CAD 92M), Thailand (CAD 69M), China (CAD 43M)[41]. As such, demand for pulp is impacted by global trends in paper production, including publishing. With the emergence of web-based publications in the early 2000s, and the associated shift of advertisement away from print to electronic publications, demand for newsprint has been experiencing a protracted decline over the past 20 years of so. As a result, pulp products have diversified as inputs into new products, such as dissolving pulp and tissues, for which the AV group is a large exporter.

2.6.1 Output of sawmills

Sawlog production appears to be generally correlated with the economic cycle, i.e. production expanding during economic growth and expanding at a slower rate or possibly contracting during recessions. As such, sawlog production would then be correlated with most other pro-cyclical variable, as shown in graphs below. This will be of significant importance in the specification of the models in following sections, since this can lead to statistical challenges.

Sawlog production in New Brunswick is a primary input for housing and non-residential construction. The number of housing starts measures the construction of new single-family homes and multi-family residential apartment buildings. Single-family homes use large quantities of lumber for both internal construction and external structures. As a result, the housing market and number of housing starts drives the demand for wood production. Residential renovation expenditures on homes also makes use of substantial volumes of lumber, though far less than that used in new construction. New construction and renovation expenditure are typically highly correlated and depend on homeowners' ability to access funds, which is impacted by prevailing borrowing rates. Non-residential construction uses more concrete, steel and other high-load materials than wood. However, lumber is still used in high quantities during internal construction, and the strength of non-residential construction can have an effect on lumber demand.

Sawlog production in Canada is also impacted by the broader North American construction market, due to its proximity. As such, the Canadian dollar strength against the currencies of major trading partners also impacts the demand for Canadian sawlogs. Generally, sawmills benefit from a lower Canadian dollar because it makes their products more competitive relative to foreign options, and therefore more competitive in export markets.

US housing starts and foreign exchange rates

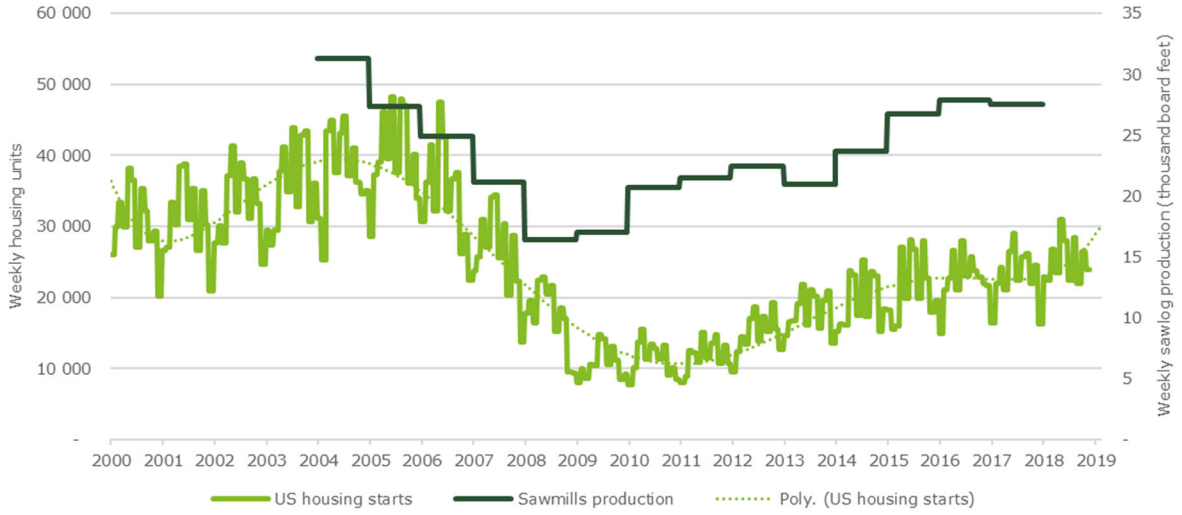
The following graphs illustrate the historical trend in New Brunswick sawlog production and housing starts in the US.

As shown in the graph below, there is a correlation between New Brunswick sawlog production and US housing starts. As the number of US housing starts decreased sharply before and during the recession, so did the demand and, ultimately, the production of New Brunswick sawlogs. As the US housing market started to

[41] Industry Canada. Trade Data Online. Accessed March 4, 2019.

recover, so did the production of New Brunswick sawlogs. It is worth noting that, while consistent over time, this relationship may sometimes experience some leads and lags, with sawmills adjusting their production more or less rapidly to changes in the US housing industry. A number of factors may explain that phenomenon, including the existence and size of inventories of wood products.

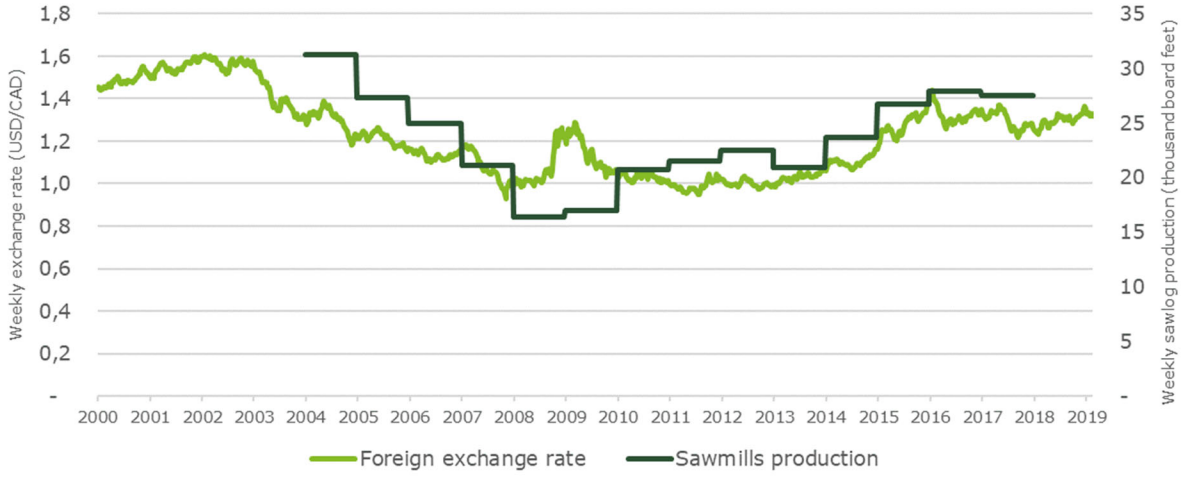
Chart 15: US housing starts and New Brunswick lumber production



Source: US Census Bureau and Government of New Brunswick Department of Natural Resources.
Note: 1. Poly in the graph above refers to the polynomial function used to smooth the US housing starts number. Poly can be interpreted as the trend line for housing starts. 2. Housing starts in the graph above were transformed to weekly periodicity from monthly data. 3. Sawmills production were transformed to weekly periodicity levels from annual data. As such, they represent weekly average production levels derived from annual data.

Sawlog production follows a similar trend with regards to foreign exchange rates. As the USD/CAD exchange rate decreases (i.e., the USD drops relative to the CAD), it becomes more expensive for US-based construction firms to purchase Canadian wood products for housing construction and as such, sawlog production also decreases.

Chart 16: USD/CAD exchange rate and New Brunswick lumber production

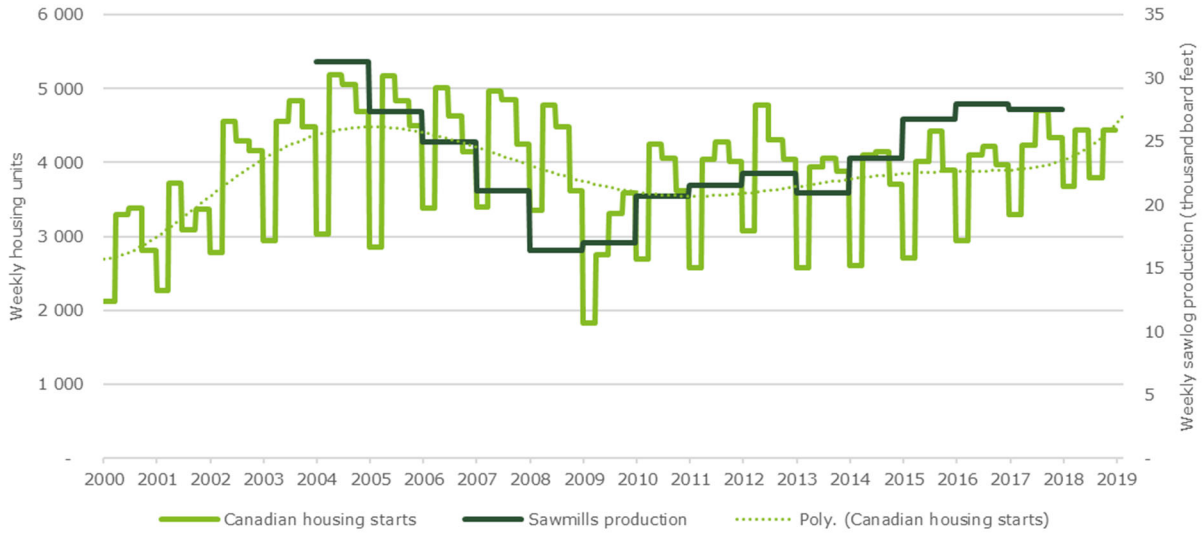


Source: Capital IQ and Government of New Brunswick Department of Natural Resources.
Note: 1. Foreign exchange rates in the graph above were transformed to weekly periodicity from daily data. 2. Sawmills production were transformed to weekly periodicity levels from annual data. As such, they represent weekly average production levels derived from annual data.

Canada's housing market and mortgage rates

Sawlog production is also correlated with Canadian housing starts and the ability of homeowners to borrow money to fund new construction and renovation expenditures. The following graphs illustrate the historical trend in sawlog production, housing starts in Canada and prevailing mortgage rates.

Chart 17: Canadian housing starts and New Brunswick lumber production



Source: Statistics Canada and Government of New Brunswick Department of Natural Resources.
Note: 1. Poly in the graph above refers to the polynomial function used to smooth the Canadian housing starts number. Poly can be interpreted as the trend line for housing starts. 2. Housing starts in the graph above were transformed to weekly periodicity from quarterly data. 3. Sawmills production were transformed to weekly periodicity levels from annual data. As such, they represent weekly average production levels derived from annual data.

Chart 18: Canadian mortgage rate and New Brunswick lumber production

Source: Statistics Canada and Government of New Brunswick Department of Natural Resources.
Note: 1. Mortgage rates in the graph above were transformed to weekly periodicity from monthly data. 2. Sawmills production were transformed to weekly periodicity levels from annual data. As such, they represent weekly average production levels derived from annual data.

There is a correlation between sawlog production and Canadian housing starts. As the number of Canadian housing starts decreases, so does the demand for sawlog and as a result, sawlog production also decreases. Canadian housing starts reached a low point near the end of 2008 due to the financial crises.

There is an inverse relationship between mortgage rates and sawlog production. As mortgage rates decrease, it becomes cheaper for consumers to borrow money and buy homes. As the number of home construction or renovation projects increase, demand for sawlogs increases and resulting production also increases.

2.6.2 Pulp production

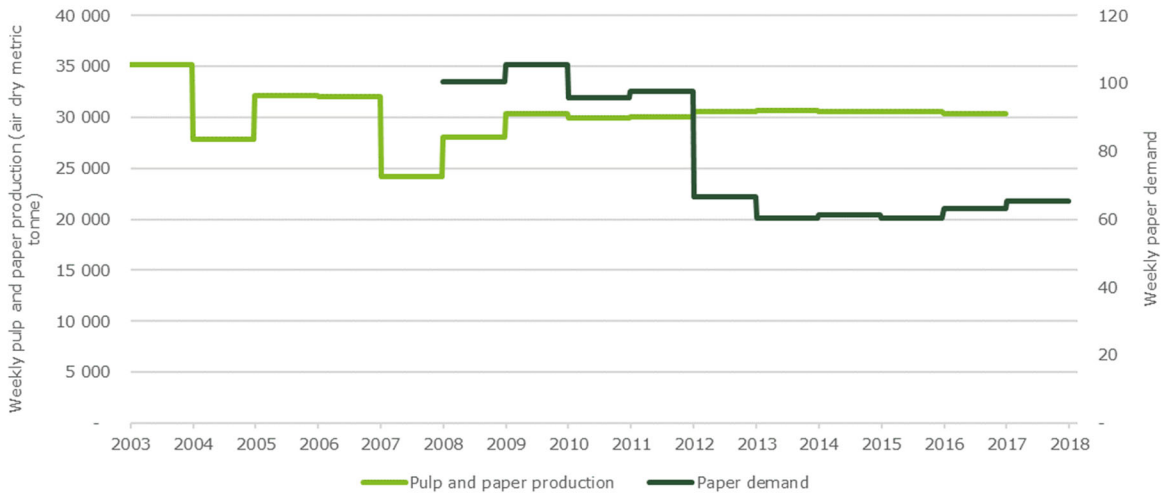
The publishing sector purchases paper and other paper products from paper mill to publish newspapers, magazines and books. Demand for paper products typically increases when the publishing sector is growing, thereby benefiting paper mills and wood pulp producers. Over the past two decades, demand for paper has decreased as more consumers turn to electronic forms of communication. This has had a significant impact on pulp production, wood pulp being the main input in paper production.

Wood pulp production in New Brunswick is the primary input for paper mills. Industry operators use machinery and chemicals to process wood pulp into paper and paper products. Paper mills supply paper to downstream manufacturers. As a result, pulp production depends on orders from paper manufacturing companies and producers of other paper products. When paper manufacturing activity increases, demand for pulp also rises.

Demand for paper

As previously mentioned, wood pulp production is impacted by demand from paper and the publishing industry.[42] The following graph illustrates the historical relationship between New Brunswick production of wood pulp and demand for paper.

Chart 19: Canadian demand for paper and New Brunswick pulp and paper production



Source: Deloitte analysis and Government of New Brunswick Department of Natural Resources.
Note: 1. Domestic demand is derived by adding spending on paper industry goods and services (i.e., revenue) within Canada to industry imports and then subtracting exports. 2. Pulp and paper production in the graph above were transformed to weekly periodicity from annual data. 3. Paper demand was transformed to weekly periodicity levels from annual data. As such, they represent weekly average production levels derived from annual data.

[42] Domestic demand is derived by adding spending on paper industry goods and services (i.e., revenue) within Canada to industry imports and then subtracting exports.

There is a decreasing trend in paper demand as consumers move away from paper to online sources. There was a big decrease in paper demand in 2012 but pulp and production stayed relatively constant. The latter may be due to two factors: (i) some pulp production may have found other end uses and/or (ii) or New Brunswick pulp producers may have borne disproportionately large price reductions in order to maintain market share. The observed production and demand for paper has been relatively constant from 2012 to 2018.

3 The primary forest products market in other jurisdictions

This chapter aims at providing an overview of different primary forest products markets in other jurisdictions that may be considered as comparators to the New Brunswick industry. It covers the regulatory environment, supply and demand of primary wood industries in Nova Scotia, Maine, Quebec and British Columbia. Nova Scotia and Maine share similar forest composition, and are both geographical neighbours to New Brunswick. Quebec is also adjacent to New Brunswick, and has a large forestry sector. Lastly, British Columbia is the most significant forest jurisdiction in Canada, with a large supply of softwood timber relative to other species, similar to New Brunswick.

The table below provides a comparative overview of the key comparable statistics for Nova Scotia, Maine, Quebec and British Columbia.

Table 5: Comparative overview of the key comparable statistics across jurisdictions

	Nova Scotia	Maine	Quebec	British Columbia
Forest region	Acadian Forest Region	Acadian Forest Region	Boreal Forest Region	Most diverse forest areas – mostly softwood forests
Ownership share	Provincial and federal governments own 47% of forest land, while the remaining 53% of forest land is privately owned	The state and federal governments own 6% of Maine's forest land, while the remaining 94% of forest land is privately owned	Public ownership of Quebec's forest land amount to 92%, the remaining 8% is privately owned	Public ownership of BC's forestland amount to 95%, the remaining 5% is privately owned
Number of mills	117 sawmills in, as of 2015	26 SPF sawmills, as of 2015	119 sawmills, as of 2014	126 sawmills, as of 2017

Given its geographical location, impacting its wood species mix, and given the number of sawmills on its territory, New Brunswick's primary forest products market likely lies between Nova Scotia and Maine. This comparison, however, does not account for different regulations and policies which may vary greatly across jurisdictions. The wood industries in the provinces considered differ in their respective organization and regulation, as well as in their mix of products. Compared to New Brunswick, the Nova Scotia primary wood industry relies more heavily on small private woodlot suppliers, due to historical factors which led to

parcelization of the province's territory. The situation is even more contrasting in Maine, where only 6% of the land is publicly owned and most of this territory is protected land or state parks, which are not destined for commercial exploitation. Maine's territory is also parcelized, with 47% of landowners having less than 100 acres each. Quebec has a relatively distinct industry of its own, with a strong dominance of provincial Crown Land supplying essentially sawlogs and studwood, with private landowners, while numerous, providing only about a fifth of all wood supply in the province. Finally, BC has the largest primary wood industry in Canada and is also a significant wood industry globally. It is not only distinct from New Brunswick by the way it manages its forest, but also by the species and maturity of trees that are harvested.

While each of the markets reviewed share some similarities with New Brunswick's primary wood industry, their organization, the relative size and role of each market player, the type of fiber they harvest on their territory and their trading patterns and influence on primary wood markets are widely different. This makes a comparison very challenging, as there is no clear basis to use as a reference point. As such, it was deemed that the differences could not be fully controlled for in any comparative analysis. As such, it was decided to develop our statistical analysis of the industry without relying on data from the neighboring jurisdictions.

3.1 Nova Scotia

Nova Scotia is part of the Acadian Forest Region. About a third (35%) of the province's forests consists of hardwood species and 65% of the province's forests is softwood species.[43] The provincial and federal governments own 47% of forest land within the province, while the remaining 53% of forest land is privately owned. Nova Scotia's Department of Natural Resources (DNR) provides the authority to harvest on provincial public Crown Land under the Crown Lands Act and the Scott Maritimes Pulp Limited Agreement (1965) Act.[44] In addition, Nova Scotia's DNR has administrative authority over provincial parks, wildlife management, forestry, and minerals. Similar to public forest lands, private lands are subject to the Forests Act, which is also enforced by Nova Scotia's DNR.[45]

Nova Scotia's DNR provides the authority to harvest wood through four forms: letters of authority, permits and/or a license, and forest utilization license agreements. Letters of authority are required to buy wood for personal use. In the context of Nova Scotia, licenses do not have the same scale as in New Brunswick, and are granted for much smaller areas of land. Permits and licenses are often used for small sales of wood, while a license and a forest utilization agreement are used with mill operators and producers of wood products that may be exported.[46] Companies granted larger and longer term timber harvest authority are required to obtain approval from the province's DNR for their Annual Operating Plan which outlines the location and type of all harvesting and operational activities planned. These companies are required to provide Annual Reports that outline the actual location of all harvest activities. Additionally, DNR needs to consent in writing to sales or exchanges of wood between wood product manufacturers.[47]

3.1.1 Sources of wood supply harvested

Nova Scotia's private woodlot owners include non-industrial woodlot owners, who often own small parcels of land, and larger industrial private woodlot owners. The smaller lots owned by individuals "limits supply because participation of private woodlot owners in harvesting activity is decreasing".[48] The province's public supply of wood comes from Crown Land owned by the Province or Federal government.

Nova Scotia has a higher proportion of timber supplied and harvested from private woodlots in the province, "specifically from relatively smaller parcels of lands owned by individuals".[49] In 2015, timber from private lands accounted for 64% of total timber harvested. Nova Scotia's DNR explains that, "the majority of Nova

[43] Province of Nova Scotia. Forest governance in the Province of Nova Scotia.
[44] Idem.
[45] Idem.
[46] Idem.
[47] Idem.
[48] Expert Report of John Asker, Ph.D.: Economic Analysis of Factors Affecting Cross Jurisdictional Stumpage Price Comparisons. 2017.
[49] Idem.

Scotia's land and water is privately owned due in part to land grants made to encourage settlement during the 18th and 19th centuries".[50] The province supports private woodlot owners by maintaining a public database of potential harvesters and contractors for individual woodlot owners, since a significant portion of the province's private lands are owned by individuals and families.[51]

3.1.2 Sources of demand for wood supply to produce forest products

Nova Scotia is home to many sawmills, most of which source their wood from private forest lands, since only fifteen mills had Crown timber rights in 2012.[52] The Nova Scotia Woodlot Home Study Program revealed that, "there is a good sawmill market for sawlogs l within a short distance of nearly every woodlot in the province".[53] In 2015, Nova Scotia's Registry of Buyers revealed that there were 117 sawmills in the province, most of which are small scale operations, with only four mils acquiring over 200 thousand cubic metres of sawlogs per year. [54]

Nova Scotia's sawmills efficiently utilize residual products from sawlogs, such as sawdust and wood chips. The chips and sawdust material support Nova Scotia's pulp and paper industry. Sawmills within the province can easily, "find a purchaser for residual fibre that can be used as pulp", which is a key input in the production of paper. The province's mills also capitalize on additional markets and sell residual products, like bark to biomass facilities as hog-fuel.[55]

Nova Scotia planned to increase its consumption of biomass energy, as this became "an important source of energy in Nova Scotia after the 2010 construction of a biomass plant at the site of the Port Hawkesbury paper mill." The plant began operating at full capacity in 2013 and the government aimed to have the plant supply 25% of Nova Scotia's electricity by 2015 and 40% by 2020".[56]

Facilities such as the Port Hawkesbury plant have resulted in increased demand for biomass/hog fuel residuals in Nova Scotia, even among individual homeowners. Nova Scotia also benefits from the easy access to the US East Coast Market. This is an area of considerable housing construction activity.[57]

3.2 Maine

Maine is situated within the Acadian Forest Region and is the most heavily forested state in the United States, with forests covering around 90% of the state. The state and federal governments own 6% of Maine's forest lands, while the remaining 94% are privately owned forest lands.[58] Maine's Forest Service administers the Forest Practices Act (FPA) and reports to the Department of Agriculture, Conservation, and Forestry. In Maine, all industry players involved in timber harvesting activities must acquire a license from and submit a Forest Operations Notification to the Department of Agriculture, Conservation, and Forestry to be allowed to harvest wood.[59]

A Forestry Operations Permit from Maine's Forest Service under the Department of Agriculture, Conservation, and Forestry is required for timber harvesting and related activities within the state. The applicants must comply with all conditions and standards identified in the permit, such as the volume removal, type of harvest, bounds of operation area, and extent and timing of harvest.[60] In addition to the permit, the Forester License is granted to allow for monitoring of the application of forestry techniques, including the

[50] Idem.
[51] Idem.
[52] Province of Nova Scotia. Forest governance in the Province of Nova Scotia.
[53] Idem.
[54] Idem.
[55] Expert Report of John Asker, Ph.D.: Economic Analysis of Factors Affecting Cross Jurisdictional Stumpage Price Comparisons (2017).
[56] Idem.
[57] Idem.
[58] Maine TREE Foundation. Forest Facts: Who Owns Maine's Forest.
[59] Maine Forest Service and Maine Department of Agriculture, Conservation & Forestry. The Forestry Rules of Maine 2017 : A Practical Guide for Foresters, Loggers and Woodlot Owners. 2nd Edition, Forest Service Documents. 2017.
[60] Idem.

establishment of forest management plans, the supervision of forestry activities, forest financial management and other forestry activities that are carried out on public or private lands.

3.2.1 Sources of wood supply harvested

The vast majority of Maine's forest lands are privately owned and 63% of it is destined to harvesting. Of this, 35% is owned by non-industrial private landowners that harvest wood. A majority of them are families and individuals, which creates a trend toward smaller woodlots throughout the state, resulting in the parcelization of forest land. The National Woodland Owner Survey revealed that over 47% of Maine's total forest acreage belongs to owners that own fewer than 100 acres each. This trend can "'affect' the supply of harvestable timber in Maine" significantly, if harvest participation rates decrease among private owners.[61] Industrial landowners account for 28% of private forest ownership and they include companies that own paper mills, sawmill and other wood processing facilities.

Among other private landowners in Maine, 14% of the forest is owned by large non-industrial owners that do not intend to harvest wood, and another 15% of forest is owned by investment companies, such as banks, insurance companies, and pension funds. The remaining 3% of private forest lands belong to Native American tribes, and Land Trusts and Conservation Organizations.[62] Most of Maine's 6% of public forest lands is comprised of state and national parks.[62]

Timber harvests in Maine tend to yield larger logs compared to other jurisdictions. This increases the value of the timber and lowers unit costs of harvesting, as larger trees are less expensive to harvest and haul, and can be used to produce more forest products. In 2014, 459,000 thousand cubic feet (about 13,000 thousand cubic metres) of wood was harvested from Maine's forest.

3.2.2 Sources of demand for wood supply to produce forest products

The sawmill industry in Maine has been increasing in capacity and efficiency. In 2015, a survey conducted by the Forest Economic Advisors revealed that the twenty-six operational SPF sawmills in Maine increased their capacity by 17% within the last two years.[63] This increase in capacity reflects an increase in demand and may also be due to Maine's low cost of operation for loggers due to the state's "high road density", which may decrease the price that mills have to pay to the loggers.[64]

In 2014, 50% of wood harvested in Maine was converted into pulpwood for paper, tissue, and packaging; over 27% was converted into sawlogs for lumber; almost 20% was converted into biomass for electricity; and under 3% was converted into firewood and pellets to heat homes.[65]

3.3 Quebec

Quebec has an extensive forest, which accounts for one fifth of Canada's forest lands and accounts for 2% of the world's forests. Quebec's forest zones include the boreal forest, which contains black spruce, balsam fir and white birch; mixed forests, which contain yellow birch and balsam fir; and hardwood forests, which contain sugar maple and yellow birch. In terms of area, 92% of Quebec's forests are under public ownership, the remaining 8% is privately owned.[66] In 2017, 93% of Quebec's public managed forests were certified under either the Sustainable Forestry Initiative (SFI) standard or the Forest Stewardship Council (FSC), and in some cases both.[67]

Quebec's Ministry of Natural Resources (MRN) manages the province's public forest through the Sustainable Forest Development Act. This Act regulates forest protection activities, the sale of wood on the free market, and ensures work carried out in public forests is monitored and controlled, amongst other responsibilities. In

[61] Expert Report of John Asker, Ph.D.: Economic Analysis of Factors Affecting Cross Jurisdictional Stumpage Price Comparisons (2017).
[62] Maine TREE Foundation. Forest Facts : Who own's Maine's Forest.
[63] Expert Report of John Asker, Ph.D.: Economic Analysis of Factors Affecting Cross Jurisdictional Stumpage Price Comparisons (2017).
[64] Expert Report of John Asker, Ph.D.: Economic Analysis of Factors Affecting Cross Jurisdictional Stumpage Price Comparisons (2017).
[65] Maine Forest Products Council. Maine's Forest Economy.
[66] Province of Quebec. Forest governance in the Province of Quebec.
[67] Idem.

addition, the MRN oversees all work authorized by permits, agreements and contracts, and is responsible for the overall implementation of provincial forest laws and regulations.

3.3.1 Sources of wood supply harvested

Most of Quebec's supply of wood comes from public forest lands. Quebec also has about 134,000 private woodlot owners located near the province's wood processing mills.[68]

The 134,000 private landowners in Quebec account for twenty-one percent of the total supply of wood delivered to processing mills within the province. Fir, spruce, jack pine, and larch (SPF) timber make up the majority of wood harvested and processed in the province. However, private woodlots contribute 13% of SPF supply to the province's mills, and in some regions, supply more SPF wood than public forest lands.

3.3.2 Sources of demand for wood supply to produce forest products

Sawmills are the dominant types of mills in Quebec. There are 119 sawmills in the province as of 2014, which represents over 97% of the total proportion of mills in the province. Pulp, paper and other mills make up the rest of the mills in the province. While sawmills account for the vast majority of facilities, they make up approximately 25% of the value of shipments from all Canadian sawmills from Quebec. This highlights the difference in scale between sawmills and pulp mills. The former are smaller and numerous, while the latter are of much larger scale but less numerous.

Sawmills utilize SPF to produce sawn wood and wood by-products. Wood chips account for over 60% of by-products created from sawmills for pulp and paper mills. Bark used for plants to produce thermal and electric power account for over 22% of by-products created by sawmills. The remaining 18% of by-products created by sawmills are sawdust and wood shavings for manufacturing boards and biofuels.[69]

3.4 British Columbia

British Columbia (BC) is Canada's most biologically and ecologically diverse province. In 2011, BC was the world's largest exporter of softwood lumber. Softwood forests account for 91% of the province's forest lands and account for almost half of Canada's softwood. The most important commercial species in the province include hemlock, Douglas fir, balsam, pine, spruce, and cedar. In terms of area, 95% of BC's forests are publicly owned, the remaining 5% are privately owned.

The province's Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRO) is responsible for ensuring compliance over public and private lands. Additionally, BC's Private Managed Forest Land Council administers the Managed Forest Program for BC's private lands.

3.4.1 Sources of wood supply harvested

Most of BC's wood supply comes from provincial Crown Land, as it accounts for 95% of the province's forest area. Half of the province's Crown Land is designated as harvestable forest area.[70] Crown forest land also has a higher average harvest yield per hectare compared to private forest land. A report on the BC Forestry Industry published in 2015 revealed that areas harvested on Crown Land averaged 180,000 hectares per year since 1990, while areas harvested on private forest land averaged 20,000 hectares annually.[70]

The timber harvested in the province is also divided into two main regions, the Coast and the Interior. The Coast produces higher value products due to the large size of the trees and "sought-after species" like Douglas fir and western red cedar.[70] However, by quantity, most of BC's timber is harvested from the interior, as the fibre costs are high in the Coastal region. Total harvest volume in 2017 was around 64,200

[68] Idem.
[69] Idem.
[70] Chartered Professional Accountants of British Columbia. Overview of the BC Forestry Industry. Industry Update. Fall 2015.

thousand cubic metres, of which interior companies harvested 74% and the coastal companies harvested the rest.[71]

3.4.2 Sources of demand for wood supply to produce forest products

In 2017, there were an estimated 126 sawmills operating in the province, accounting for 72% total primary log use in 2017.[72] In 2017, estimates of the province's operating mills also included seventeen veneer mills, fifteen pulp mills, five paper mills, thirteen pellet plants, and thirty-six shake and shingle mills. The variety of mills is a reflection of BC's diverse forest.[73]

Sawmills mills are the most significant mills in terms of volume of logs used. Over 46% of the wood sent to sawmills was converted into lumber and over 16% of wood used by sawmills was converted into sawdust shavings for bio-energy. 35% of sawmill inputs were also converted into chips to be used by pulp mills. In addition to the chips received from sawmills, pulp mills also receive over 65% of their pulp inputs from sawmills. BC'S veneer and plywood mills produce mostly veneer, pulp mills produce mainly paper products, while pellet mills utilize sawmill residues in order to create wood fuel. The shake and shingle industry uses blocks of timber to create a number of sidewall shingle products.

BC is the largest exporter of softwood lumber, its total forest product export sales in 2016 were $13.96 billion. The province's largest export markets are the United States (53%), China (24.5%), and Japan (8.8%).[74] Pulp and log exports are particularly significant for China's market. In 2013 China received 61% of the province's pulp exports and 44% of exported logs.[75]

[71] Ministry of Forests, Lands, Natural Resource Operations and Rural Development. Major Primary Timber Processing Facilities in British Columbia. 2017.
[72] Idem.
[73] Idem.
[74] Province of British Columbia. Forest governance in the Province of British Columbia.
[75] Chartered Professional Accountants of British Columbia. Overview of the BC Forestry Industry. Industry Update. Fall 2015.

4 Statistical analysis of New Brunswick primary forest products market

This chapter provides a description of the data and methods used in the statistical modelling of the New Brunswick primary wood industry. It includes the development of the conceptual analytical framework and the results of our statistical analysis.

The purpose of the statistical and econometric analysis envisaged in this section is to model the factors determining private woodlot stumpage prices across the province in order to identify whether or not there are any deviations in stumpage prices relative to prices prevailing in competitive markets (defined as markets with no concentration, no market power and prices equal to marginal cost) and if so, what the order of magnitude of these deviations may be.

The first step in this modelling was to identify the data available for this purpose. We identified a subset of marketing board transaction-level data which contains recorded stumpage prices paid to private woodlot owners. Most transaction-level data collected by marketing boards (by virtue of the administration fees they are mandated to collect on all private woodlot transactions) contain only mill gate prices. However, we learned that marketing boards also provide contract administration services to independent contractors. In these cases, the marketing boards remit the stumpage to the woodlot owners (on behalf of contractors) and by virtue of this, they collect private woodlot stumpage prices.

The second step was to request and collect the data from the marketing boards, which involved extensive discussions about non-disclosure agreements, data privacy and data extraction issues, including from different legacy systems used by each marketing board. We have sought to collect this data as well as all other transaction-level data collected by the marketing boards in order to allow for any weighting of the stumpage price data that may be required to ensure that the stumpage price data is representative of the entire population of private woodlot stumpage transactions. The third step involved data cleaning, preparation and standardization across the multiple datasets extracted. This was a major undertaking as the legacy administrative databases held by the marketing boards were never intended to be extracted for analytical purposes. Appendix A provides details of the data we collected, how it was prepared and how markets were defined.

The key insight at the heart of the modelling strategy is that market conditions tend to differ considerably across the province in terms of private woodlot transactions. For example, in some parts of the province, the market structure appears to be competitive with multiple buyers and sellers. Specifically, woodlot owners have multiple choices of mills to sell their wood to, including some mills in other provinces. On the other hand, in other parts of the province, woodlot owners appear to be selling to only one or two mills. This means that it should be possible to model price differences in private stumpage transactions across different regional markets within the province and thereby determine what differences can be attributed to differences in supply and demand conditions, and what differences can be attributed to differences in market power held by industry groups (i.e., groups of mill owners). Given the large number (40,000+) of private woodlot owners supplying timber to the primary forest product market, it is unlikely any one of them has capacity to influence stumpage prices on its own. Hence, it is first necessary to define the relevant regional markets for

stumpage transactions. Section 4.1 below presents a review of TUS data and trends over time. Section 4.2 reviews the conceptual framework for our econometric analysis, while section 4.3 presents the results of the econometric analysis.

4.1 Analysis of the Timber Utilization Survey

The Timber Utilization Survey (TUS) is a comprehensive source of wood flows prepared by the Government of New Brunswick based on survey data received from forest products industry participants. It was first produced in the early 1980s as a method of determining the fibre requirements of New Brunswick mills. Over time, use of the TUS has evolved; while monitoring fibre requirements of mills is still part of the report's function, the report is primarily used to monitor trends in wood fibre consumption.[76]

It is a requirement that industry participants complete the survey. Hence, it can serve as an authoritative source of the volume of wood flows by origin (i.e., Crown Land, federal land, imports, industrial freehold and private woodlots by marketing board) and by destination (i.e., mills and domestic versus export destinations outside the province). The TUS data is collected from industry participants who receive an AAC allocation as a Crown licensee/sub-licensee. A minority of industry participants by volume of wood used who do not consume any wood from Crown Land are not required to complete the survey and, accordingly, these industry participants' data is not included in the TUS. As a result, it is probable that non-Crown consumption is slightly higher than indicated by survey results. Additionally, the TUS does not include the following volumes of wood:

- Crown wood harvested and exported;
- Crown wood harvested and delivered to holding yards;
- Crown wood delivered to small (<500m3) mills and/or local sales (ex. fuelwood);
- Marketing board wood harvested and exported;
- Marketing board wood harvested and delivered to non-Crown using mills, or local sales;
- Marketing board wood delivered to holding yards; and
- Industrial freehold wood harvested and exported.

In order to ensure a complete date set and capture all wood flows in New Brunswick we augmented the TUS data with data from the New Brunswick Forest Product Commission and Crown scale database.

For the purposes of this report, the TUS wood flow data also sets the overall context for our analysis of private woodlot markets and provides the data regarding other wood sources and destinations and their impacts on private woodlot sales and stumpage prices. We have also analyzed the TUS for trends in wood consumption for the years 2006 to 2017 and wood harvested in NB for the years 2008 to 2017.

Our objective in completing the TUS analyses was to identify trends and insights in wood harvested in NB and consumed in NB over time as it relates to our primary forest products market study. This section of our report comments on the results of our analysis. It includes the changes in wood harvested in NB by source over time as well as the change in wood consumption by different mills in NB over time in different regions of the province.

The entire forest of New Brunswick is characterized by high diversity in forest composition. There are some differences in the composition of the forest across the province, i.e., hardwood versus softwood, which translates into types of mills, i.e., hardwood pulp mill versus softwood sawmill, situated in different areas of the province. As well, land ownership by type of owner differs across the province. For instance, private woodlot ownership is more prevalent along the western and southern parts of the province and Crown Land

[76] Beginning with the 2015-16 TUS, ERD changed Table 1A so that it reflected the total provincial harvest volume. In order to populate the new version of Table 1A, ERD leveraged the best possible source of data for each land base which allows for a more accurate assessment of total harvest within the province. ERD also provided Deloitte with the data for past years so that they could include past years in the analysis.

is more prevalent in the central and northern parts of the province. These dynamics and the geographic location of the province create different market dynamics in different parts of the province. These differences in the forest contribute to the creation of different markets within the province, which we discuss in section 5.

New Brunswick's wood consumption includes two species group and two product groups. In order to simplify our analyses and make it more focused, we grouped certain tree species in the survey. Mainly we grouped those species which are more or less meaningful from a commercial point of view by volume, which therefore emphasizes the more relevant commercial species. For the purposes of our analysis, we grouped tree species as follows:

- Hardwood:
  - Poplar;
  - Maple; and
  - Other hardwood
- Softwood:
  - Cedar;
  - Spruce, Fir, Jack Pine, White Pine, Red Pine; and
  - Other softwood
- Mixed (hardwood and softwood). This category was not considered any further in our analysis and represents only a minor part of the volume under review.

The New Brunswick forest products sector produces an array of products, some more specialized than others and some that are commonly recognized as the largest use of the wood harvested by volume. A portion of both the hardwood and softwood tree is used to produce lumber or solid wood products, and a portion of the tree is used to produce wood that is used to produce pulp or boards, such as oriented strand board ("OSB"). A smaller volume of wood is used for more specialized or limited use products. We have analyzed the wood harvested in NB and wood used by the mills in NB based on a categorization of use as either saw or studwood, or pulpwood and roundwood chips[77] or a residual "other" category. These are the most significant uses of the wood supply by volume. For each of these product categories we also completed our analysis by both hardwood and softwood species, grouped as previously discussed. We grouped wood products as follows:

- Saw and studwood:
  - Studs;
  - Sawlogs; and
  - Tree length.
- Pulpwood and roundwood chips:
  - Pulp;
  - Chips; and
  - Oriented strand board.

[77] For the purpose of this report, the category "pulpwood and roundwood chips" includes pulpwood, roundwood chips, boards and other primary wood products produced by pulp mills. For more details on category aggregation, please consult Appendix A.

    - Other:
- Veneer;
- Biomass; and
- Posts.

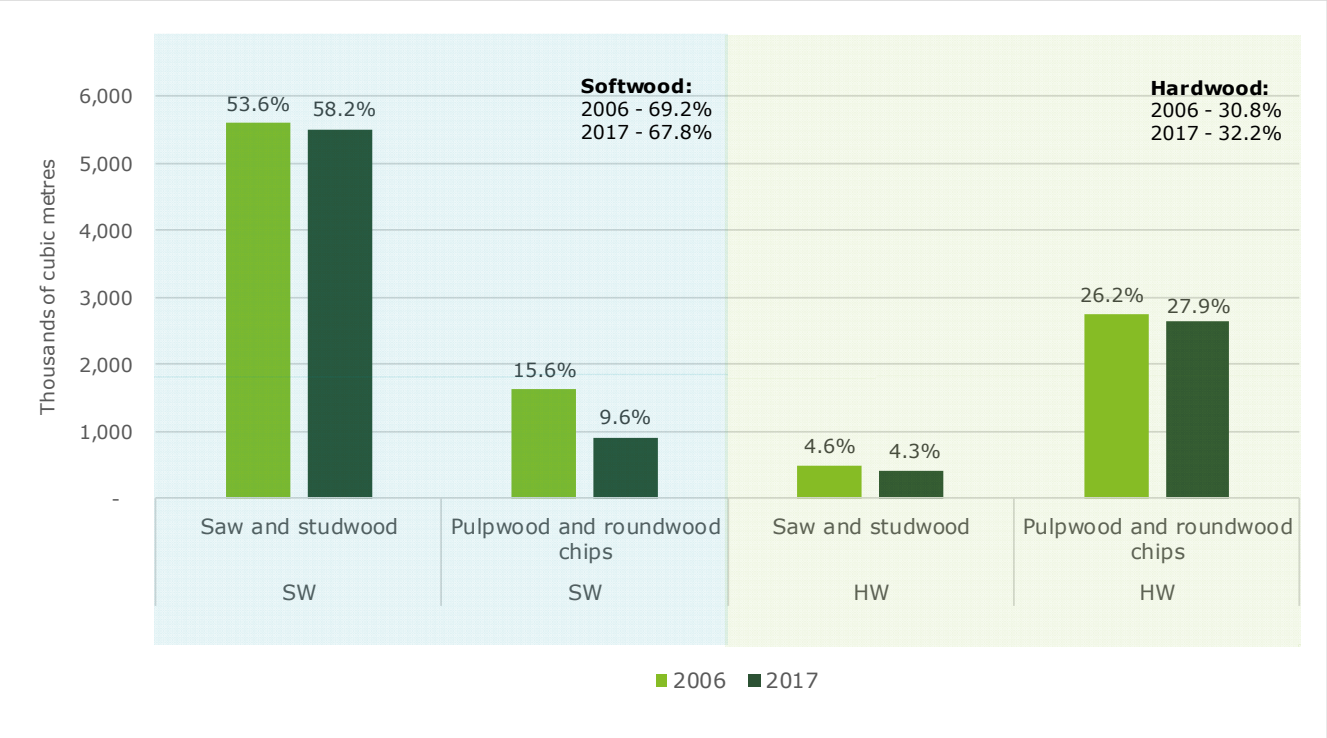
The geographic location of the province also contributes to creating different market dynamics in different parts of the province. New Brunswick is surrounded on the north by Quebec, on the southeast by Nova Scotia and on the west by Maine. This is supportive of our view that there are multiple private woodlot markets in New Brunswick. Imports shown in this section include all imports from US, Nova Scotia, Prince Edward Island and Quebec. Exports include all exports to Europe, US, Prince Edward Island, Ontario, Quebec and other destinations.

All the charts in this section present wood volume rounded in thousands of cubic metres and percentage points. In most of the c charts, the volume of wood is displayed on the x-axis and the years on the y-axis. The TUS data is presented on an April to March year-end basis. As an example, the year 2017 represents the period April 1, 2017 to March 31, 2018.

4.1.1 Wood consumed in NB

This section presents a view of hardwood and softwood consumption by mills in New Brunswick and the sources of the wood. This includes wood consumed from all sources of origin including imports (minus exports). As a means of showing the change in wood consumption in New Brunswick over the time, the following chart depicts in percentage terms hardwood and softwood consumption by wood product type in 2006, the first year that we have data for, and in 2017, the last year we have data for.

Chart 20: Wood consumption by wood type (Hardwood, Softwood), and by product type (Saw and studwood, Pulpwood and roundwood chips) for 2006 and 2017, in thousands of cubic metres and shares in %



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.

For 2006, softwood represented 69.2% of total wood consumption in NB while hardwood represented 30.8% of wood consumed. By 2017, there had been a slight decrease in the proportion of softwood consumed to 67.8% and increase of hardwood to 32.2%.

The major product categories for which the wood was used in 2006 were softwood saw and studwood (54%), hardwood pulpwood and roundwood chips (26%) and softwood pulpwood and roundwood chips (16%). Overall, these three categories represent 96% of the wood consumption for 2006.

The major product categories for which the wood was used in 2017 were softwood saw and studwood (58%) and up from 54% in 2006, hardwood pulpwood and roundwood chips (28%) and up slightly from 26% and softwood pulpwood and roundwood chips (10%) which fell by approximately 1/3 from 16% in 2006. Overall, those three categories represent 96% of the consumption for 2017.

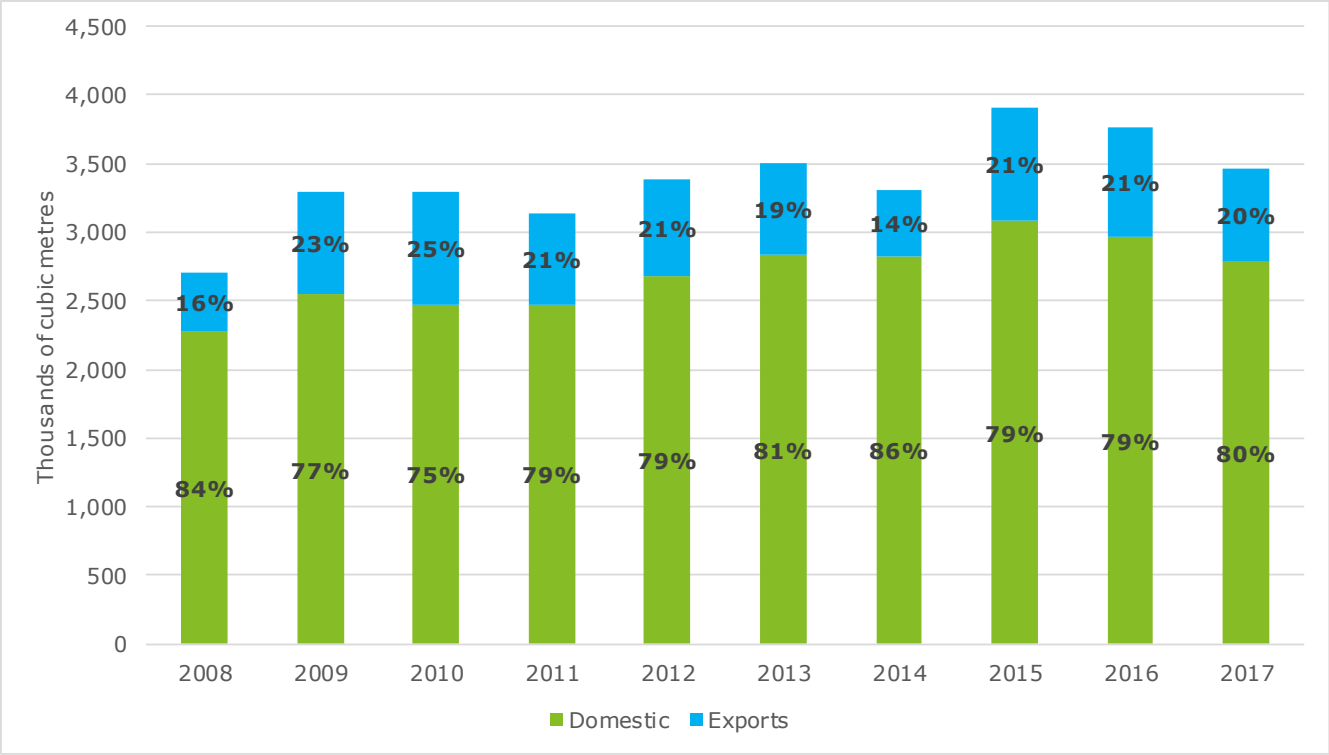
The majority of hardwood is consumed by pulp mills. For 2006, 85% of hardwood was consumed for pulpwood and roundwood chips. This proportion increased to 87% in 2017. The majority of softwood is

consumed by sawmills. In 2006, 78% of softwood by volume was consumed for saw and studwood. This proportion increased to 86% in 2017, mainly due to a decline in softwood pulp capacity.

4.1.2 Wood harvested in NB

This chart presents the sources of wood harvested in New Brunswick and its destination (i.e., to mills in the province or to mills in other provinces or the US). This includes wood harvested from all sources of origin excluding imports (plus exports). This is summarized by hardwood and softwood in the following charts.

Chart 21: Hardwood harvested in NB by destination, all products, volume in thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.
Note: Fuelwood market is not included in this chart as well as volume of wood harvested but not further utilized.

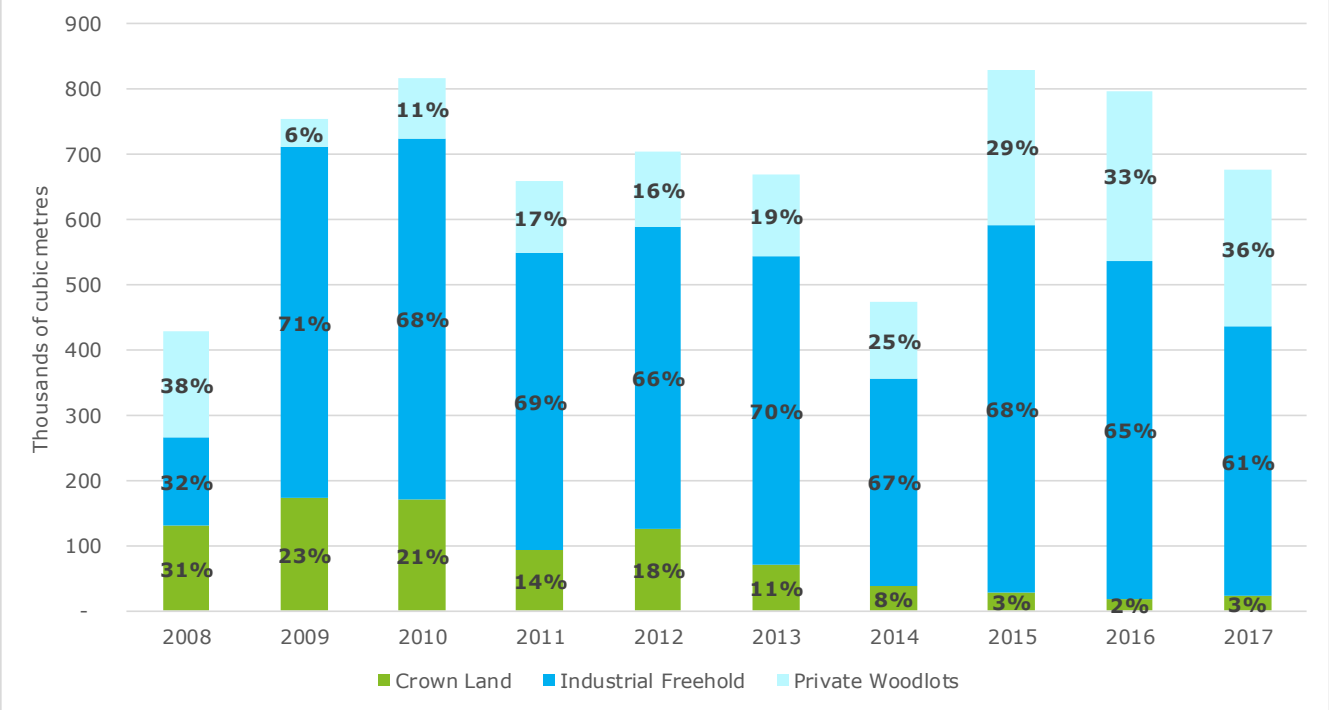
As shown in the chart above, almost all hardwood harvested in New Brunswick is consumed domestically. The share of hardwood harvested that is exported appears largely stable at about 19% to 23%, with a few exceptions. The share of hardwood exports was 16% in 2008, 25% in 2009 and 14% in 2014.

The overall increase in hardwood harvested in NB from 2008 to 2009 and 2014 to 2015 was partially related to an increase in exports. Share of exports increased from 16% (430 thousand cubic metres) in 2008 to 23% (750 thousand cubic metres) in 2009 and from 14% (470 thousand cubic metres) in 2014 to 21% (830 thousand cubic metres) in 2015.

It is also important to note that hardwood destined for the cash fuel wood market is not included in the chart above. Some stakeholders have suggested that this component of the hardwood market is about 600 thousand cubic metres by volume on an annual basis.

A closer look on wood harvested in NB and exported is presented in the next chart.

Chart 22: Hardwood harvested in NB and used for export by its source, all products, volume in thousands of cubic metres

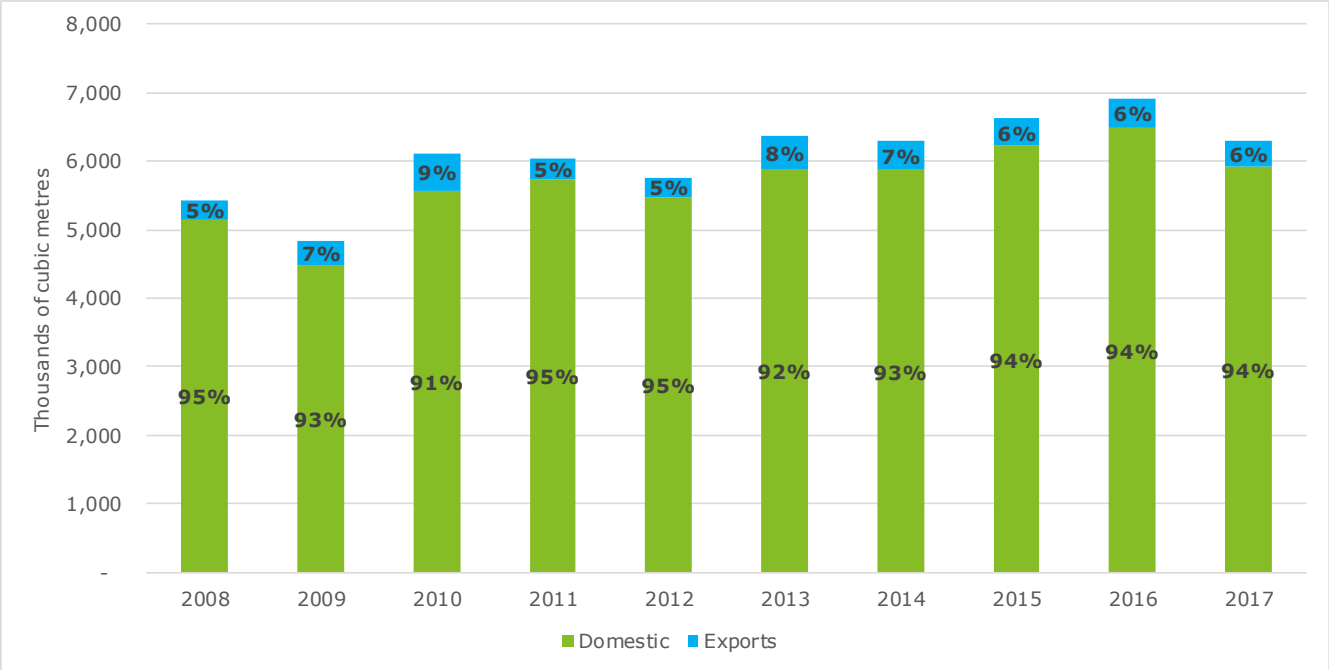


Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.

The proportion of wood harvested from Crown Land and exported is minimal compared to domestic consumption, particularly in the most recent years, as shown in the chart above. Industrial freehold and private woodlots are free to export to jurisdictions outside of the province such as the US and therefore the hardwood exported to the US and other foreign markets is primarily supplied by these sources.

Over 60% of hardwood volume that is exported is from industrial freehold lands. However, an increasing share of hardwood exports have come from private woodlots – increasing from 6% of hardwood exports in 2009 to 36% in 2017 – potentially reflecting the strengthening of the US markets for hardwood and the rise in the US dollar which has translated into higher prices for Canadian sellers when expressed in Canadian–dollar terms.

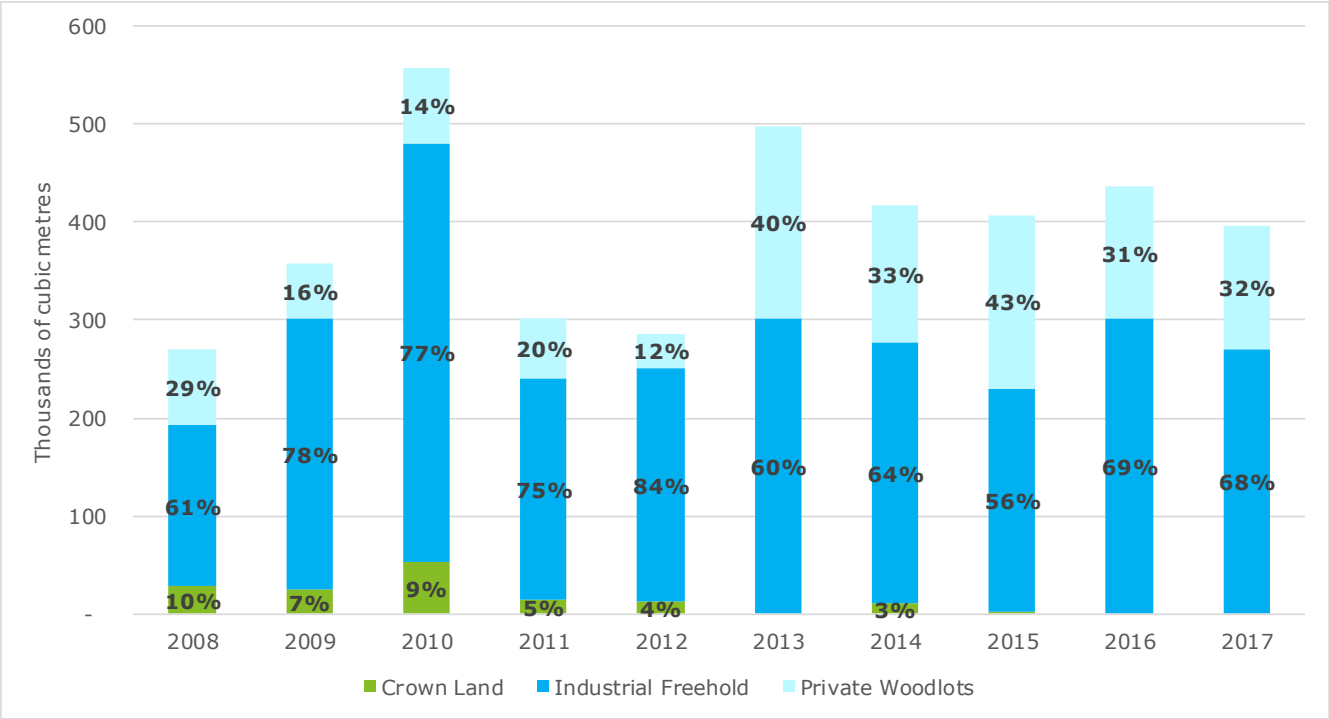
Chart 23: Softwood harvested in NB by destination, all products, volume in thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.

Similar to hardwood, almost all softwood harvested in New Brunswick is consumed domestically and very little softwood is exported (5-9% of total volume exported in given years).

Chart 24: Softwood harvested in NB and used for export by its source, all products, volume in thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.

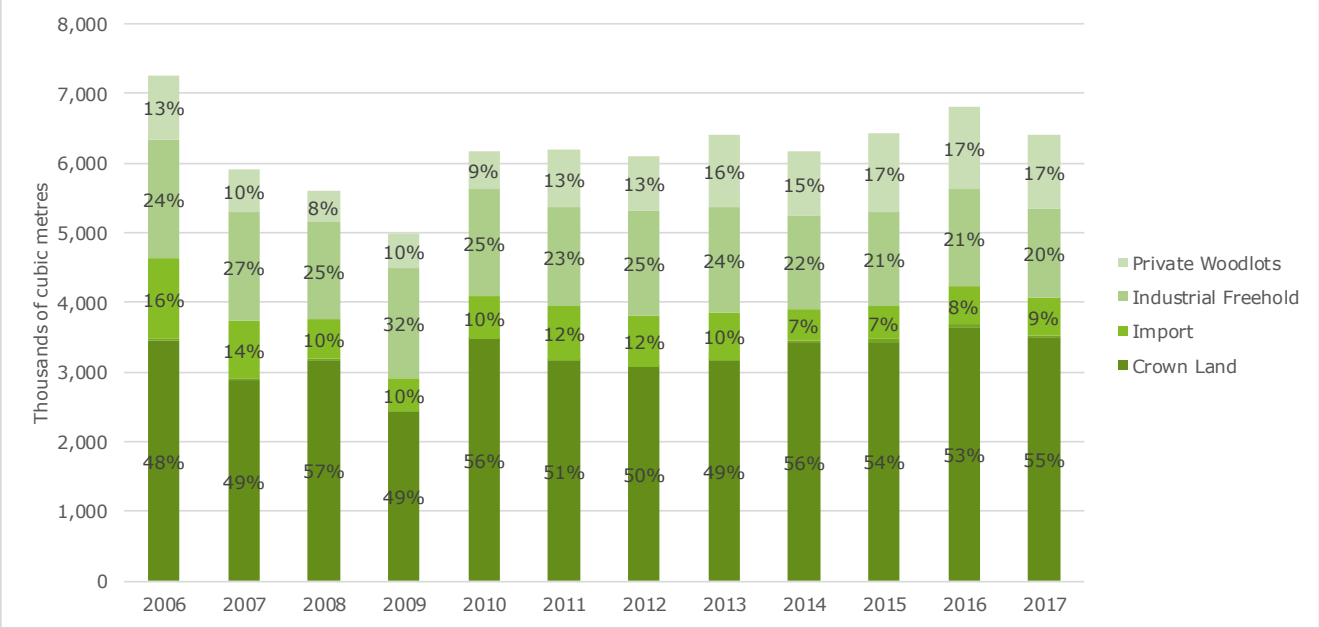
As shown in the chart above, the amount of wood that is harvested from Crown Land and exported is minimal. The large majority of exported softwood is from industrial freehold with the next largest portion from woodlots. The portion of softwood exports from private woodlots has changed over the time period under review.

4.1.3 Softwood used by New Brunswick mills to produce forest products during the 2006-2017 period

This section looks at softwood consumption by source during the period 2006 through 2017. Starting from an overall source perspective we then look at more distinct aspects of consumption by wood product and by source. Since softwood consumption is the most significant wood type in the province by volume, it is the most material part of the New Brunswick primary forest products market.

The following chart, softwood consumption by source, all products, shows the percentage by source over time. All sources of wood are relevant and significant except for federal land. Federal land is shown from a completeness perspective. As previously discussed, sources include private woodlots, industrial freehold, imported wood from outside of New Brunswick and Crown Land. We make observations about these changes in consumption over time.

Chart 25: Softwood used by NB mills by source, all products, volume is thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.
Note: Federal Land is included in the chart above for each year during the 2006-2017 period. However, the percentage of softwood consumption by the Federal Land source ranges from 0.1% to 0.5% across the 2006-2017 period, and as such, it is not visually distinguished in the chart above. The First Nations Land source is not reflected in the chart above due to data limitations.

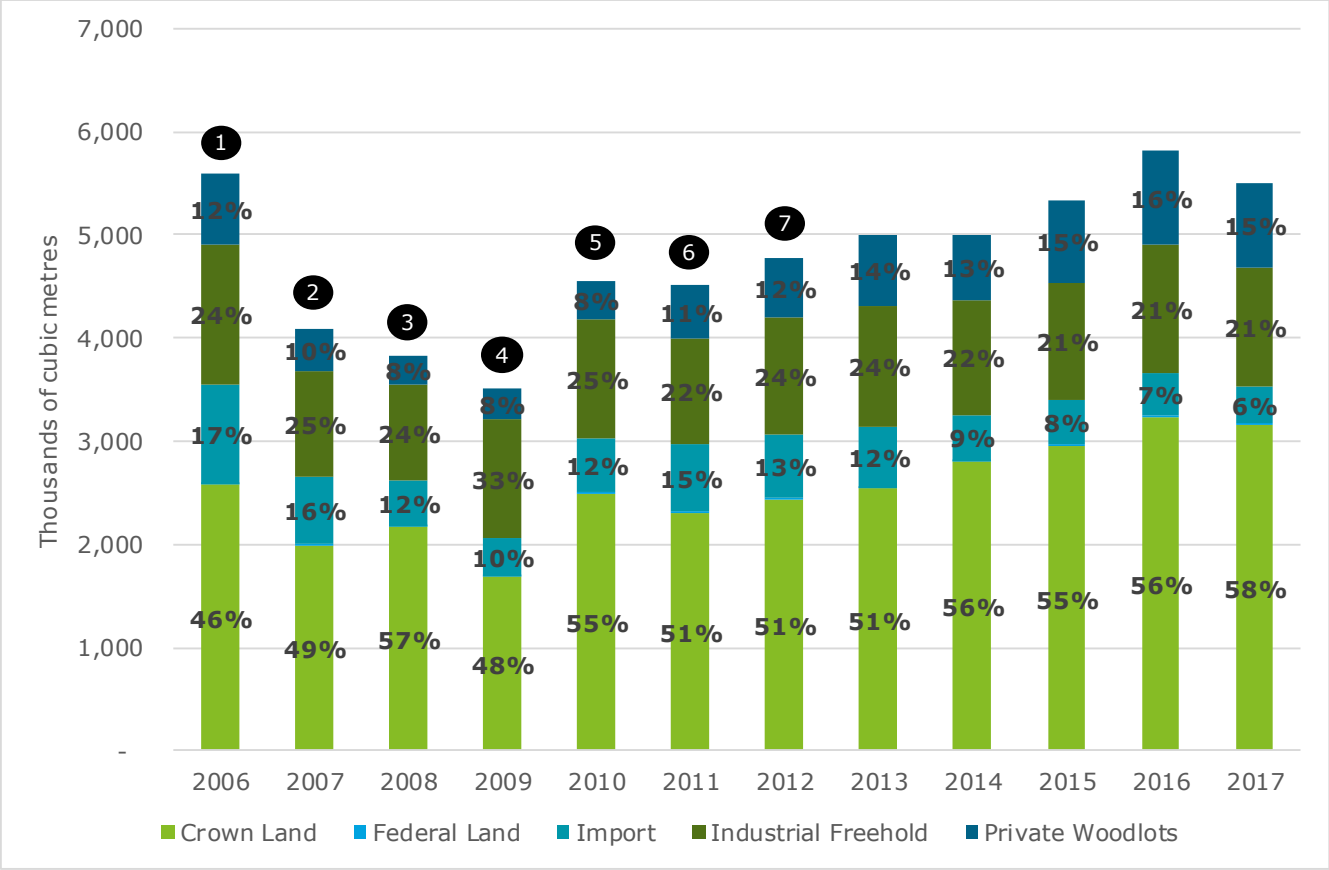
Softwood consumption overall by source shows that the share of consumption from Crown Land increased from 48% in 2006 to 55% in 2017. As noted, there was an increase in AAC in the province allocation in 2014 which was mainly for softwood.

Share of consumption from private woodlots increased from 13% in 2006 to 17% in 2017. However, share of consumption from industrial freehold decreased from 24% in 2006 to 20% in 2017. Imports of softwood also decreased from 16% to 9% during this same time period.

The increase in Crown share (seven percentage points) and private woodlot share (four percentage points) was at the expense of imports (seven percentage points) and industrial freehold (four percentage points).

These changes in wood consumption are generally explained by the reduction in demand for pulpwood and the increase in demand for saw wood at the same time as the AAC from Crown Licensees accessing Crown Land increased.

Chart 26: Softwood used by NB mills for Saw and studwood products by source, volume in thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.
Note: Federal wood consumption is included in the chart above for each year during the 2006-2017 period. However, the percentage of softwood saw and studwood consumption by the Federal Land source ranges from 0.1% to 0.4% across the 2006-2017 period, and as such, it is not visually distinguished in the chart above. The First Nations Land source is not reflected in the chart above due to data limitations.

Significant changes in softwood saw and studwood consumption in New Brunswick during the period under review can be attributed to the following mill-related events (as shown in the chart above). Majority of the events occurred during the 2008-09 recession and due to decline in US housing starts, which occurred in the two prior years:

1. Closures of Bishop Lumber sawmill (located in Canaan Forks in SNB Marketing Board ("MB"), sourced wood from Crown License 6 and 7), D.E. Beckett sawmill (located in Grand Bay in SNB MB, sourced wood from Crown License 7), Chipman sawmill (located in Chipman in SNB MB and sourced wood mainly from Crown License 6 and SNB private woodlot) and SWP Arthurette (located in Arthurette located in CV and sourced wood mainly from Crown License 6 and 9, imports and CV MB).
2. Closures of North American Forest Products – St. Arthur sawmill (located in St. Arthur in NSH MB, sourced wood mainly from Crown Licenses 1 and 9) and M.L. Wilkins & Son sawmill (located in Fredericton in YSC MB, sourced wood mainly from Crown License 8 and MBs: YSC and SNB). Closure of

other mills – T.P Downey (located in Weldon in SNB MB and sourced wood mainly from Crown License 7), UPM Blackville (located in Blackville in NTH MB and sourced wood mainly from Crown License 3) and Moulin McGraw (located in Losier Settlement in NSH MB and sourced wood mainly from Crown License 3).

3. Closure of Fawcett Lumber Co. sawmill (located in Petitcodiac in SNB MB, sourced wood mainly from Crown License 7 and MBs: SENB and SNB).
4. Closure of Marwood Blissville sawmill (located in Blissville in SNB MB and sourced wood from Crown licence 6) and SWP Bayside sawmill (located in Bayside in YSC MB and sourced wood mainly from import, Crown License 6 and YSC MB).
5. Increased capacity of sawmills driven by Twin Rivers Paper Co. Inc. – Plaster Rock (Acquired from Fraser Papers, located in Plaster Rock in CV MB, sourced wood mainly from Crown Licenses 3 and 9 and CV MB) and Fornebu Bathurst Lumber (Acquired from UPM, located in Bathurst in NSH MB and sourced wood mainly from Crown License 3). Closure of Juniper sawmill – owned by Twin Rivers.
6. Closure of Westwood Manufacturing sawmill (located in Dieppe in SENB MB and sourced wood mainly from Crown License 3 and 7), and one sawmills owned by JDI – Deersdale (located in Deersdale in YSC MB and sourced wood mainly from its own freehold).
7. Closure of Newcastle Lumber sawmill (Located in Miramichi in NTH MB. Sourced and sourced wood mainly from Crown License 3).

Softwood saw and studwood is the largest component of use of softwood by volume. It represents the largest component of wood used by mills at roughly 5,000 thousand cubic metres per year. Volumes have been cyclical, but there is an overall trend increase since 2009. Other than the impact of the increase in AAC in 2014, this increase can largely be attributed to cyclical factors.

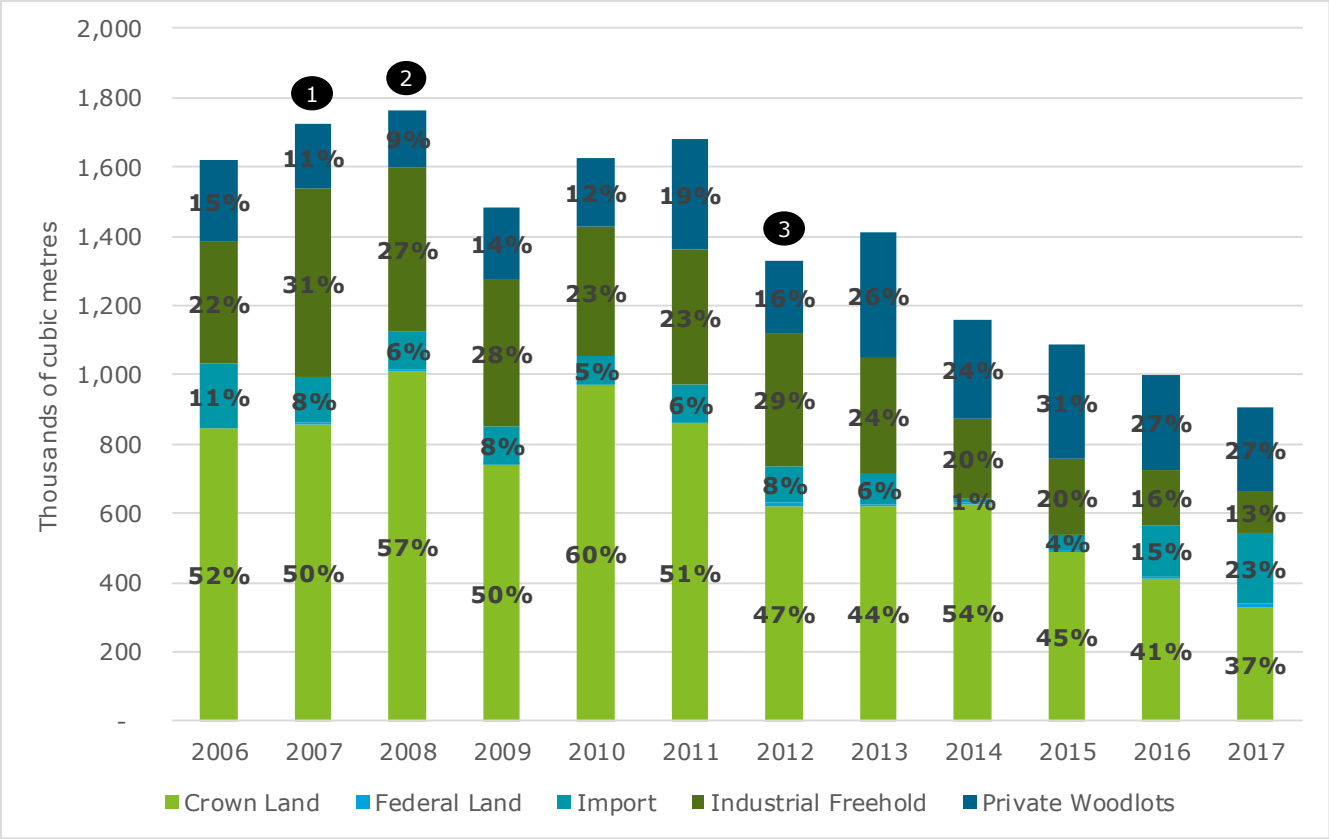
Overall consumption has increased significantly since the 2009 trough of 3,500 thousand cubic metres, but it is still just under the 2006 level of 5,500 thousand cubic metres. Consumption exceeded 2006 levels in 2016 at 5,800 thousand cubic metres.

Crown Land share increased from 46% (2,500 thousand cubic metres) in 2006 to 58% (3,100 thousand cubic metres) in 2017. In 2014, the AAC allocation for softwood increased by about 700 thousand cubic metres. Consumption from Crown Land for softwood increased by around 300 thousand cubic metres in 2014 and 100 thousand cubic metres in 2015.

Industrial freehold share decreased from 24% (1,400 thousand cubic metres) in 2006 to 21% (1,200 thousand cubic metres) in 2017. Private woodlots share increased from 12% of total softwood saw and studwood consumed in 2006 to 15% in 2017. In fact, share of private wood has almost doubled from the trough in 2008 of 8% of total softwood saw and studwood consumed to 15% in 2017.

Share of softwood saw and studwood sourced from Crown Lands has increased significantly (12 percentage points), and so has the share from private woodlots (3 percentage points). Both increased at the expense of imports (11 percentage points) and industrial freehold (3 percentage points).

Chart 27: Softwood used by NB mills for pulpwood and roundwood chips products by source, volume in thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.
Note: Federal wood consumption is included in the chart above for each year during the 2006-2017 period. However, the percentage of softwood pulpwood and roundwood chips consumption by the Federal Land source ranges from 0% to 0.9% across the 2006-2017 period, and as such, it is not visually distinguished in the chart above. The First Nations Land source is not reflected in the chart above due to data limitations.

Significant changes in softwood used for pulpwood products, roundwood chips and boards in New Brunswick during the period under review can be attributed to the following mill-related events (as shown in the chart above):

1. A decrease in softwood used for pulpwood products by the UPM Kymmene paper mill in 2007 of 259 thousand cubic metres (Located in Miramichi in NTH MB. Sourced wood mainly from Crown License 3 and MBs: SENB, NTH and NSH.)
2. UPM Kymmene closed in 2008. Abitibi Bowater closed in 2008 and entered creditor protection in 2009 (Located in Miramichi in NTH MB).
3. In 2012, Arbec Forest Products entered the market by acquiring the OSB mill formerly owned by Weyerhaeuser, which had been shut for 5 years. Before the closure the Weyerhaeuser mill mainly consumed hardwood. After reopening, the Arbec mill significantly increased consumption of softwood while consumption of hardwood remained stable. Located in Miramichi in NTH MB. Sourced wood mainly from Crown License 3, and MBs: NTH, NSH and SENB).

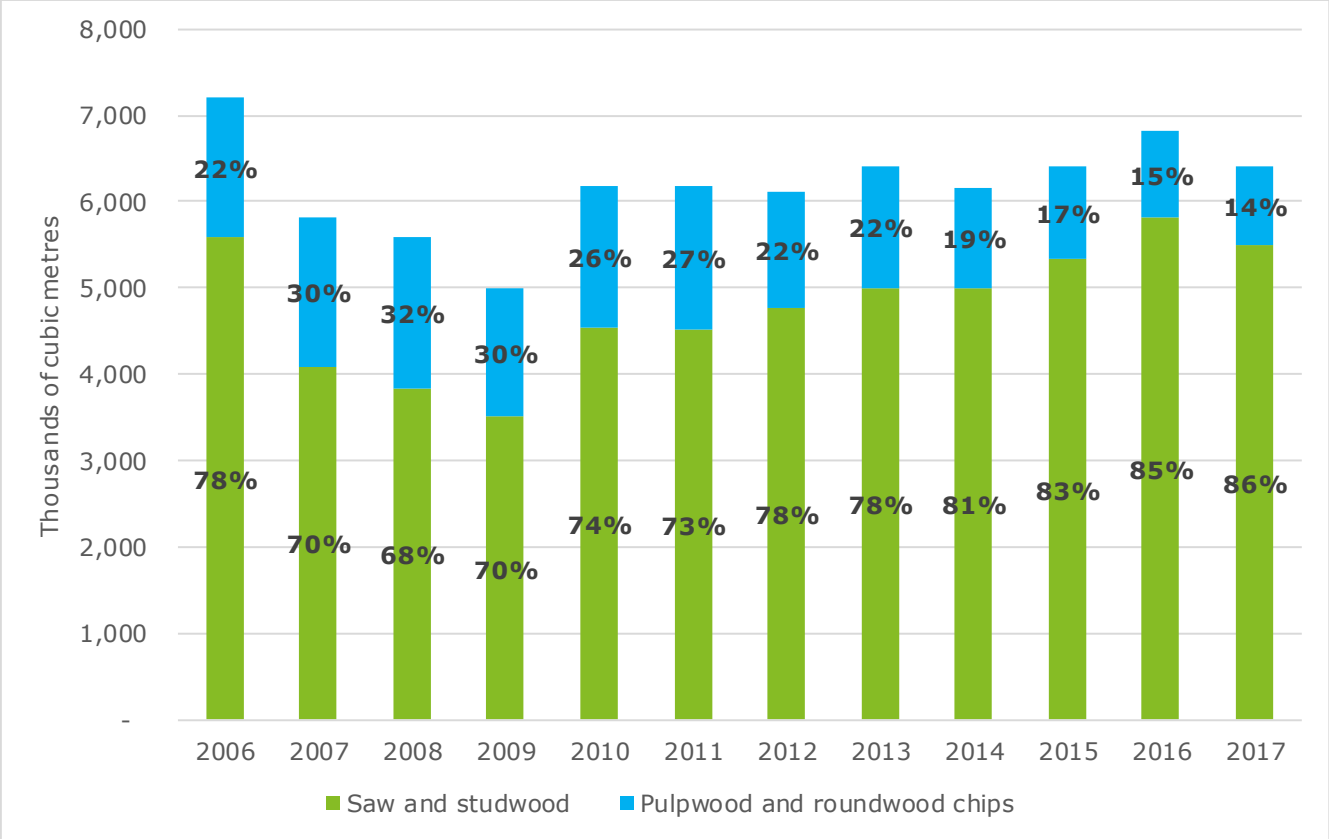
The consumption of softwood pulpwood and roundwood chips by volume has been in a structural decline, with a drop in volume by almost one-half during the period from 2006 to 2017. In particular, post 2011

consumption declined from 1,700 thousand cubic metres in 2011 to 900 thousand cubic metres in 2017. The main reason for this decline in softwood pulpwood and roundwood chips was the decline in end market demand for pulp products and structural pulp mill closures in New Brunswick during this period. This structural change began a few years before the economic downturn, the closure of first paper mills began in 2004. Nowadays, the industry is less dependent on the printing and publishing demand and the majority of pulpwood is sold to companies manufacturing tissue products, OSB, dissolving pulp, particleboard, fibreboard and specialty printing and packaging papers.

There has also been a significant shift in the source for the reduced volume of softwood pulpwood. The share of softwood pulpwood and roundwood chips sourced from Crown Lands decreased significantly from 52% (800 thousand cubic metres) in 2006 to 37% (300 thousand cubic metres) in 2017. Industrial freehold share decreased from 22% (400 thousand cubic metres) in 2006 to 13% (100 thousand cubic metres) in 2017. However, private woodlots share of the pulpwood volume increased significantly from 15% in 2006 to 27% in 2017 even though the consumption volume for private woodlots stayed relatively even at 200 hundred thousand cubic metres.

This change is confirmed in the next chart which shows that the share of softwood pulpwood and roundwood chips consumed by mills (relative to softwood saw and studwood) declined from a peak of 32% in 2008 to 14% in 2017. The decline in consumption of softwood pulpwood and roundwood chips by volume in 2009 can be attributed to a decrease in wood fibre consumption at JDI's Irving Paper, JDI's Irving Pulp and Paper in Saint John, the Fraser Paper Edmundston mills and the closure of the UPM pulp mill in Miramichi.

Chart 28: Softwood used by NB mills by product type, volume in thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.

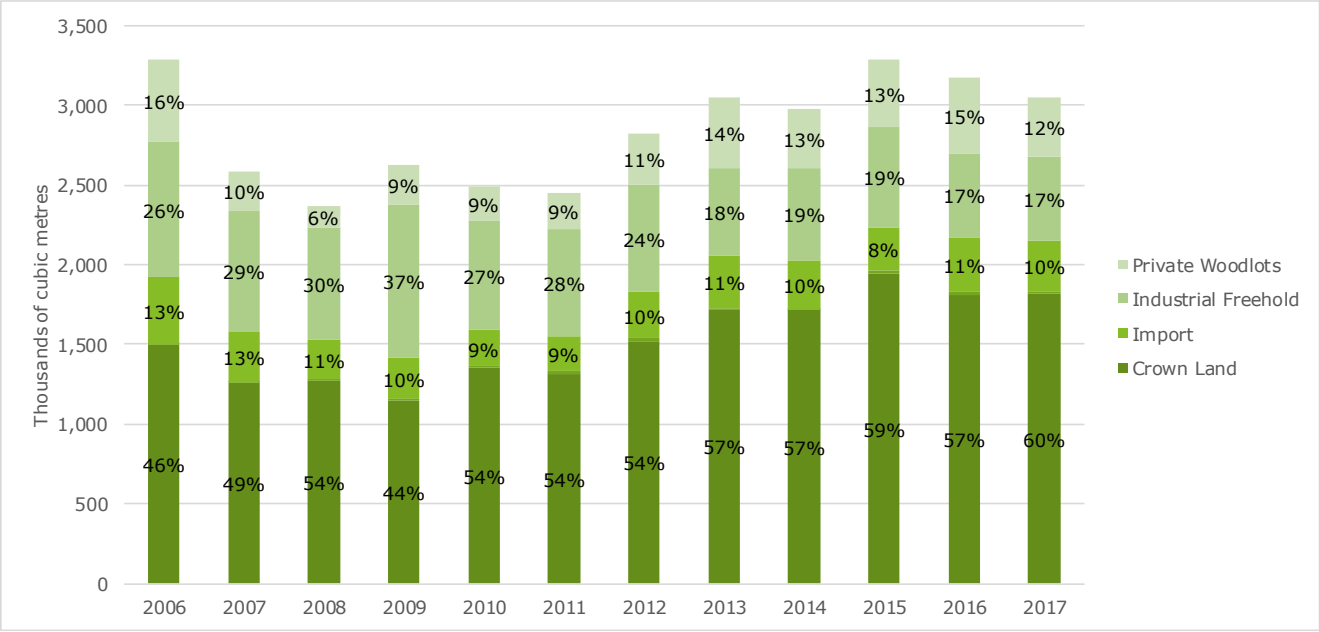
The proportion of saw and studwood volume consumed versus pulpwood and roundwood chips increased significantly over the period under review. The proportion of saw and studwood by volume increased from 78% of total consumption in 2006 to 86% in 2017. This increase was impacted by several factors, one of them being the consumption of smaller diameter trees as sawlogs and studwood instead of pulpwood which reduced the consumption of roundwood chips. The proportion of the consumption of the pulpwood and roundwood chips decreased from 22% in 2006 to 14% in 2017.

This change in consumption is also reflective of a significant change in the forest products produced by the sector with a shift from pulp and paper products to lumber products. As previously mentioned, pulp and paper production capacity decreased and sawmills production capacity increased. Some notable increases and changes in sawmill capacity occurred at Twin Rivers, Fornebu Lumber and JDI mills across the province.

4.1.4 Hardwood used by New Brunswick mills to produce forest products during the 2006-2017 period

Similar to the softwood section, we look at hardwood consumption by source during the period 2006 to 2017. We analyze the consumption from an overall source perspective and then we look at other aspects such as consumption of hardwood by wood product and by source.

Chart 29: Hardwood used by NB mills by source, all products, volume in thousands of cubic metres

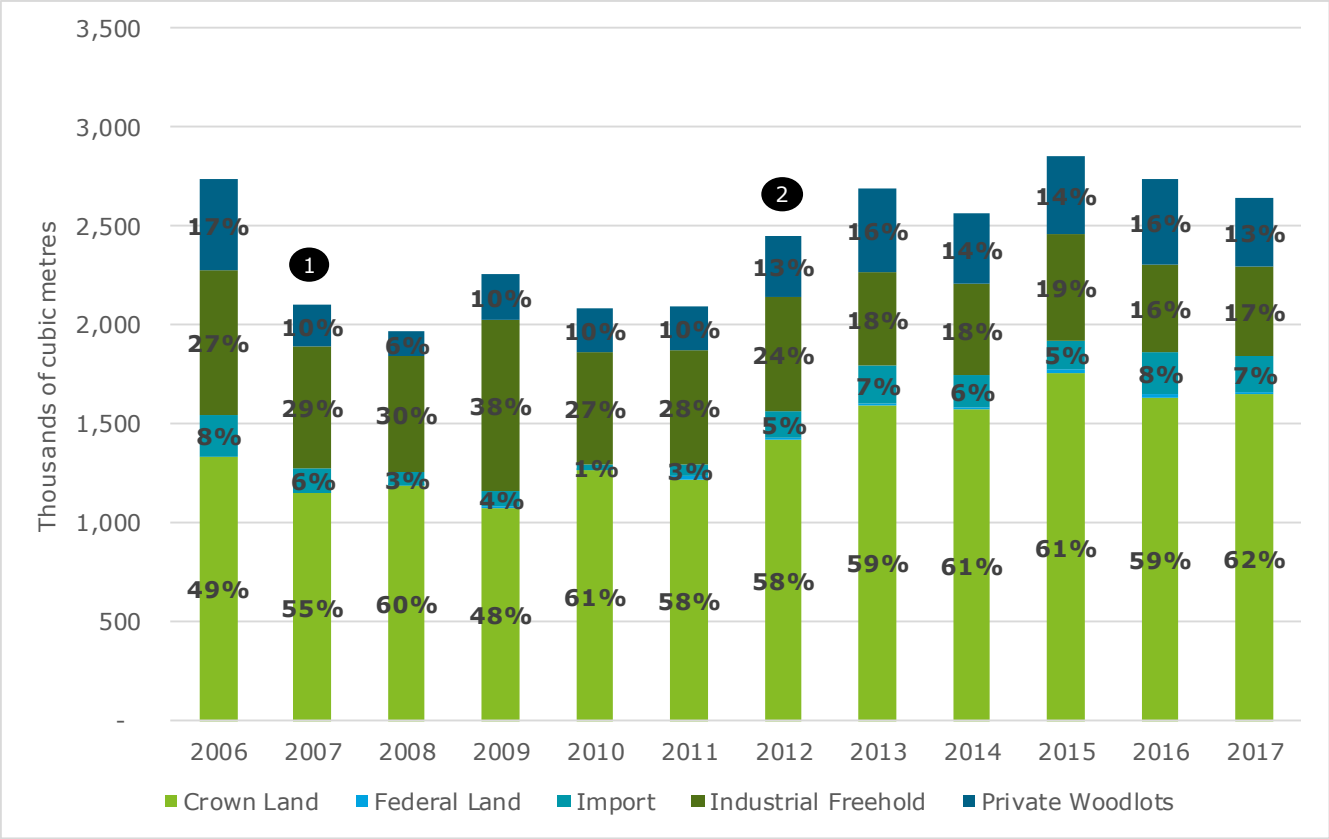


Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.
Note: Federal Land is included in the chart above for each year during the 2006-2017 period. However, the percentage of hardwood consumption by the Federal Land source ranges from 0% to 0.6% across the 2006-2017 period, and as such, it is not visually distinguished in the chart above. The First Nations Land source is not reflected in the chart above due to data limitations.

Hardwood consumption overall by source shows that the share of consumption from Crown Land increased from 46% in 2006 to 60% in 2017. Share of consumption from industrial freehold decreased from 26% in 2006 to 17% in 2017 and the share from private woodlots also decreased from 16% to 12% in the same time period. Imports also decreased from 13% in 2006 to 10% in 2017.

The increase in Crown share (14 percentage points) was largely at the expense of industrial freehold (9 percentage points) and private woodlots (4 percentage points) with a small drop in imports (3 percentage points).

Chart 30: Hardwood used by NB mills for pulpwood and roundwood chips products by source, volume in thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.
Note: Federal wood consumption is included in the chart above for each year during the 2006-2017 period. However, the percentage of hardwood pulpwood and roundwood chips consumption by the Federal Land source ranges from 0% to 0.7% across the 2006-2017 period, and as such, it is not visually distinguished in the chart above. The First Nations Land source is not reflected in the chart above due to data limitations.

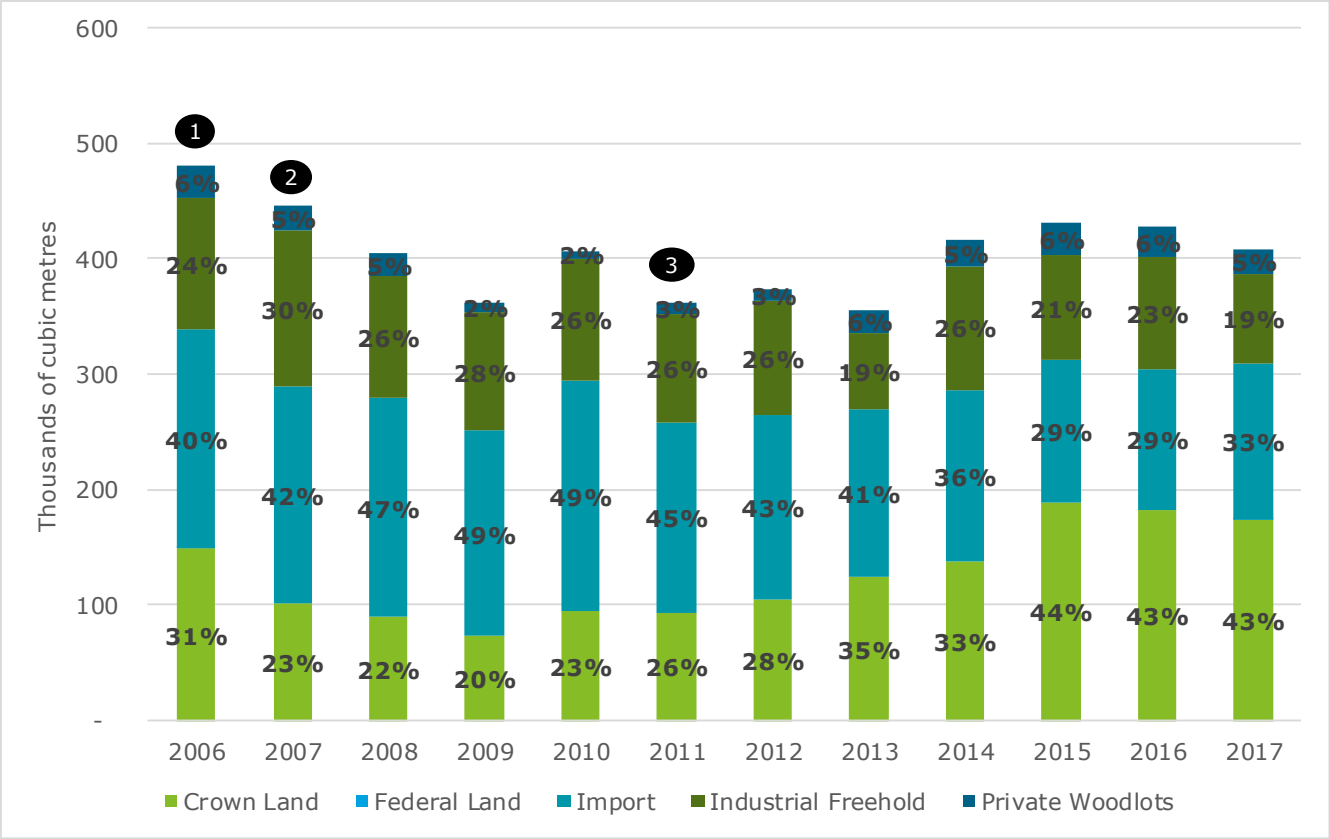
Significant changes in hardwood pulpwood consumption in New Brunswick during the period under review can be attributed to the following mill-related events (as shown in the chart above):

1. Weyerhaeuser closed an OSB mill in 2007. The mill was located in Miramichi in NTH MB. The OSB mill sourced timber mainly from Crown License 3 and MBs: NTH, NSH and SENB.

2. In 2012, Arbec Forest Products acquired the Weyerhaeuser mill and restored its operations a year later. After reopening, the mill significantly increased its consumption of softwood while the consumption of hardwood remained stable. Groupe Savoie mill increased its consumption of hardwood pulpwood by 80 thousand cubic metres from 260 thousand cubic metres in 2011 to 340 thousand cubic metres in 2012. The Groupe Savoie mill sourced wood mainly from NSH MB.

Crown share increased from 49% (1,300 thousand cubic metres) in 2006 to 62% (1,600 thousand cubic metres) in 2017. This came at the expense of industrial freehold share that decreased from 27% (700 thousand cubic metres) in 2006 to 17% (450 thousand cubic metres) in 2017. Private woodlot share also decreased from 17% (450 thousand cubic metres) in 2006 to 13% (300 thousand cubic metres) in 2017. Import share decreased from 8% in 2006 to 7% in 2017 while maintaining consumption at 200 thousand cubic metres.

Chart 31: Hardwood used by NB mills for Saw and Palletwood products by source, volume in thousands of cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.
Note: Federal wood consumption is included in the chart above for each year during the 2006-2017 period. However, the percentage of hardwood saw and palletwood consumption by the Federal Land source is less than 0.02% across the 2006-2017 period, and as such, it is not visually distinguished in the chart above. The First Nations Land source is not reflected in the chart above due to data limitations.

Significant changes in hardwood saw wood consumption in New Brunswick during the period under review can be attributed to the following mill-related events (as shown in the chart above):

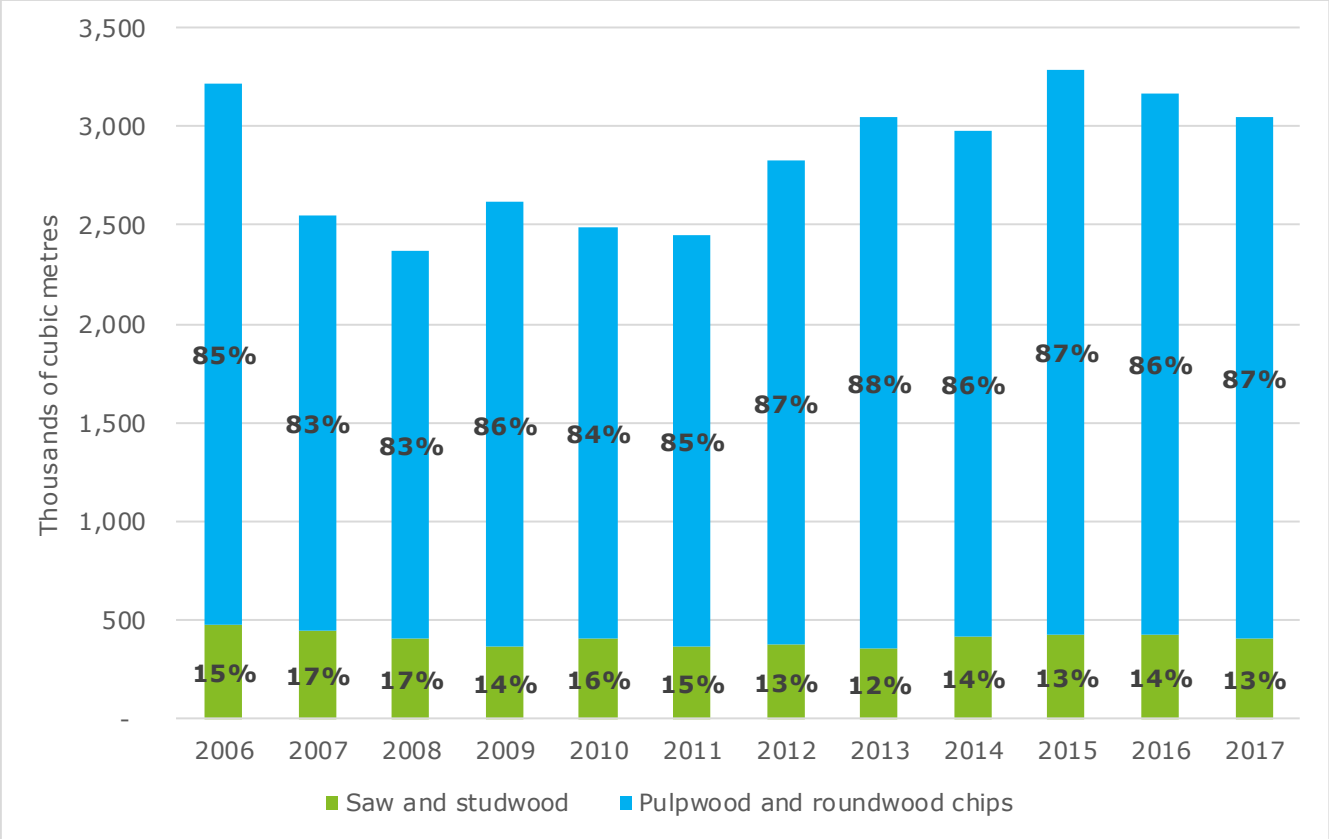
1. The entry of J.D. Irving's Veneer Siding mill in 2006; located in St. Leonard in MAD MB.
2. The closure of the Atcon Plywood mill in 2007; located in Miramichi in NTH MB.
3. The closure of the JDI sawmill consuming hardwood; located in Clair in MAD MB which imported the majority of its wood supply.

Hardwood saw and palletwood represents a small part of the hardwood flows, accounting for less than 500 thousand cubic metres of volume consumed throughout the period 2006 to 2017. Overall consumption in 2017 was still below the peak in consumption in 2006 of 480 thousand cubic metres. It should be noted that the above chart excludes the volume of wood consumed in the cash fuelwood market.

Crown share increased since the trough in 2009, rising especially in the 2013 to 2015 period partially due to an AAC increase. Crown share in 2017 was 43% (175 thousand cubic metres). This increase was at the expense of imports (7 percentage points) and industrial freehold (5 percentage points).

Hardwood AAC increase of 100 thousand cubic metres was allocated to Crown License 1 (Crown Licensee AV Cell) and Crown License 3 (Crown Licensee Fornebu). However, the increased consumption was mainly from Groupe Savoie, located in St. Quentin, NSH MB.

Chart 32: Hardwood used by NB mills by product type, volume in thousand cubic metres



Source: Timber Utilization Survey, New Brunswick Forest Product Commission and Crown scale database.

Pulpwood and roundwood chips account for 83% to 88% of hardwood consumption and saw and studwood account for 12% to 17% of hardwood consumption over the period. This proportion stayed relatively stable over the years under review which indicates that there has been no structural change in the mix of hardwood consumed.

4.1.5 New Brunswick private wood harvested in NB by defined markets analysis during the 2008-2017 period

This section reviews wood harvested from private woodlot owners located in the defined market regions during the period 2008 through 2017. Starting from certain defined markets, we then look at more distinct aspects of supply by product type and by destination. The defined markets, which will be discussed in more detail in a subsequent section, are as follows:

- North Shore market, a hardwood market;
- Carleton-Victoria market, a combined hardwood and softwood market;
- Northumberland market, a combined hardwood and softwood market;
- Softwood market for the York-Sunbury-Charlotte market area;
- Softwood market for the Southern New Brunswick market area; and
- York-Sunbury-Charlotte/Southern New Brunswick market for hardwood.

The wood harvested from New Brunswick was mainly consumed by mills located in the following destinations:

- Within the same marketing board region;
- In different marketing board regions in New Brunswick; and
- Outside of New Brunswick (mainly Quebec, Nova Scotia and Maine).

The marketing board regions in New Brunswick are as follows:

- North Shore marketing board region ("NSH");
- Carleton-Victoria marketing board region ("CV");
- Northumberland marketing board region ("NTH");
- York-Sunbury-Charlotte marketing board region ("YSC");
- Southern New Brunswick marketing board region ("SNB");
- South Eastern New Brunswick marketing board region ("SENB");and
- Madawaska marketing board region ("MAD").

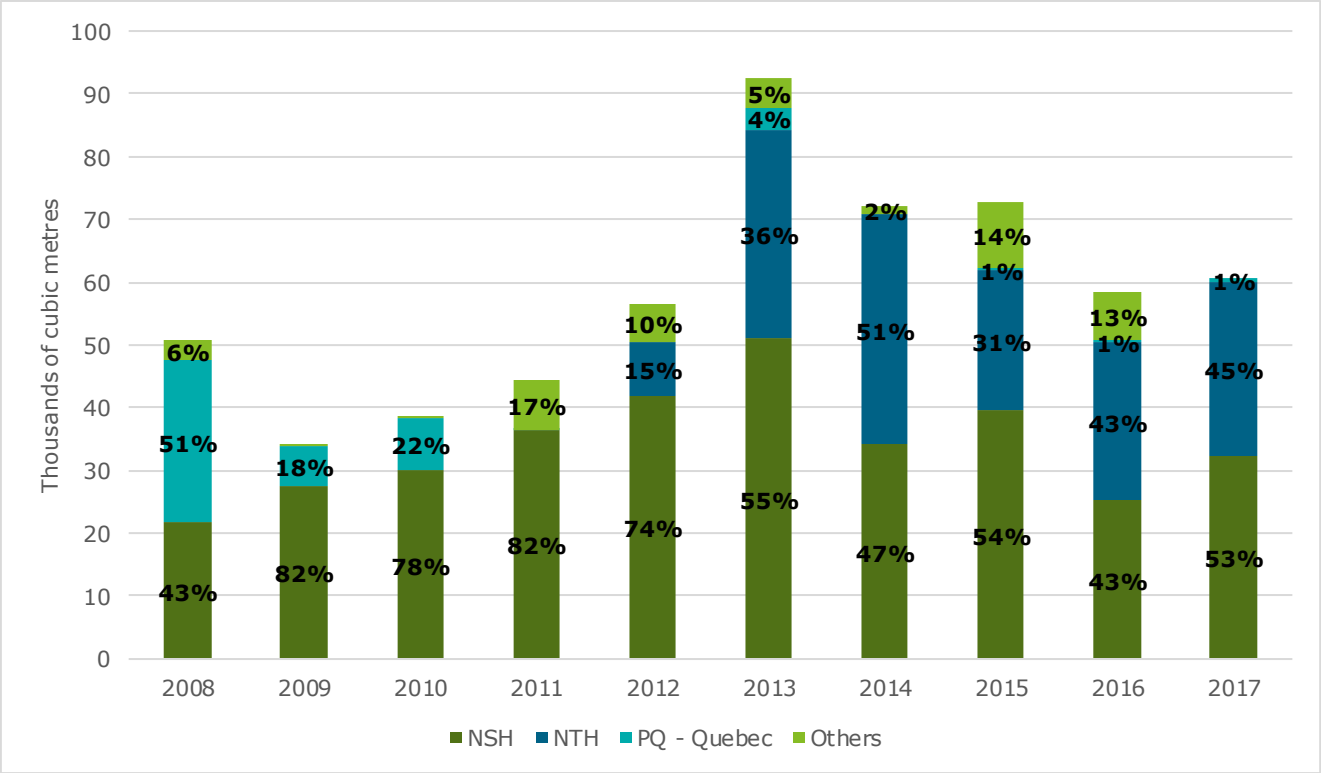
We analyze each of the above markets separately by the following wood product types: (i) Saw and Studwood and (ii) Pulpwood and roundwood chips.

North Shore hardwood market ("NSH hardwood market")

The following charts show hardwood harvested from NSH hardwood market separately for saw and studwood and pulpwood and roundwood chips by destination. NSH hardwood market is located in the north of New Brunswick, bordering Quebec in the north and bordering MAD and NTH in the south.

Over the period 2008 to 2017, NSH hardwood market harvested more pulpwood and roundwood chips than saw and studwood. The volume of pulpwood and roundwood chips harvested amounted to approximately 61 thousand cubic metres in 2017. The volume of saw and studwood harvested amounted to approximately 20 thousand cubic metres in the same year.

Chart 33: Wood harvested from private woodlot owners in the defined market – NSH hardwood market, pulpwood and roundwood chips, by destination, volume in thousands of cubic metres



Source: Timber Utilization Survey.

The overall volume of wood harvested from NSH hardwood market for pulpwood and roundwood chips amounted to approximately 50 thousand cubic metres in 2008. The majority of this wood was consumed within NSH or exported to Quebec. In the following year, the overall wood harvested decreased by 33% to 34 thousand cubic metres, which was mainly due to a drop in wood exported to Quebec. Since 2010, the volume of wood harvested has grown steadily until 2012, with a further major increase in 2013.

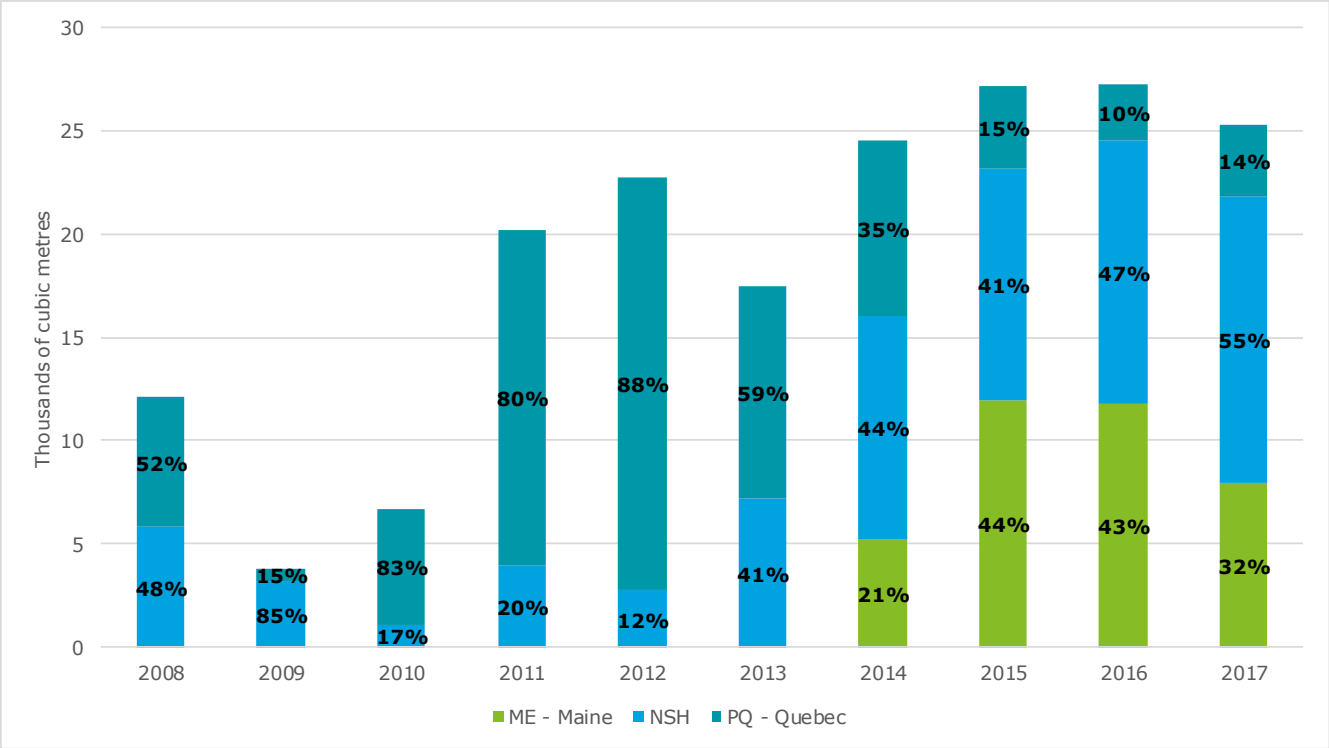
In 2012, Arbec Forest Products, a significant market participant, re-entered the New Brunswick forest products industry. This resulted in an increase in the volume of pulpwood and roundwood chips harvested from NSH hardwood market to NTH from 2012 onwards. The volume of wood harvested from NSH hardwood market increased by 64% to 93 thousand cubic metres in 2013. The proportion of wood harvested by NSH hardwood to NTH increased from 15% in 2012 to 45% in 2017.

From 2013 to 2017 the overall wood harvested from NSH hardwood market for pulpwood and roundwood chips decreased to approximately 61 thousand cubic metres. This decrease was mainly due to the decreasing volume of wood harvested from within NSH. Wood harvested from within NSH was mainly consumed by Shaw Resources, AV Cell Inc. and Group Savoie Inc.

The volume of wood exported from the NSH hardwood market to Quebec decreased during the years under review from 26 thousand cubic metres in 2008 to 3 thousand cubic metres in 2013. In 2014, the volume of wood decreased to a minimal amount and it has remained at an immaterial level since then.

The NSH hardwood market continues to supply a very low volume of wood to Nova Scotia and Maine and the MAD and YSC marketing boards.

Chart 34: Wood harvested from private woodlot owners in the defined market – NSH hardwood market, Saw and studwood, by destination, volume in thousands of cubic metres



Source: Timber Utilization Survey.

The annual volume of wood harvested from NSH hardwood market for saw and studwood was less than 27 thousand cubic metres during the period from 2008 to 2017. The volume of wood harvested increased from 12 thousand cubic metres in 2008 to 25 thousand cubic metres in 2017; with a one year decrease in volume to 8 thousand cubic metres in 2009.

Wood harvested from within NSH increased from 6 thousand cubic metres in 2008 to 14 thousand cubic metres in 2017, the majority of which was consumed by Groupe Savoie Inc.

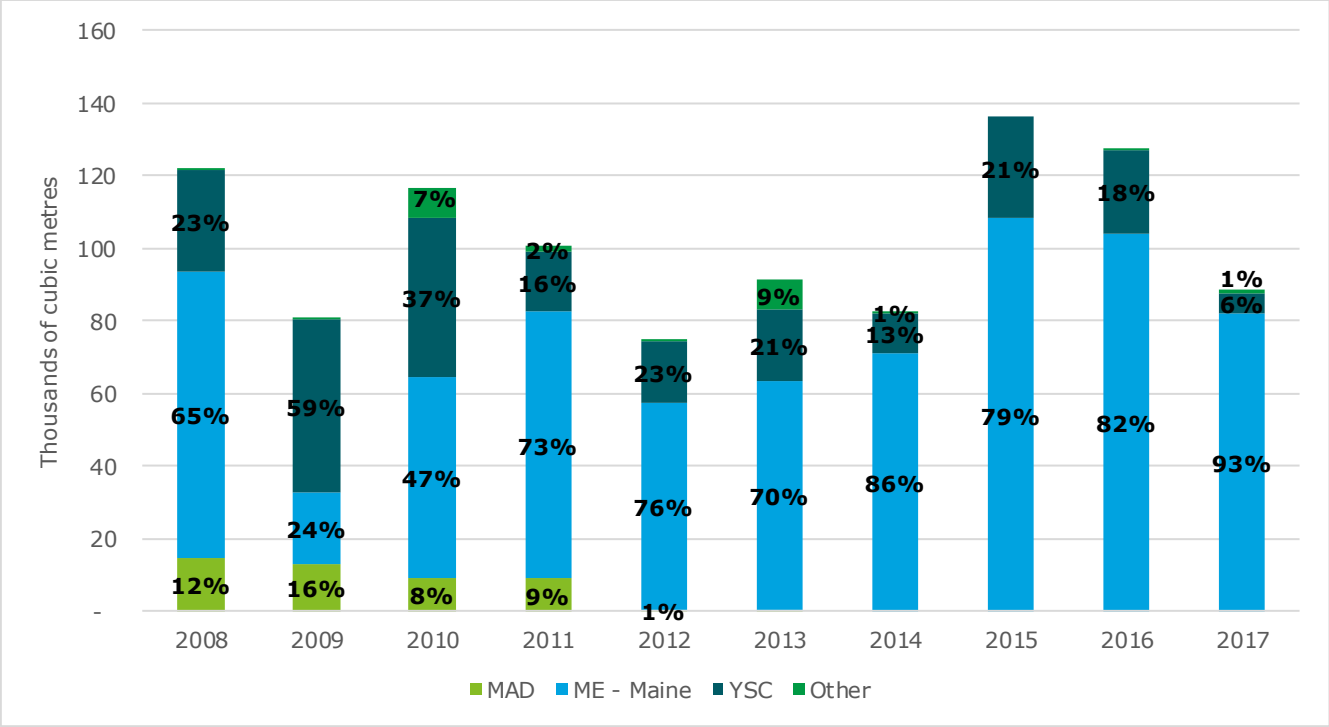
Saw and studwood exports supplied to Maine and Quebec from NSH hardwood market increased from 2008 to 2017 for all years except in 2009, when it collapsed to less than 5 thousand cubic metres. The proportion of wood exported to Quebec increased from 15% in 2009 to 88% in 2012. From 2012 to 2017, the proportion of wood exported to Quebec decreased from 88% to 14%. Beginning in 2014 the proportion and annual volume of hardwood exported to Maine increased from essentially no volume to as high as 44% of total volume in 2015. This was due to the rise in the US dollar after 2014 which meant higher private stumpage prices in Maine when expressed in Canadian dollars.

Carleton-Victoria hardwood and softwood market ("CV combined market")

The following charts show hardwood and softwood harvested from CV combined market for saw and studwood and pulpwood and roundwood chips. The CV combined market is located in the west of New Brunswick. It is bordered by Maine in the west, YSC to the South, MAD and NSH in the North and NTH to the East.

During the period from 2008 to 2017 the type of wood that was harvested from the CV combined market and consumed in New Brunswick changed from a larger proportion of pulpwood and roundwood chips to a larger proportion of saw and studwood.

Chart 35: Wood harvested from private woodlot owners in the defined market – CV combined market, pulpwood and roundwood chips, by destination, volume in thousands of cubic metres



Source: Timber Utilization Survey.

Wood harvested from the CV combined market for pulpwood and roundwood chips fluctuated through the years 2008 to 2017, but overall it decreased from 122 thousand cubic metres in 2008 to 89 thousand cubic metres in 2017.

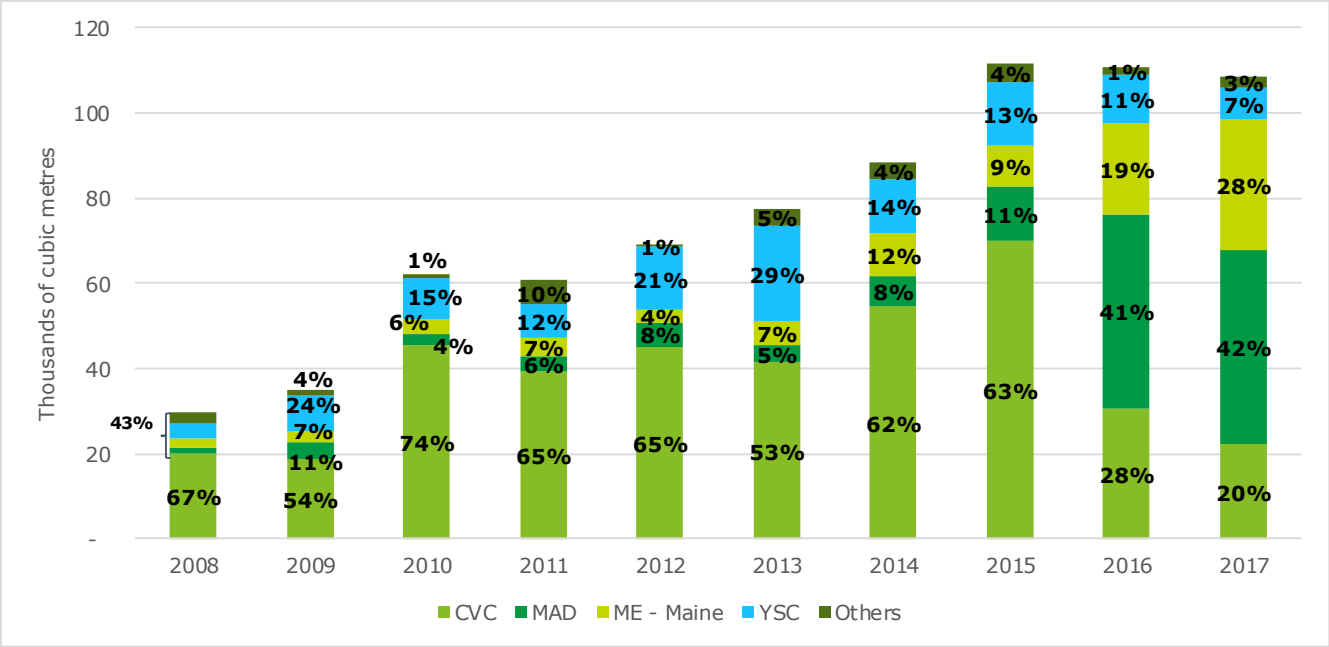
As shown in the chart, none of the wood harvested from CV combined market was consumed within CV in the period 2018 to 2017. The majority of wood harvested was exported to Maine throughout the period, which represented more than 70% of overall supply in most years, likely due to CV's proximity to Maine and favourable exchange rates from 2014 onwards.

Wood supplied to YSC decreased from 28 thousand cubic metres in 2008 to 6 thousand cubic metres in 2017. The majority of this hardwood pulpwood was consumed by AV Nackawic.

The increased share of CV pulpwood exported to Maine in recent years (and the reduced share going to YSC) shows how these wood flows from private woodlots respond to market forces over time.

The remaining immaterial volume supplied from this market was consumed in Nova Scotia and the NSH and SNB marketing boards.

Chart 36: Wood harvested from private woodlot owners in the defined market – CV combined market, Saw and studwood, by destination, volume in thousands of cubic metres



Source: Timber Utilization Survey.

The overall volume of wood harvested from CV combined market for saw and studwood increased from 30 thousand cubic metres in 2008 to 109 thousand cubic metres in 2017 due to an increase in mill capacity and exports to Maine.

The majority of wood harvested was consumed within CV by the Plaster Rock sawmill (owned by Fraser Paper and later acquired by Twin Rivers Paper Co. in 2010). In 2010, the Plaster Rock sawmill increased its capacity, which resulted in an increased supply from CV. There was an increase in the proportion of wood supplied to MAD in 2016. This was due to an increase in consumption by the St. Leonard sawmill (JDI).

The share of supply exported to Maine increased from 2014 onward, since the decline in the Canadian dollar relative to the US dollar made CV saw and studwood more competitive in the Maine market. The proportion of wood supplied to YSC fluctuated over the period between 7% and 29% due to consumption by H.J. Crabbe & Sons Ltd.

The remaining immaterial volume harvested from this market was consumed in Quebec and the NSH, NTH and SNB marketing boards.

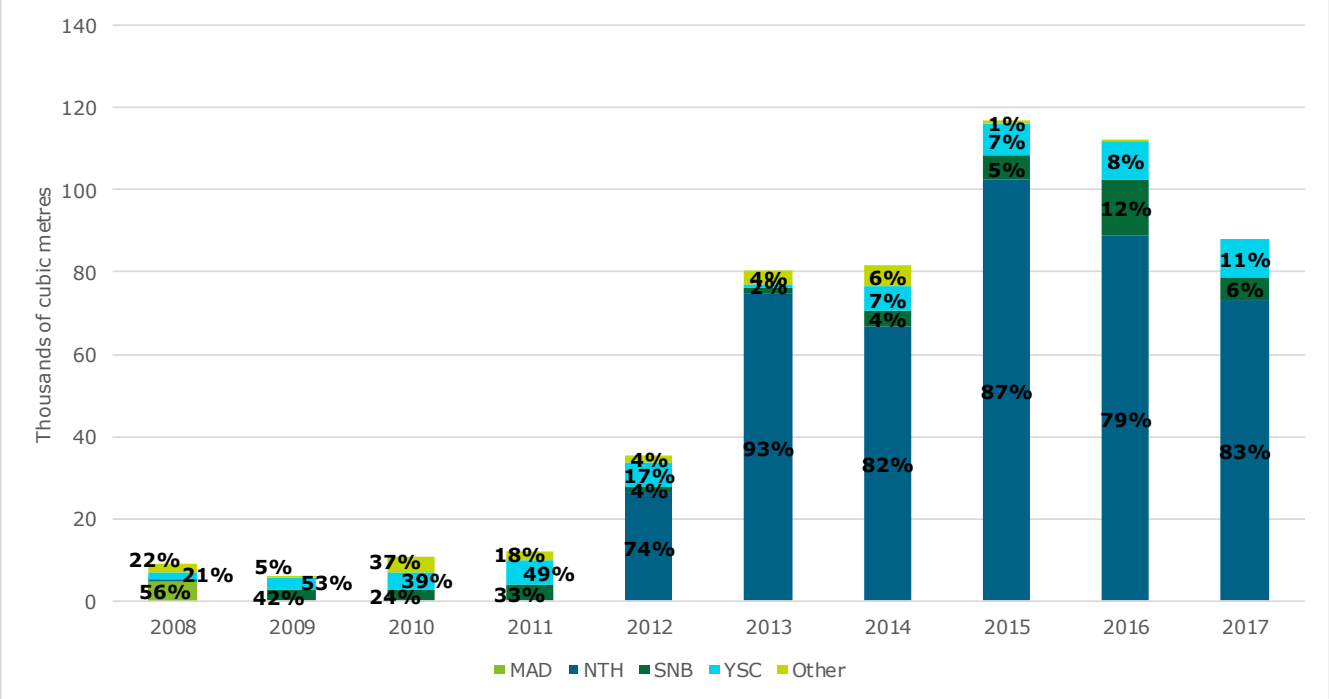
Northumberland hardwood and softwood market ("NTH combined market")
The following charts show hardwood and softwood harvested from the NTH combined market for saw and studwood and pulpwood and roundwood chips. The NTH combined market is located in the centre, toward the east of New Brunswick. It borders all the other marketing board regions except MAD.

The volume of private wood harvested from NTH combined market for pulpwood and roundwood chips was minimal until 2012 ranging from 6 thousand cubic metres to 21 thousand cubic metres for pulpwood and roundwood chips and saw and studwood.

In essence, the market for private wood in NTH essentially collapsed between 2008 and 2011 due to mill closures associated with the US housing market crisis. The market began to recover with the increase in mill capacity beginning in 2012 and onwards.

The majority of pulpwood and roundwood chips harvested from NTH combined market stayed within NTH, while the majority of saw and studwood was delivered to markets outside of NTH.

Chart 37: Wood harvested from private woodlot owners in the defined market – NTH combined market, pulpwood and roundwood chips, by destination, volume in thousands of cubic metres



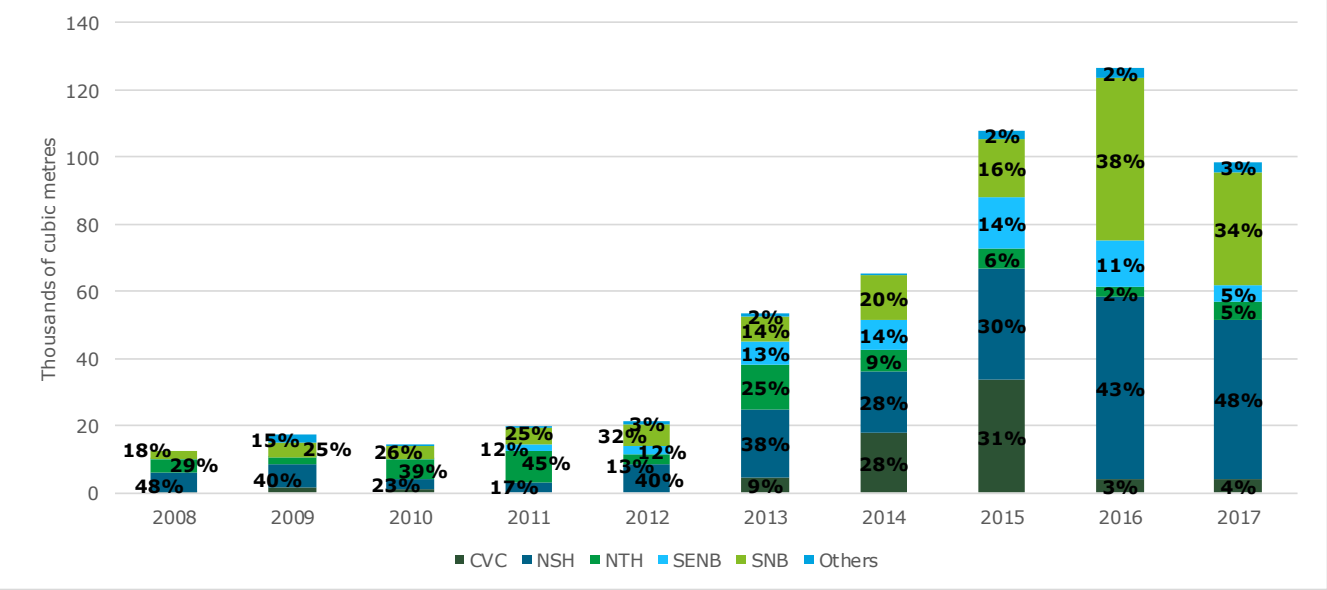
Source: Timber Utilization Survey.

The volume of wood harvested from the NTH combined market for pulpwood and roundwood chips was less than 13 thousand cubic metres between 2008 and 2011 but increased significantly from 2012 onward to peak at 117 thousand cubic metres in 2017, before decreasing to 88 thousand cubic metres in 2017.

No wood was consumed by mills located in NTH from 2008 until 2012 when Arbec Forest Products entered the New Brunswick industry and consumed 74% of the total wood supply. Since then, approximately 80% of the wood harvested from NTH combined market stayed within NTH.

Exports to Nova Scotia, Quebec and Maine are insignificant in NTH due to its geographic location. The volume of wood that was supplied to other New Brunswick marketing boards, including MAD, SNB, YSC, NSH and SENB, was minimal.

Chart 38: Wood harvested from private woodlot owners in the defined market – NTH combined market, Saw and studwood, by destination, volume in thousands of cubic metres



Source: Timber Utilization Survey.

The overall volume of wood harvested from the NTH combined market for saw and studwood was less than 21 thousand cubic metres from 2008 to 2012. This was attributable to a drop in consumption by Fawcett Lumber beginning in 2006 and the closure of the mill in 2008, which historically was a major consumer of wood from the NTH combined market.

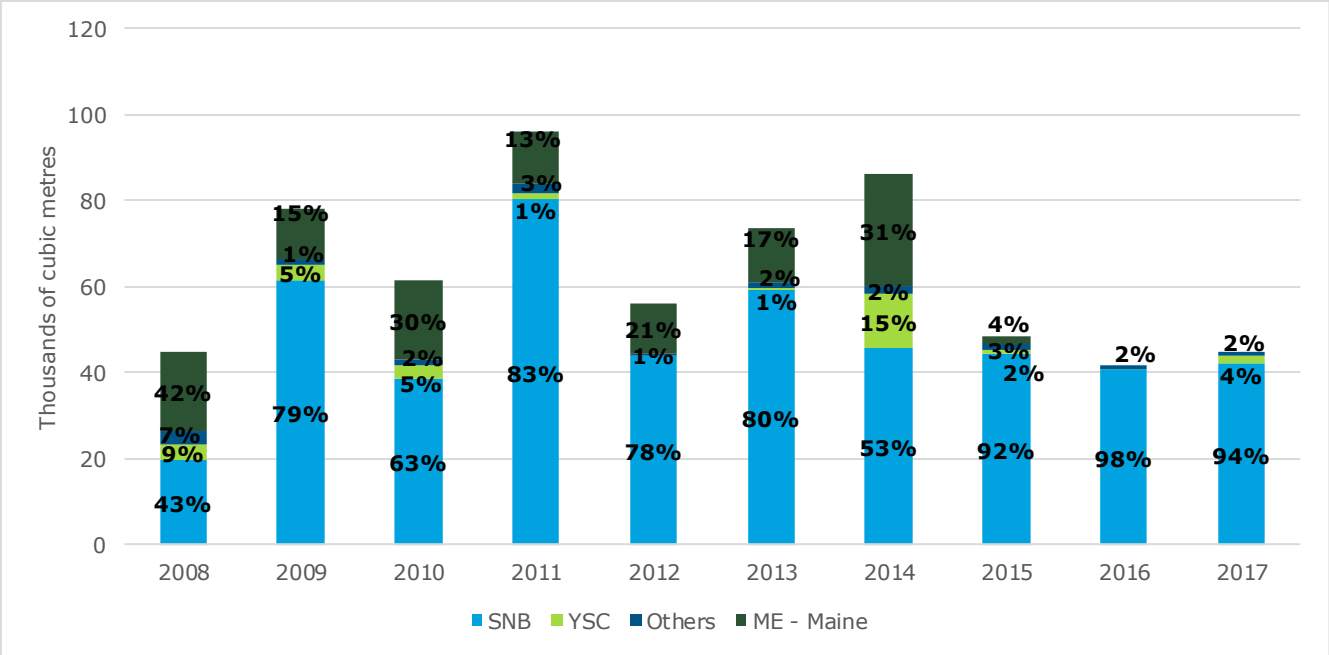
There was a significant increase from 2013 onward in the volume of wood supplied to NSH, CV and SNB. The proportion of wood supplied to NSH increased from 38% in 2013 to 48% in 2017, due to an increase in consumption by the Bathurst Sawmill (owned by Fornebu Lumber since 2009) and Chaleur Sawmills Associates. The overall increase in wood supplied to other regions was also due to an increase in consumption by the Plaster Rock mill (Twin Rivers Paper Co.) located in CV, and the Grand Lake Timber mill (J.D. Irving) located in SNB.

Wood exports to Nova Scotia, Quebec and Maine were minimal. The remaining immaterial volume supplied from this market was consumed in other marketing boards, including MAD and YSC.

York-Sunbury-Charlotte softwood market ("YSC softwood market")
The following charts show softwood saw and studwood and pulpwood and roundwood chips harvested from YSC. YSC softwood market is located in the southwest portion of New Brunswick. YSC softwood market borders Maine, CV, NTH and SNB.

During the period under review, there was a structural shift in wood harvested from the market from pulpwood and roundwood chips to saw and studwood due to the decline in end market demand for pulpwood associated with the decline of the paper and related industry. In 2009, the volume of saw and studwood harvested was 56 thousand cubic metres and the volume of pulpwood and roundwood chips harvested was 78 thousand cubic metres. However, the volume of saw and studwood harvested increased to 154 thousand cubic metres in 2017 while the volume of pulpwood and roundwood chips harvested decreased to 45 thousand cubic metres.

Chart 39: Wood harvested from private woodlot owners in the defined market – YSC softwood market, pulpwood and roundwood chips, by destination, volume in thousands of cubic metres



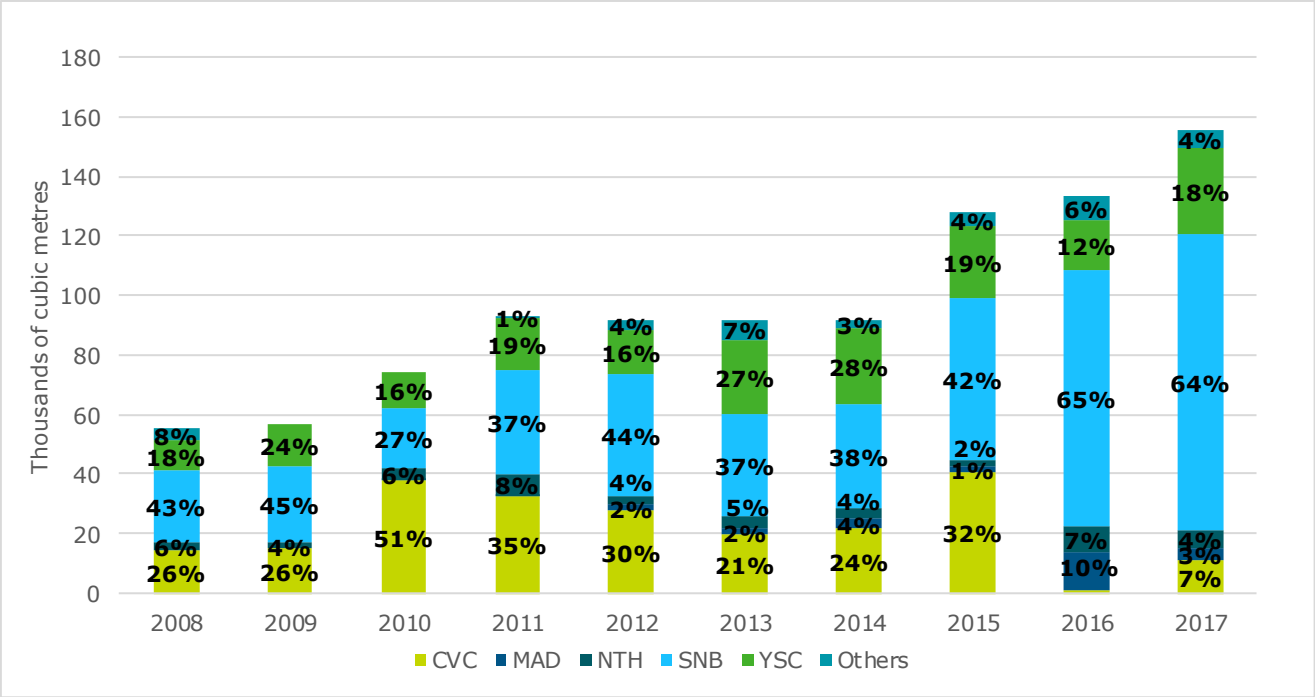
Source: Timber Utilization Survey.

The volume of wood harvested from YSC softwood market for pulpwood and roundwood chips fluctuated between 45 thousand and 96 thousand cubic metres during the period 2008 to 2014. The volume of wood harvested has fallen back to approximately 45 thousand cubic metres since 2015 due to the structural decline in end market demand for softwood pulp.

The majority of wood was supplied to SNB, increasing from 43% in 2008 to 94% in 2017, which was mainly consumed by Irving Pulp & Paper (JDI) and Sussex chip plant (JDI). However, the volume of pulpwood supplied to SNB decreased by almost half since 2011, again reflecting the structural change described above.

Only minor volumes were consumed by mills within YSC. Exports played an important role between 2008 and 2014, which was mainly to Maine, but have dwindled since 2015. The remaining immaterial volume supplied from this market was consumed in Nova Scotia and the MAD, NTH and SENB marketing boards.

Chart 40: Wood harvested from private woodlot owners in the defined market – YSC softwood market, Saw and studwood, by destination, volume in thousands of cubic metres



Source: Timber Utilization Survey.

The volume of wood harvested from YSC softwood market for saw and studwood almost tripled since 2008 from 55 thousand cubic metres to 156 thousand cubic metres in 2017, due to an increase in consumption and mill capacity. The proportion of wood harvested within YSC was relatively stable, ranging from 18% to 28% of the total, which was mainly consumed by Devon Lumber Co. Ltd. and H.J. Crabbe & Sons Ltd.

The majority of wood was supplied to mills located in SNB. Furthermore, the proportion of wood harvested increased from 43% in 2008 to 64% in 2017 due to increased consumption by the Grand Lake Timber mill (JDI) associated with the AAC increase. The mill increased its production in 2014 by 60%.

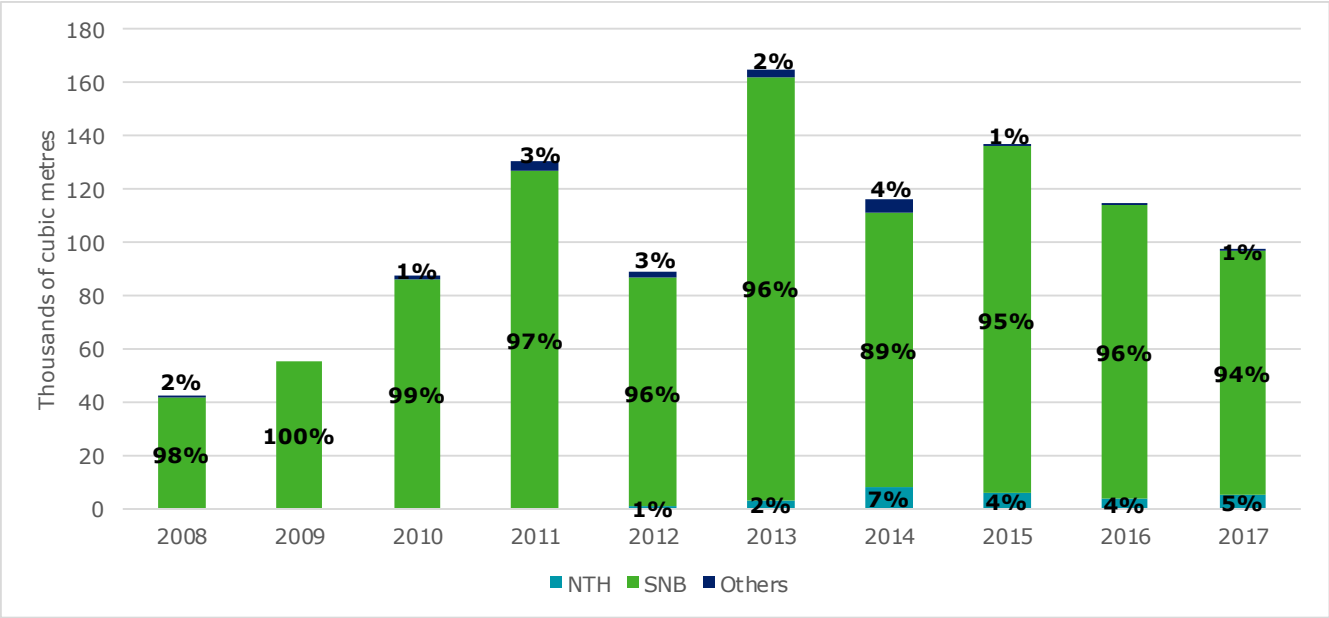
The proportion of wood supplied to CV grew to 51%of total in 2010 due to a modernization that the Plaster Rock lumber mill (Twin Rivers Paper Co.) underwent in 2009.

The remaining immaterial volume harvested from this market was consumed in Maine and Nova Scotia and the NSH and SENB marketing boards. Maine was the largest destination by volume amongst the "Others" category.

Southern New Brunswick softwood market ("SNB softwood market")
The following charts show softwood saw and studwood and pulpwood and roundwood chips harvested from SNB. The SNB softwood market is located in the southeast of New Brunswick. It is nearby Nova Scotia to the east as well as bordering YSC and SENB.

The volume of pulpwood and roundwood chips harvested from SNB softwood market doubled since 2008. The volume of saw and studwood harvested also increased from 53 thousand cubic metres in 2008 to 311 thousand cubic metres in 2017, almost returning to historical levels from before 2006.

Chart 41: Wood harvested from private woodlot owners in the defined market – SNB softwood market, pulpwood and roundwood chips, by destination, volume in thousands of cubic metres



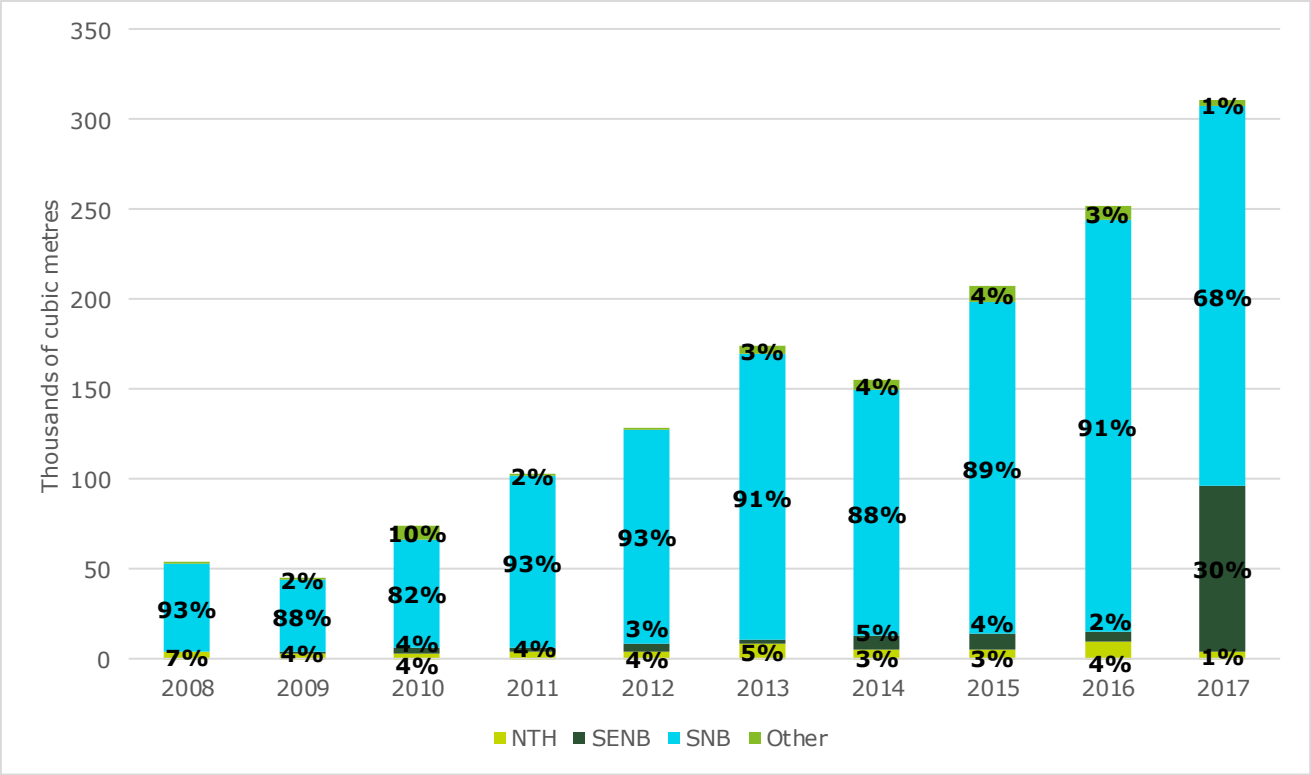
Source: Timber Utilization Survey.

Except in 2014, more than 94% of the softwood pulpwood and roundwood chips from SNB was consumed by mills located within SNB. The pulpwood and roundwood chips were mainly consumed by the chip plant in Sussex (JDI) and Irving Pulp and Paper (JDI) in Saint John.

The proportion of wood supplied to NTH ranged from 1% to 7% of total between 2012 and 2017. This wood was mainly consumed by Arbec Forest Products.

The remaining immaterial volume supplied from this market was consumed in Nova Scotia and Maine and the SENB and YSC marketing boards.

Chart 42: Wood harvested from private woodlot owners in the defined market – SNB softwood market, Saw and studwood, by destination, volume in thousands of cubic metres



Source: Timber Utilization Survey.

The overall volume of wood harvested from SNB softwood market for saw and studwood increased by more than five times from 53 thousand cubic metres in 2008 to 311 thousand cubic metres in 2017. The majority of wood harvested was consumed by mills located within SNB, mainly by Grand Lake Timber (JDI) and the Sussex sawmill (JDI). The increase in harvest in 2015 was due to Grand Lake Timber (JDI), which increased its wood consumption in 2014 by 60%.

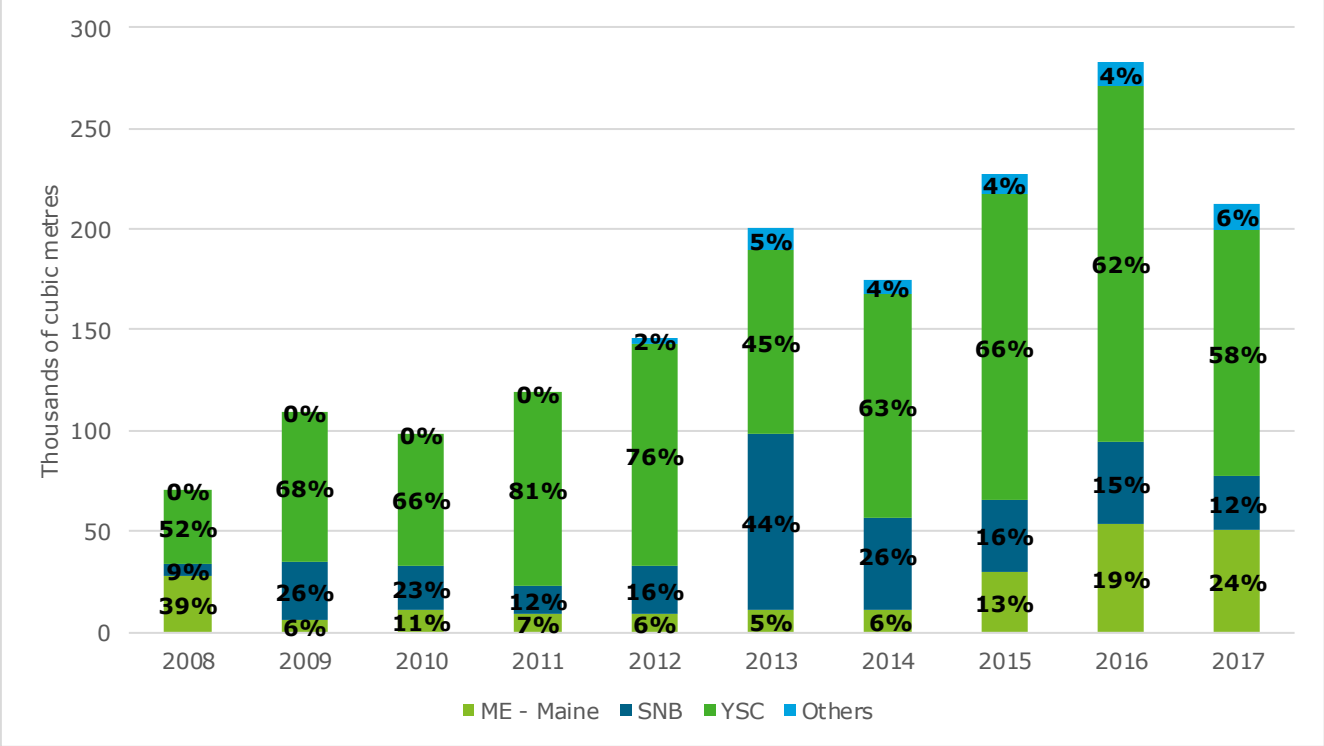
There was a significant increase in the proportion of wood supplied to SENB from 2% in 2016 to 30% in 2017. This was due to a significant increase in consumption by Delco Forest Products.

The remaining immaterial volume of wood harvested from this market was consumed in Nova Scotia and Maine and other marketing boards including CV, MAD, NSH and YSC.

York-Sunbury-Charlotte/Southern New Brunswick hardwood market ("YSC/SNB hardwood market")

The following chart shows hardwood harvested from YSC/SNB hardwood market for pulpwood and roundwood chips. We do not depict and analyze saw and studwood supply as the volumes are minimal.

Chart 43: Wood harvested from private woodlot owners in the defined market – YSC/SNB hardwood market, pulpwood and roundwood chips, by destination, volume in thousands of cubic metres



Source: Timber Utilization Survey.

The overall volume of wood harvested from YSC/SNB hardwood market for pulpwood and roundwood chips increased more than four times from 70 thousand cubic metres in 2008 to a peak of 283 thousand cubic metres in 2016, before decreasing to 213 thousand cubic metres in 2017.

The majority of wood harvested from this market was consumed by mills located in YSC, representing more than 60% of the total in most years. This volume was mainly consumed by AV Nackawic.

Most of the wood supplied to SNB was consumed by the Irving Pulp and Paper mill (JDI) and the Utopia mill (JDI). The proportion of wood consumed in SNB increased from 16% in 2012 to 44% in 2013 due to an increase in consumption by the Irving Pulp and Paper mill (JDI).

The remaining immaterial volume harvested from this market was consumed in Nova Scotia and the SENB and NTH marketing board regions.

Summary of findings

Our review above suggests that private wood volumes (including exports) in each of the defined markets has tended to be very pro-cyclical over time. That is, private wood production has risen significantly during the cyclical upswing, when end market demand for wood products is rising, and has dropped significantly during downturns. This is the case for every defined market we examined above, with the exception of softwood pulp in YSC and SNB, where the impact of structural changes in downstream demand for wood has dominated any cyclical changes. Hence, this suggests that private woodlot production is very sensitive to changes in end market demand for wood products. It also implies that market prices for private stumpage are likely to incorporate the impact of changes in end market demand for wood products.

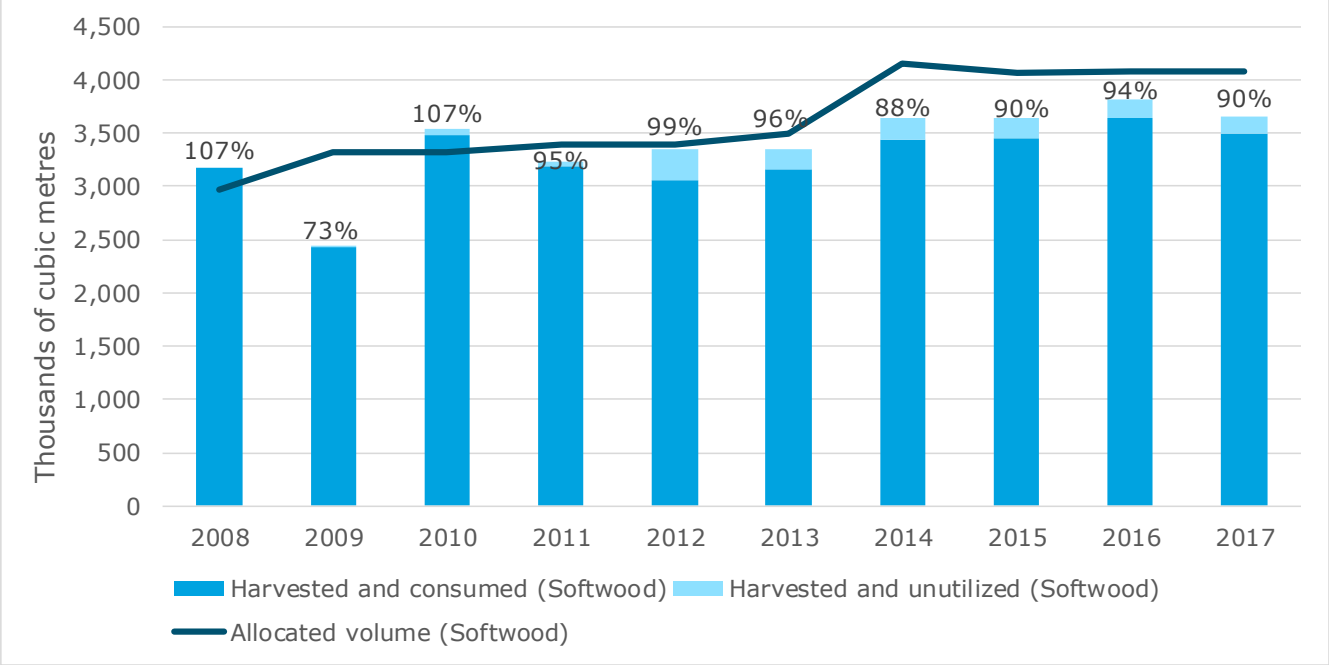
4.1.6 Wood harvested from Crown Land, AAC and its allocation, and Crown stumpage rates

This section analyzes wood harvested from Crown Land and the annual allowable cut ("AAC") and its allocation for hardwood and softwood for the years 2008 to 2017. The AAC designates the amount of timber that can be harvested from each Crown License annually, which is then allocated to specific mills (Crown Licensees and Sub-licensees) based on mill productive capacity. For the purposes of our analysis, we compared the allocated volume with the actual harvest from the Crown Land.

We further look at the evolution of Crown stumpage royalties over time and compare them to pulp and lumber end product prices.

The following chart shows wood harvested from Crown Land and allocated volume for softwood for the period 2008 to 2017.

Chart 44: Softwood harvested from Crown Land and its allocated volume, all products, volume in thousands of cubic metres



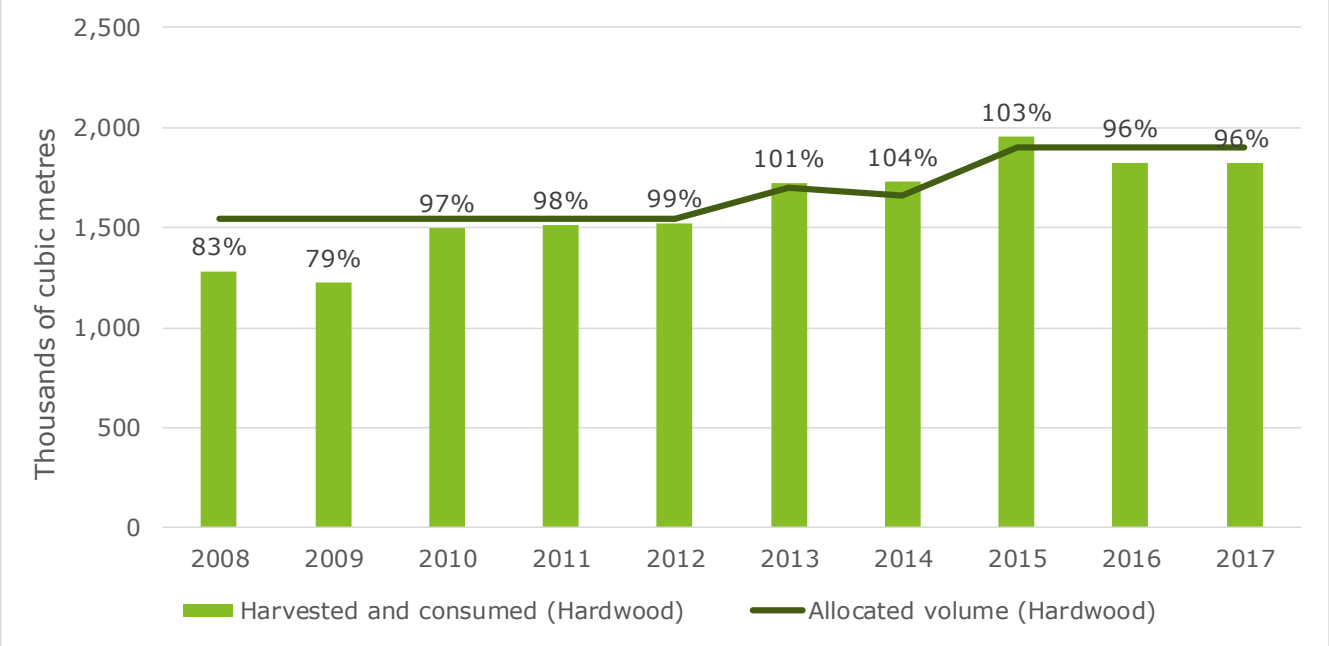
Source: Timber Utilization Survey and Government of New Brunswick
Note: Crown supply is calculated as a percentage of allocated volume softwood

The wood harvested from Crown Land includes unutilized softwood pulpwood. This is part of the allocated volume that was harvested but not utilized due to limited markets for softwood pulpwood. The AAC and allocated volume is set for five-year periods and allows for +/- 10% variations in annual harvests around the average annual allocated volume.

The allocated volume for softwood gradually increased during the period 2008 through 2013. In 2014, the allocated volume increased significantly by 600 thousand cubic metres to 4,200 thousand cubic metres for softwood. This increase was allocated to specific mills in exchange for investments and commitments agreed in a Memorandum of Agreement ("MOA"). However, the take up of the increase in allocated volume happened in the years subsequent to 2014. The delay in the take up of softwood harvested from Crown Land may have been due to the following reasons:

- Investments by mills to increase mill capacity required time; and
- Mills were unable to obtain additional shifts to run operations.

Chart 45: Hardwood harvested from Crown Land and its allocated volume, all products, volume in thousands of cubic metres



Source: Timber Utilization Survey and Government of New Brunswick
Note: Crown supply is calculated as a percentage of allocated volume for hardwood

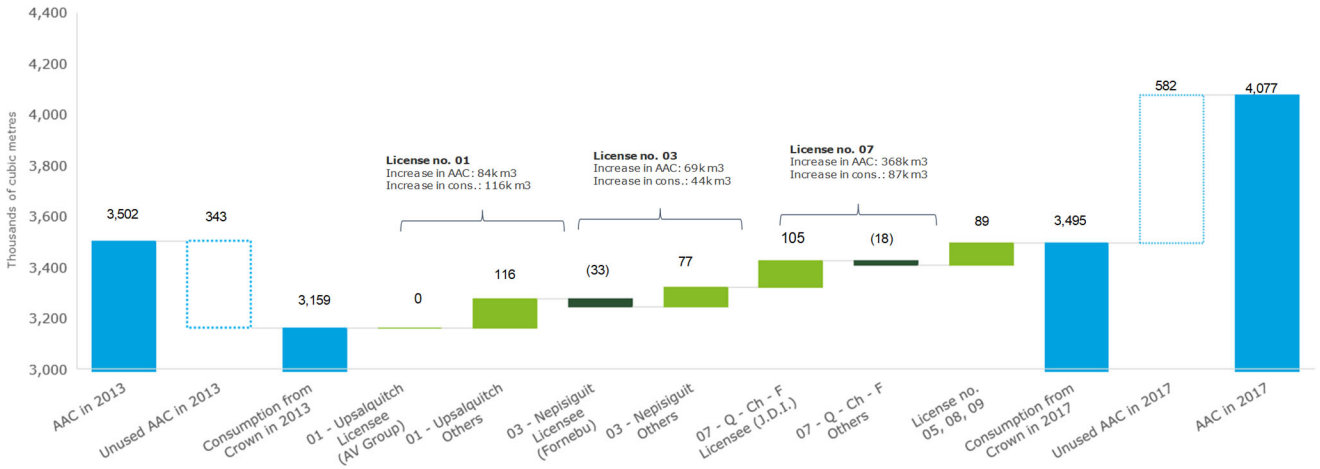
The allocated volume for hardwood remained stable during the period 2008 through 2012, however there was an increase in allocated volume by 200 thousand cubic metres in years 2013 and 2015. Since 2015, the allocated for hardwood remained stable. The volume of hardwood harvested from Crown Land had closely followed the trend in allocated volume.

In the following section, we look at the allocated volume increase for softwood between the years 2013 and 2017. The allocated volume increased by 600 thousand cubic metres, from 3,500 thousand cubic metres to 4,100 thousand cubic metres. The increase in volume was allocated to the following Crown Licenses:

- Crown License 1 (Crown Licensee AV Group) – 84 thousand cubic metres;
- Crown License 3 (Crown Licensee Fornebu) – 69 thousand cubic metres;
- Crown License 7 (Crown Licensee JDI) – 368 thousand cubic metres; and
- Crown License 5, 8 and 9 – 54 thousand cubic metres.

The chart below shows the increase in allocated volume and the resulting increase in softwood harvested from Crown Land by Crown Licenses and mills between 2013 and 2017.

Chart 46: Additional allocation of AAC to mills and resulting change in consumption from 2013 to 2017, softwood, all products, volume in thousands of cubic metres



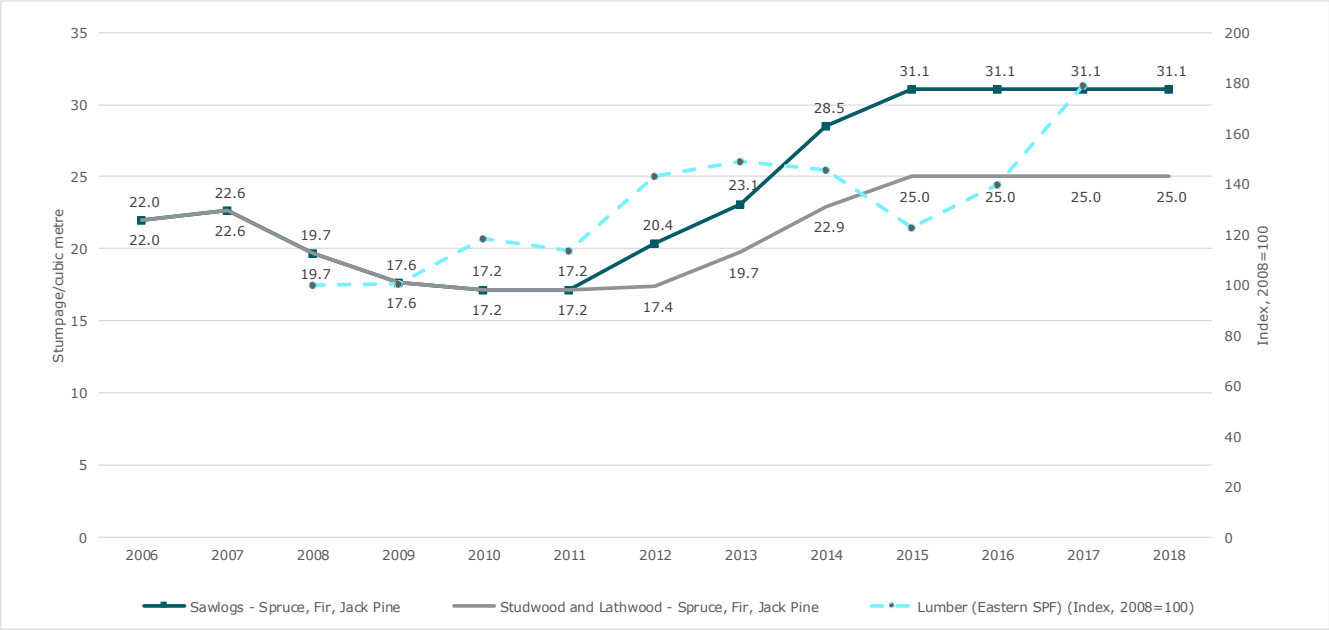
Source: Timber Utilization Survey and Government of New Brunswick
Note: k represents one thousand.

The overall consumption of softwood from Crown Licenses between 2013 and 2017 increased by approximately 300 thousand cubic metres, from 3,200 thousand cubic metres to 3,500 thousand cubic metres. The increase in allocated volume and the resulting increase in consumption by the Crown Licensees was as follows:

- Crown License 1 (Crown Licensee AV Group) was allocated an additional 84 thousand cubic metres of softwood. The consumption of softwood sourced from this license increased by 116 thousand cubic metres from 2013 to 2017. AV Group, however, did not consume any softwood from this license.
- Crown License 3 (Crown Licensee Fornebu) was allocated an additional 69 thousand cubic metres of softwood. The consumption of softwood sourced from this license increased by 44 thousand cubic metres between 2013 and 2017. Fornebu decreased its softwood consumption from this license by 33 thousand cubic metres while other mills sourcing softwood from this license increased their consumption by 77 thousand cubic metres.
- Crown License 7 (Crown Licensee JDI) was allocated an additional 368 thousand cubic metres of softwood. The consumption of softwood sourced from this license increased by 87 thousand cubic metres. JDI increased its softwood consumption from this license by 105 thousand cubic metres between 2013 and 2017. Other mills sourcing softwood from this license decreased consumption by 18 thousand cubic metres.
- Crown Licenses 5, 8 and 9 were allocated an additional 54 thousand cubic metres of softwood. The consumption of softwood sourced from these three licenses increased by 89 thousand cubic metres.

In the following charts, we compare Crown stumpage royalties and end product prices by wood type and product type during the period from 2006 through 2018. Crown stumpage royalties are published by the Government of New Brunswick when there is an amendment to the stumpage royalty rate. The amendment was last published in 2015.

Chart 47: Crown stumpage rates per cubic metre and end product price index, 100=298 USD per MFBM, softwood, Saw and studwood

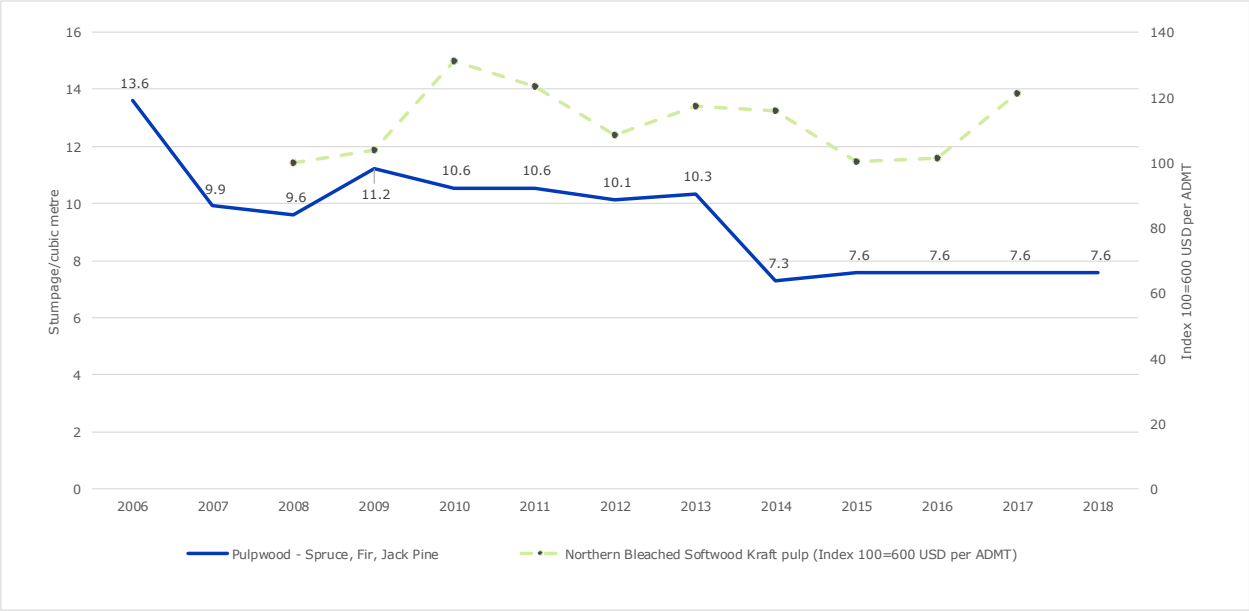


Source: Government of New Brunswick and Madison's Canadian Lumber Reporter.
Note: Lumber (Eastern SPF) prices are indexed with a base price of 298 USD per MFBM.
Stumpage rates for Sawlogs – SPF overlap with Studwood and Lathwood – SPF for the years 2006 to 2011.

Crown stumpage royalty rates for SFJP softwood saw and studwood were very similar in 2010 and 2011. After 2011 sawlog stumpage royalty rates increased well above the studwood stumpage royalty rates. Softwood stumpage royalty rates rose from 2011 to 2015 at which point ERD chose not to make any upward or downward royalty rate changes. Crown royalty rates for cedar sawlogs, studwood and lathwood decreased from 2011 to 2013, but increased in 2014 and 2015. ERD also chose not to make any upward or downward royalty rate changes for cedar sawlogs, studwood and lathwood after 2015. It is noted that softwood stumpage royalty rates were increased in 2014 and 2015 and that there was a significant increase in the Crown AAC in 2014.

Lumber (eastern SPF) prices were somewhat volatile but generally were on a steady price rise during the period 2008 through 2017. Overall the lumber price increased significantly during this time period. Although Crown stumpage royalty rates for softwood saw and studwood and lumber prices were on the same upward trend, there appears to be little direct correlation between softwood saw and studwood stumpage royalty rates and softwood lumber prices.

Chart 48: Crown stumpage rates per cubic metre and end product price index, 100=600 USD per ADMT, softwood, pulpwood and roundwood chips

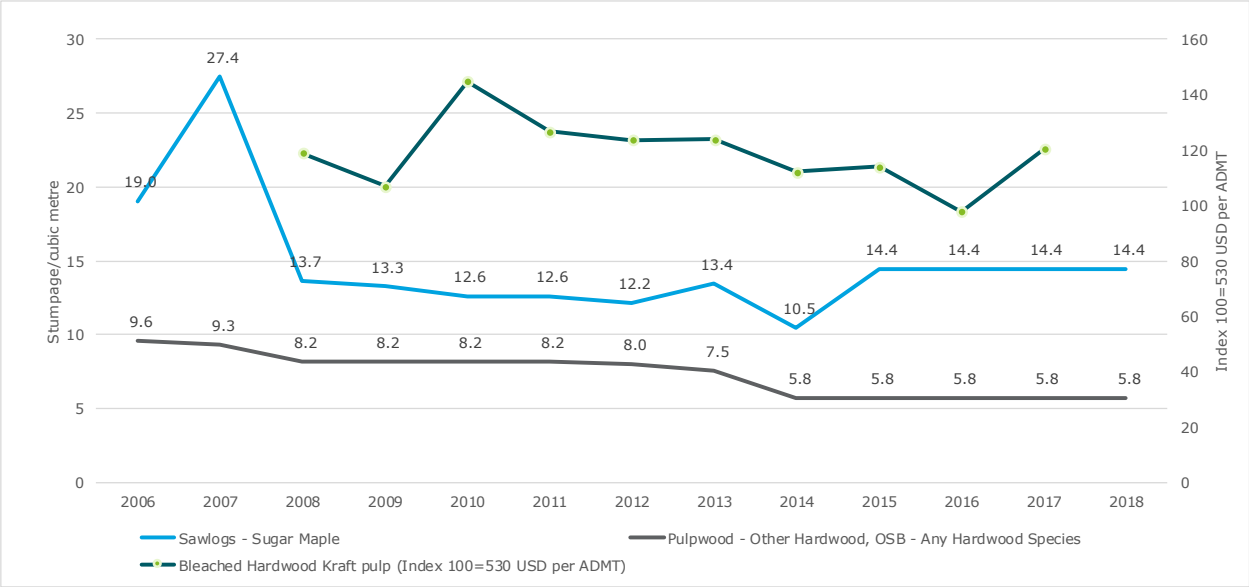


Source: Government of New Brunswick and Brian McClay & Associates Inc.
Note: Bleached Softwood Kraft pulp prices are indexed with a base price of 600 USD per ADMT.

Crown stumpage royalty rates for SPF pulpwood decreased significantly in 2007 and 2008 in line with the sectoral change in the industry. Royalty rates increased again in 2009 and then remained relatively constant until 2014 when there was another important royalty rate decrease, which was coincident with the Crown AAC increase. After a small increase in 2015 softwood pulpwood stumpage royalty rates have remained unchanged.

Northern Bleached Softwood Kraft pulp prices have been somewhat volatile during the period 2008 through 2017. There appears to be little direct correlation between softwood pulp stumpage royalty rates and softwood pulp prices.

Chart 49: Crown stumpage rates per cubic metre and end product price index, 100=530 USD per ADMT, hardwood, all products



Source: Government of New Brunswick and Brian McClay & Associates Inc.
Note Bleached Hardwood Kraft pulp prices are indexed with a base price of 530 USD per ADMT.

Crown stumpage rates for sugar maple sawlogs experienced a significant increase in 2008 and a significant decrease in 2007. Sugar maple sawlogs stumpage royalty rates remained relatively stable from 2008 to 2013, but experienced another decrease in 2014. The stumpage royalty rate increased again in 2015 and has remained unchanged since then.

Crown stumpage rates for hardwood pulpwood and OSB have been relatively stable throughout the period under review. However, the hardwood pulpwood and OSB stumpage royalty rates decreased in 2014 at about the time of the Crown AAC increase.

Northern Bleached Hardwood Kraft pulp prices have been somewhat volatile during the period 2008 through 2017, increasing by almost 40% in 2010. Since 2010, pulp prices have been on a decreasing trend until 2017 after which there was a 20% increase.

There appears to be little direct correlation between hardwood pulpwood stumpage royalty rates and hardwood pulp prices.

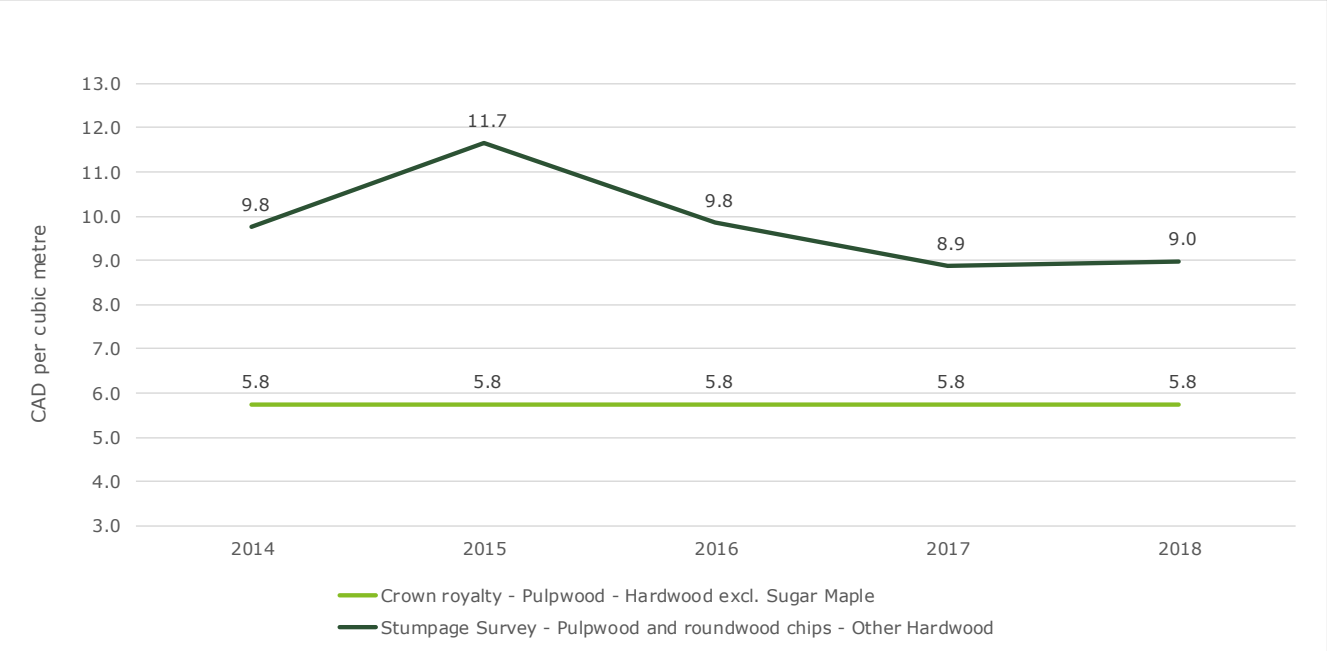
4.1.7 Private versus Crown stumpage prices

In this section, we compare Crown stumpage royalty rates and private stumpage prices. Private stumpage prices are obtained from the stumpage survey published by the Forest Products Commission over the period 2014 through 2018. Crown stumpage royalties are published by the Government of New Brunswick when there is an amendment to the stumpage royalty rate. The last amendment was published in 2015.

We selected wood types and product types that are meaningful to compare and substantial in terms of the total number of transactions recorded. We calculated private stumpage prices as a median of individual transactions on a yearly basis. Private stumpage prices reported in this section may not be readily comparable to those reported in our statistical analysis section, due to different sources and additional aggregation and weighting of data in the following section.

In the following charts, we compare crown and private stumpage rates per wood type and product type for the period 2014 through 2018.

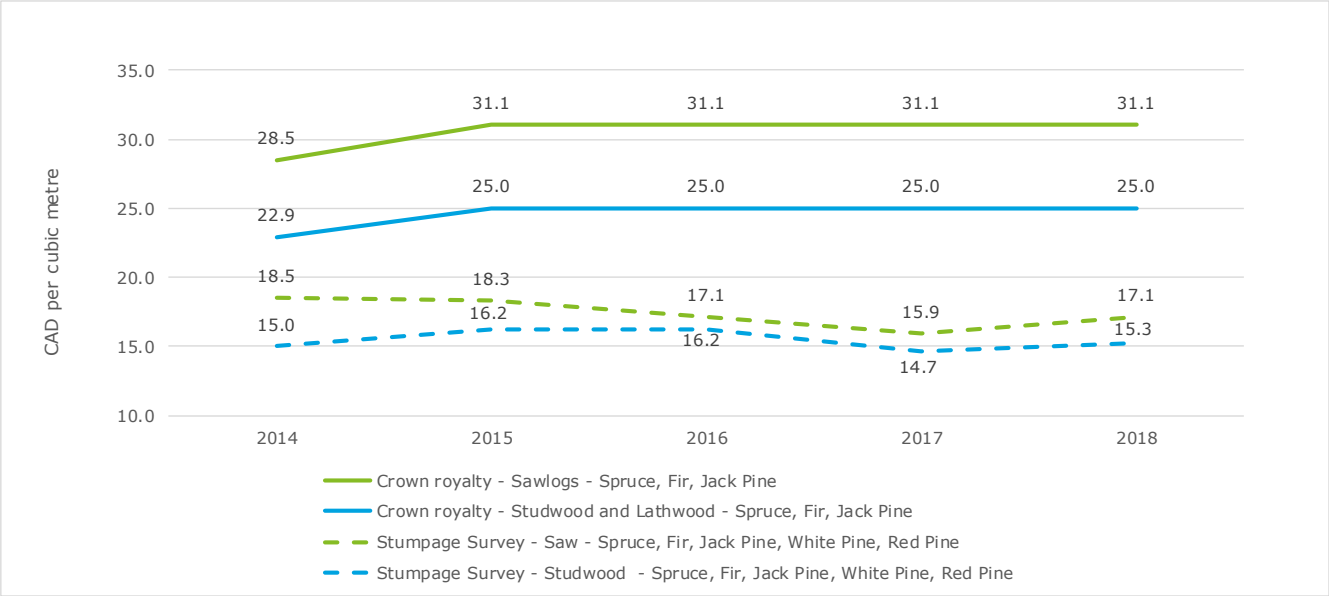
Chart 50: Crown versus private stumpage rates per cubic metre, hardwood – pulpwood and roundwood chips



Source: Based on data provided by Government of New Brunswick and Forest Products Commission.
Note: The private stumpage rates are calculated as a median of individual transactions on a yearly basis (year end as of March).

During the period under review private stumpage prices for hardwood pulpwood were higher than the Crown stumpage royalty rates for the same type of pulpwood. Crown stumpage royalty rates for hardwood pulpwood remained stable during the period under review. Private stumpage prices for hardwood pulpwood increased to the highest point in 2015 and decreased subsequently.

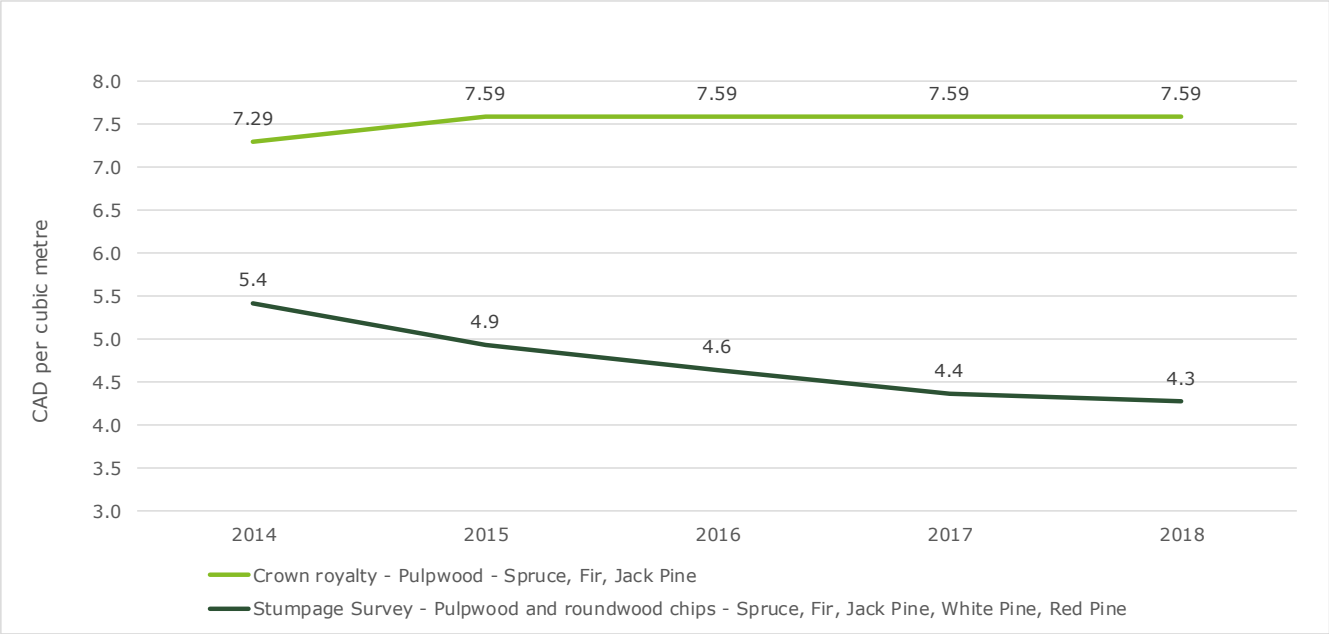
Chart 51: Crown versus private stumpage rates per cubic metre, softwood – Saw and studwood



Source: Based on data provided by Government of New Brunswick and Forest Products Commission.
Note: The private stumpage rates are calculated as a median of individual transactions on a yearly basis (year end as of March).

Both Crown stumpage royalty rates for softwood sawlogs and studwood were higher than private stumpage rates during the period 2014 to 2018. Crown stumpage royalty rates increased in 2015 and have been unchanged since then. Private stumpage prices for SPF saw and studwood remained relatively stable throughout the period under review, although it appears that private stumpage prices did drop slightly in 2017 only to pick up again in 2018.

Chart 52: Crown versus private stumpage rates per cubic metre, softwood – pulpwood and roundwood chips



Source: Based on data provided by Government of New Brunswick and Forest Products Commission.
Note: The private stumpage rates are calculated as a median of individual transactions on a yearly basis (year end as of March).

Crown stumpage royalty rates for softwood pulpwood were higher than private stumpage prices during the period under review. Crown stumpage royalty rates increased in 2015 and have remained unchanged since then. Private stumpage prices for softwood pulpwood were on a decreasing trend from 2014 to 2018.

4.1.8 Wood harvested by industrial freehold owners

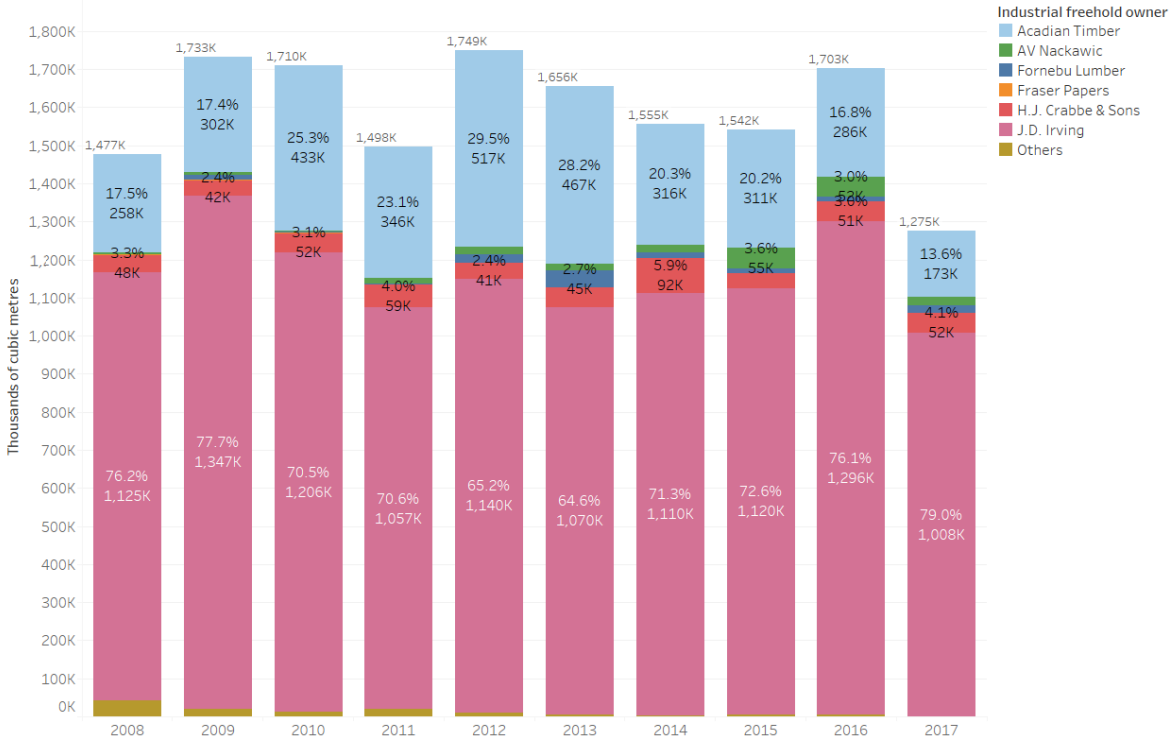
This section looks separately at softwood and hardwood wood harvested in New Brunswick from industrial freehold by its owners during the period 2008 through 2017.

The total volume of softwood harvested on an annual basis by owners of industrial freehold fluctuated between 1.3 million to 1.7 million cubic metres annually as shown in the following chart. The lowest volume of softwood harvested from industrial was in 2017, which was partially attributable to the drop in export volumes to Maine.

The company harvesting the largest volume of softwood from its industrial freehold was JDI. JDI's harvest and use of industrial freehold softwood was between 1.0 million cubic metres, or 65% of total harvest volume, and 1.3 million cubic metres, or 79% of total harvest volume from industrial freehold volume harvested each year during the period under review. JDI supplies wood from its own land to its own mills located in the MAD and SNB marketing board regions. The volume of wood harvested by JDI remained relatively stable over the years, however JDI's portion of the total volume fluctuated from 65% to 80% of total volume as other industrial freehold owners changed the volume of wood harvested from their land.

The second major company harvesting softwood timber from its industrial freehold land before 2006 was Fraser Paper, supplying more than 20% of the overall volume. In 2007, Twin Rivers acquired Fraser Paper's properties and assets and entered into a supply agreement with Acadian Timber. Since 2007, Acadian Timber is the second biggest company harvesting softwood from its industrial freehold. The annual volume of softwood timber that Acadian Timber harvested from its industrial freehold land has fluctuated quite significantly during the period under review. Subject to not having an understanding of Acadian Timber's supply agreement commitments, it is reasonable to conclude that it responded to market conditions and macro-economic factors when choosing the annual volume of softwood it harvested each year. The following chart relates to softwood harvested by owners of softwood.

Chart 53: Softwood harvested in NB by owners of industrial freehold, volume in thousands of cubic metres

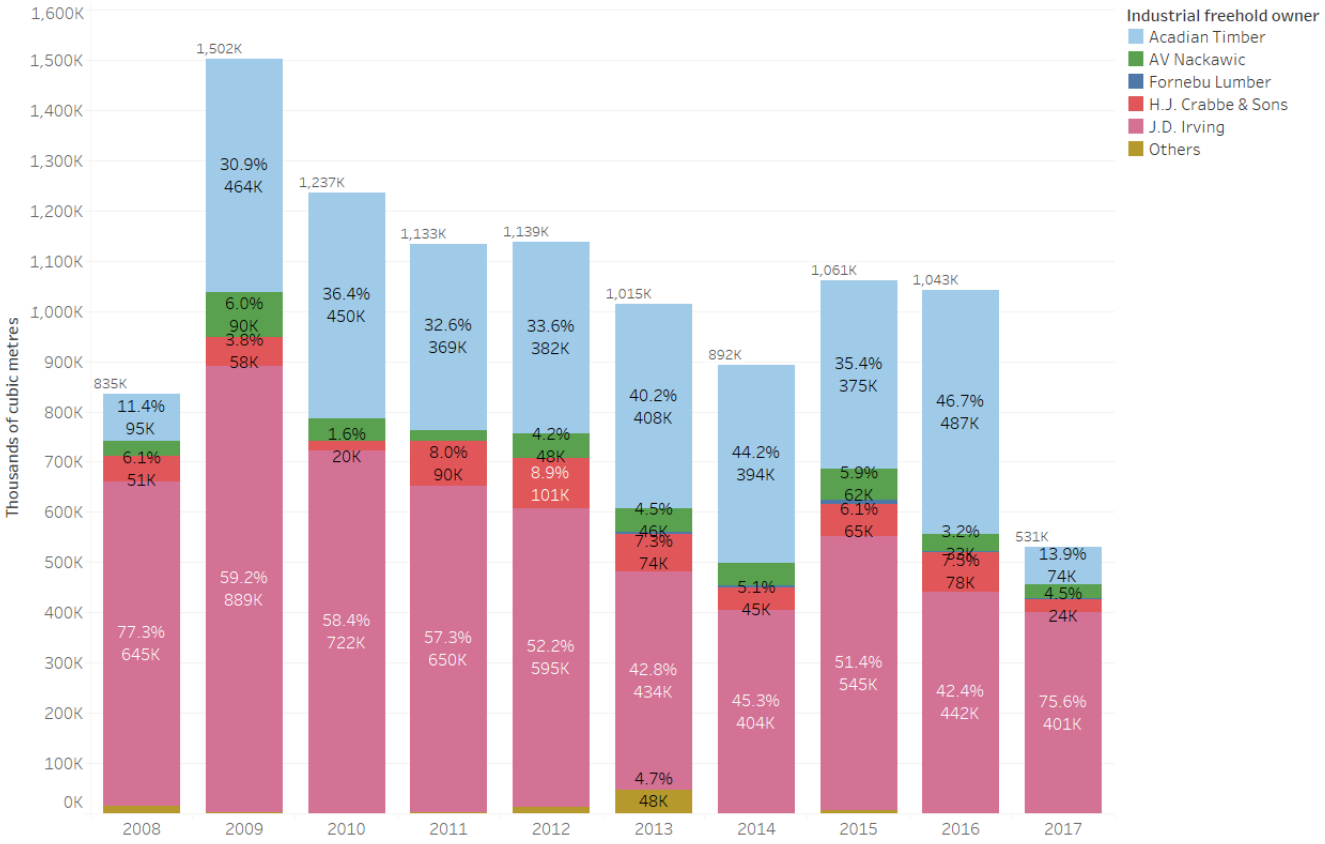


Source: Timber Utilization Survey

The volume of hardwood harvested by industrial freehold owners in NB grew rapidly in 2009 due to an increase in volume exported to Maine and Quebec. Since 2009, the volume of hardwood has gradually decreased to 500 thousand cubic metres in 2017 due to a decrease in export volume as shown in the following chart.

JDI was the largest company harvesting hardwood from its industrial freehold together with the next largest Acadian Timber, during the period under review. JDI supplied most of the harvested hardwood to its own mills located in SNB and YSC marketing board regions, and a portion of the hardwood volume was exported to Maine and Quebec. Since 2009 Acadian Timber exported a major part of the hardwood volume harvested from its freehold to Maine and Quebec. The following chart relates to hardwood harvested by owners of industrial freehold during the period 2008 to 2017.

Chart 54: Hardwood harvested in NB by owners of industrial freehold, volume in thousands of cubic metres



Source: Timber Utilization Survey

4.1.9 Change in wood consumption from 2006 to 2017

This section analyzes the overall change in wood consumption by wood type and by product group during the following three phases:

Phase 1 – represents the pre-downturn period from 2006 to 2007;

Phase 2 – represents the downturn period from 2008 to 2010; and

Phase 3 – represents the recovery period from 2011 to 2017.

The following two tables show the overall change in wood consumption or use from 2006 to 2017 by wood type (i.e., softwood or hardwood) and by product group (i.e., saw and studwood and pulpwood, roundwood chips and boards). The two tables summarize the results of the TUS analysis described in the previous sections for softwood and hardwood separately.

Table 6: Change in softwood consumption from 2006 to 2017 by wood type and product group

Change in softwood consumption by product group						
Product group	Phase	Total change[1]	Proportion of wood consumption by source in % and net change			
			Crown Land	Industrial Freehold	Private Woodlots	Imports
Saw and studwood	1	↓ 5.5 → 4.0 mil. m^3 Δ (27%) Δ (1.5) mil. m^3	↑ 46% → 49% ↓ Δ (570) th. m^3	↑ 24% → 25% ↓ Δ (339) th. m^3	↓ 12% → 10% ↓ Δ (257) th. m^3	↓ 17% → 16% ↓ Δ (310) th. m^3
	2	↑ 3.8 → 4.5 mil. m^3 Δ 19% Δ 724 th. m^3	↓ 57% → 55% ↑ Δ 333 th. m^3	↑ 24% → 26% ↑ Δ 245 th. m^3	– 8% → 8% ↑ Δ 73 th. m^3	– 11% → 11% ↑ Δ 73 th. m^3
	3	↑ 4.5 → 5.4 mil. m^3 Δ 21% Δ 934 th. m^3	↑ 51% → 58% ↑ Δ 833 th. m^3	↓ 23% → 21% ↑ Δ 129 th. m^3	↑ 11% → 15% ↑ Δ 299 th. m^3	↓ 15% → 6% ↓ Δ (337) th. m^3
Pulpwood and roundwood chips	1	↑ 1.6 → 1.7 mil. m^3 Δ 6% Δ 103 th. m^3	↓ 52% → 50% ↑ Δ 11 th. m^3	↑ 22% → 31% ↑ Δ 189 th. m^3	↓ 15% → 11% ↓ Δ (49) th. m^3	↓ 11% → 8% ↓ Δ (50) th. m^3
	2	↓ 1.8 → 1.6 mil. m^3 Δ (8)% Δ (137) th. m^3	↑ 57% → 60% ↓ Δ (38) th. m^3	↓ 27% → 23% ↓ Δ (100) th. m^3	↑ 9% → 12% ↑ Δ 36 th. m^3	↓ 6% → 5% ↓ Δ (32) th. m^3
	3	↓ 1.7 → 0.9 mil. m^3 Δ (46)% Δ (777) th. m^3	↓ 51% → 36% ↓ Δ (530) th. m^3	↓ 23% → 13% ↓ Δ (274) th. m^3	↑ 19% → 27% ↓ Δ (77) th. m^3	↑ 6% → 23% ↑ Δ 101 th. m^3

Source: Timber Utilization Survey
Notes:
Phase I represents the pre-downturn period from 2006 to 2007
Phase II represents the downturn period from 2008 to 2010
Phase III represents the recovery period from 2011 to 2017
1 – The first line represents the total volume consumed, the second line represents net percentage change in volume and the third line represents net change in volume during each phase.
Δ represents net change in percentage points or in volume during each phase.

The consumption of softwood saw and studwood decreased by 1.5 million cubic metres in phase one and increased by 0.7 million cubic metres in phase two. There was a proportionate change in all sources of wood

during both phases. In phase three, the consumption of softwood saw and studwood increased by 0.9 million cubic metres which was mainly from an increase in wood harvested from Crown Land.

The consumption of softwood pulpwood, boards and chips increased by 100 thousand cubic metres in phase one, which was mainly from an increase in wood harvested from industrial freehold. In phase two, consumption decreased by 100 thousand cubic metres which was mainly from a decrease in industrial freehold. During phase three, consumption decreased by 800 thousand cubic metres which was mainly from Crown Land and industrial freehold. This is the only segment of the wood supply market in which the share of wood sourced from Crown Lands dropped substantially. This decrease was due to a structural shift in wood supplied for pulpwood, roundwood chips and boards to an increase in wood supplied for saw and studwood. This change stemmed from a decline in end market demand for pulpwood and an increase in demand for saw and studwood.

Table 7: Change in hardwood consumption from 2006 to 2017 by wood type and product group

Change in hardwood consumption by product group						
Product group	**Phase**	**Total change[1]**	**Proportion of wood consumption by source in % and net change**			
			Crown Land	**Industrial Freehold**	**Private Woodlots**	**Imports**
Pulpwood and roundwood chips	1	↓ 2.7 → 2.1 mil. m^3 Δ (23%) Δ (630) th. m^3	↑ 49% → 55% ↓ Δ (184) th. m^3	↑ 27% → 29% ↓ Δ (113) th. m^3	↓ 17% → 10% ↓ Δ (243) th. m^3	↓ 8% → 6% ↓ Δ (90) th. m^3
	2	↑ 2.0 → 2.1 mil. m^3 Δ 6% Δ 119 th. m^3	↑ 60% → 61% ↑ Δ 75 th. m^3	↓ 30% → 27% ↓ Δ (21) th. m^3	↑ 6% → 10% ↑ Δ 99 th. m^3	↓ 3% → 1% ↓ Δ (35) th. m^3
	3	↑ 2.1 → 2.6 mil. m^3 Δ 26% Δ 543 th. m^3	↑ 58% → 62% ↑ Δ 424 th. m^3	↓ 28% → 17% ↓ Δ (135) th. m^3	↑ 10% → 13% ↑ Δ 128 th. m^3	↑ 3% → 7% ↑ Δ 130 th. m^3
Saw and studwood	1	↓ 480 → 446 th. m^3 Δ (7%) Δ (35) th. m^3	↓ 31% → 23% ↓ Δ (48) th. m^3	↑ 24% → 30% ↑ Δ 21 th. m^3	↓ 6% → 5% ↓ Δ (7) th. m^3	↑ 40% → 42% ↓ Δ (2) th. m^3
	2	↑ 404 → 407 th. m^3 Δ 1% Δ 3 th. m^3	↑ 22% → 23% ↑ Δ 5 th. m^3	▬ 26% → 26% ↑ Δ 0.4 th. m^3	↓ 5% → 2% ↓ Δ (13) th. m^3	↑ 47% → 49% ↑ Δ 10 th. m^3
	3	↑ 362 → 415 th. m^3 Δ 15% Δ 53 th. m^3	↑ 26% → 42% ↑ Δ 81 th. m^3	↓ 26% → 20% ↓ Δ (11) th. m^3	↑ 3% → 5% ↑ Δ 12 th. m^3	↓ 45% → 33% ↓ Δ (30) th. m^3

Source: Timber Utilization Survey
Notes:
Phase I represents the pre-downturn period from 2006 to 2007
Phase II represents the downturn period from 2008 to 2010
Phase III represents the recovery period from 2011 to 2017
1 – The first line represents the total volume, the second line represents net percentage change and the third line represents net change in volume during the period in each phase.
Δ represents net change in percentage points or in volume during the period in each phase.

The consumption of hardwood pulpwood decreased by 600 thousand cubic metres in phase one. There was a decrease in use or consumption from all sources, as the proportion of wood harvested from Crown Land and industrial freehold increased at the expense of private woodlots and imports. In phase two, consumption increased by 100 thousand cubic metres which was from Crown Land and private woodlots. In phase three,

the overall use or consumption increased by 500 thousand cubic metres and this was mainly as a result of an increase in wood harvested from Crown Land.

The overall change in consumption of hardwood saw and studwood was insignificant in all three phases. In phase one, use or consumption decreased by 35 thousand cubic metres which was as a result of a decrease in wood harvested from Crown Land. The consumption increased by 3 thousand cubic metres in phase two which and was mainly driven by imports. During phase three, use or consumption increased by 53 thousand and was mainly from an increase in wood harvested from Crown Land. (Note that this consumption view excludes hardwood sold into the cash fuel wood market).

Summary of findings

In summary, we can draw the following inferences from the wood consumption data by wood type and product group for the three market phases. The share of wood consumed by New Brunswick mills which was sourced from Crown Lands increased overall for all wood products, except for softwood pulpwood, roundwood chips and boards. However, when we examine the changes in each of the three phases of the market where the proportion of wood harvested from Crown Land rose between 2006 and 2017, the data suggests important nuances.

In the case of the softwood saw and studwood, which is by far the largest segment of the market in volume terms, the proportion of wood harvested from Crown Land and private woodlots both rose significantly in phase three by similar amounts in relative terms. There was a similar trend in both hardwood products. Both hardwood saw and studwood and pulpwood, roundwood chips and boards had an increase in the proportion of wood harvested from Crown Land and private woodlots by similar amounts in relative terms during phase three.

Hence, the rise in the proportion of wood harvested from Crown Land did not necessarily come at the expense of wood harvested from private woodlots. Rather, the private woodlot harvest volume fluctuated during the three market phases and ultimately increased with the demand for wood by the mills. This change in private woodlot harvest volume suggests that the private woodlot market responds to macroeconomic factors and market conditions. Woodlot owners changed harvest levels to respond to mill owners' demand for types of wood. Over time, woodlot owners also relied less on wood as a primary source of income, which increased their sensitivity to price fluctuations. As wood harvesting became a discretionary source of income, woodlot owners were more likely to hold supply under less favourable price conditions, and vice and versa under more favourable price conditions.

In a previous section of this chapter, we looked at Crown stumpage royalty rates and private stumpage prices in relation to end forest products prices. Crown stumpage royalty rates could not be directly correlated to end forest product prices. Crown stumpage royalty rates did, however, change in relation to the sectoral shift away from softwood pulp production and the increase in sawmill production. Crown royalty rates declined for softwood pulpwood and increased for softwood saw and studwood. Private stumpage prices declined for softwood pulpwood and remained constant or fluctuated to some degree with market demand for softwood saw and studwood.

4.1.10 Wood used by the largest market participants

This section looks at the sources and volume of softwood and hardwood used by the largest mills in New Brunswick by the volume of wood consumed during the period 2006 through 2017. Given the change in the forest products industry from more of a pulp-based (including boards) sector to more of a sawmill-based sector, there were changes in the industry participants through closures, mergers and acquisitions and new capital investment in converting plant capacity.

We identified the top four market participants by volume of wood consumed in both 2006 and 2017 for all of the mills operated by each user company, on both a softwood and hardwood basis. We next looked at the sources and volume of wood supply during the period 2016 through 2017 for the wood consumed by these selected market participants, on both a softwood and hardwood basis.

Top four softwood market participants

In 2006 the following four companies (on a consolidated group basis) consumed in their mills more than 75% of the total volume of softwood used for saw and studwood products:

- J.D. Irving;
- Fraser Paper;
- Chaleur Sawmills Associates; and
- UPM Bathurst.

In 2017 the following four companies (on a consolidated group basis) consumed in their mills more than 90% of the total volume of softwood used for saw and studwood products:

- J.D. Irving;
- Twin Rivers Paper Company;
- Chaleur Sawmills Associates; and
- Fornebu Lumber Company.

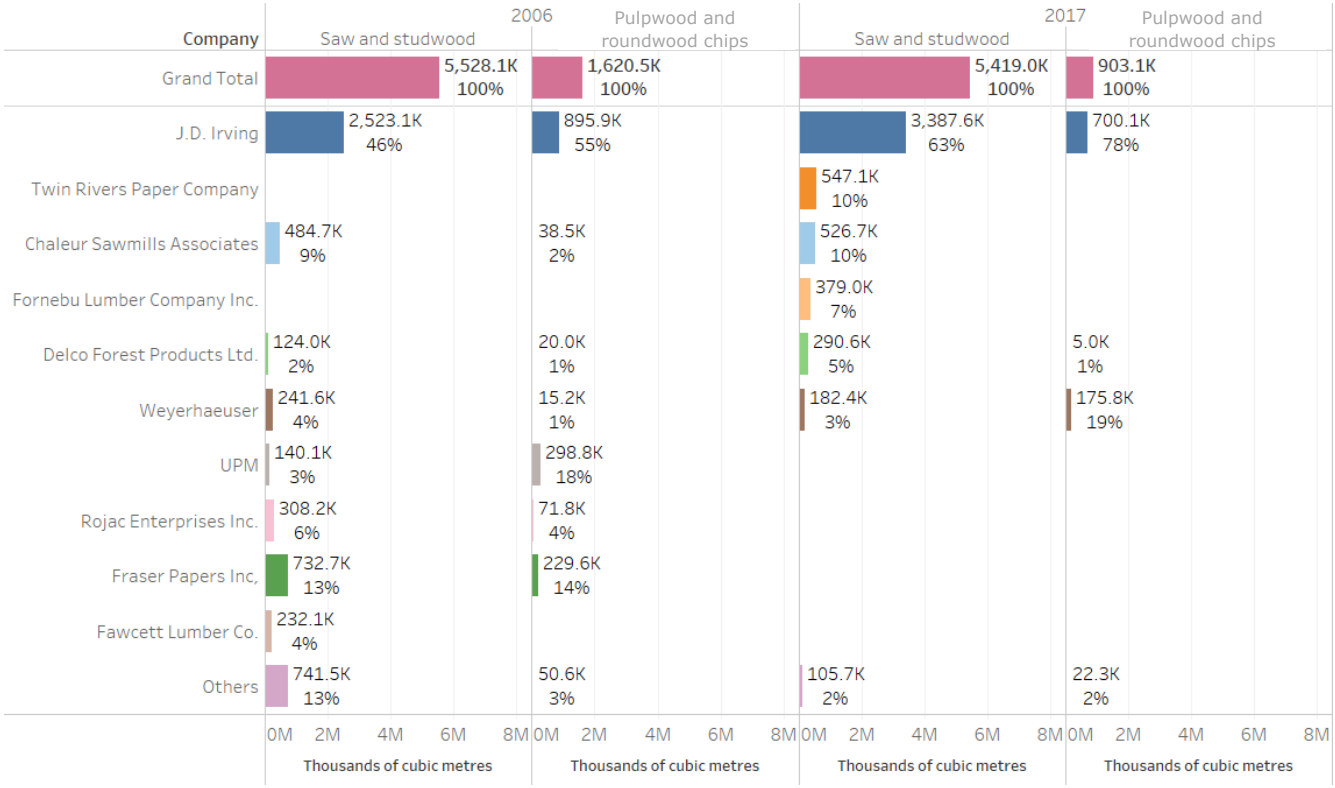
In 2006 the following four companies (on a consolidated group basis) consumed in their mills more than 90% of the total volume of softwood used for pulp and board products:

- J.D. Irving;
- UPM;
- Fraser Paper; and
- UPM Bathurst.

In 2017 two companies; J.D. Irving and Arbec Forest Products consumed approximately 97% of the total volume of softwood used for pulp and board products.

The following chart represents the total volume of wood consumed by industry participants for saw and studwood and pulpwood and boards in 2006 and 2017 by volume consumed.

Chart 55: Total volume of softwood consumed by mills located in NB in 2006 and 2017 and by products, volume in thousands of cubic metres



Source: Timber Utilization Survey

Softwood

The following chart presents the use or consumption of saw and studwood and pulp and board softwood by the selected top four companies. For the period 2006 through 2017, the chart shows by year the volume of wood by source of supply and as a portion of the total. As previously discussed, sources of supply include Crown Land, Federal land, private woodlots, industrial freehold, and imported wood from outside of New Brunswick. In the chart, the caption called marketing boards represents wood supply from private wood lots.

Chart 56: Softwood used by four largest market participants by source, all products, volume in thousands of cubic metres

Source: Timber Utilization Survey

JDI is the largest user of softwood from all sources of wood supply. J.D. Irving sources a significant portion of its softwood supply from Crown Land. It is the Licensee for Crown License 7 and a Sub-Licensee for all other Crown Licenses. The proportion of JDI's total wood supply from Crown Land increased from 38.5% of total in 2006 to 46.0% of total in 2017.

The second largest source of JDI's wood supply is the industrial freehold land that it owns. While the proportion of JDI's total wood supply from industrial freehold decreased from 33.2% of total in 2006 to 25.2% of total in 2017, the volume of wood supplied from its industrial freehold on annual basis remained relatively constant. JDI sourced less imported softwood from Maine, as the proportion of total decreased steadily over the years from 22.8% in 2006 to 11.8% in 2017.

Of interest is the volume of wood and the proportion of total wood supply which JDI sourced from private woodlots during the period under review. In 2006 J.D. Irving's use of private wood lot supply was insignificant, but in 2016 and 2017 it was 17.0% and 16.4% respectively of its total wood supply. As previously discussed, during the period under review JDI Irving increased the productive capacity of its pulp mill and sawmills. The necessary increase in wood supply, which was required to supply the increase in J.D. Irving's milling capacity, was sourced from a combination of Crown Land and private woodlots. The private woodlot increase in supply to JDI suggests that this wood market responded to changing market conditions and changing macro-economic circumstances.

Twin Rivers Paper Company is currently the second largest user of softwood from all sources of wood supply. In 2010 Twin Rivers Paper Company acquired pulp mills in Edmundston and Madawaska as well as sawmill in Plaster Rock, all of which were previously owned by Fraser Paper. Going back to 2006, Fraser Paper would have also been a major user of softwood to produce forest products. Twin River's mills sources softwood wood supply mainly from Crown License 9, for which it is the Licensee, and from industrial freehold land owned by Acadian Timber. The proportion of wood by volume sourced from Crown Land increased in relative terms from 38.3% of total wood supply in 2006 to 66.3% of total wood supply in 2017, but remained almost the same in

absolute volume terms due to decreases in wood supply sourced from industrial freehold and private wood lots.

Chaleur Sawmills Associates is the third largest consumer of softwood used to produce forest products .This was the case in 2017 as it was in 2006. The majority of the softwood it uses is sourced from Crown License 1 (AV Group Licensee) and Crown License 3 (Fornebu Lumber Licensee). Softwood supply from Crown Land was 56.2% of total wood supply in 2006 and 88.3% of total wood supply in 2017. This is due to relatively few private woodlots in the NSH region where Chaleur Sawmills Associates is located.

Fornebu Lumber Company is the fourth largest consumer of softwood used to produce forest products. This was the case in 2017 as it was in 2006. The vast majority of softwood consumed by Fornebu's mills was sourced from Crown License 3 (Fornebu Lumber Licensee), which accounted for 89.3% of total wood supply in 2009 and 76.9% of total wood supply in 2017.

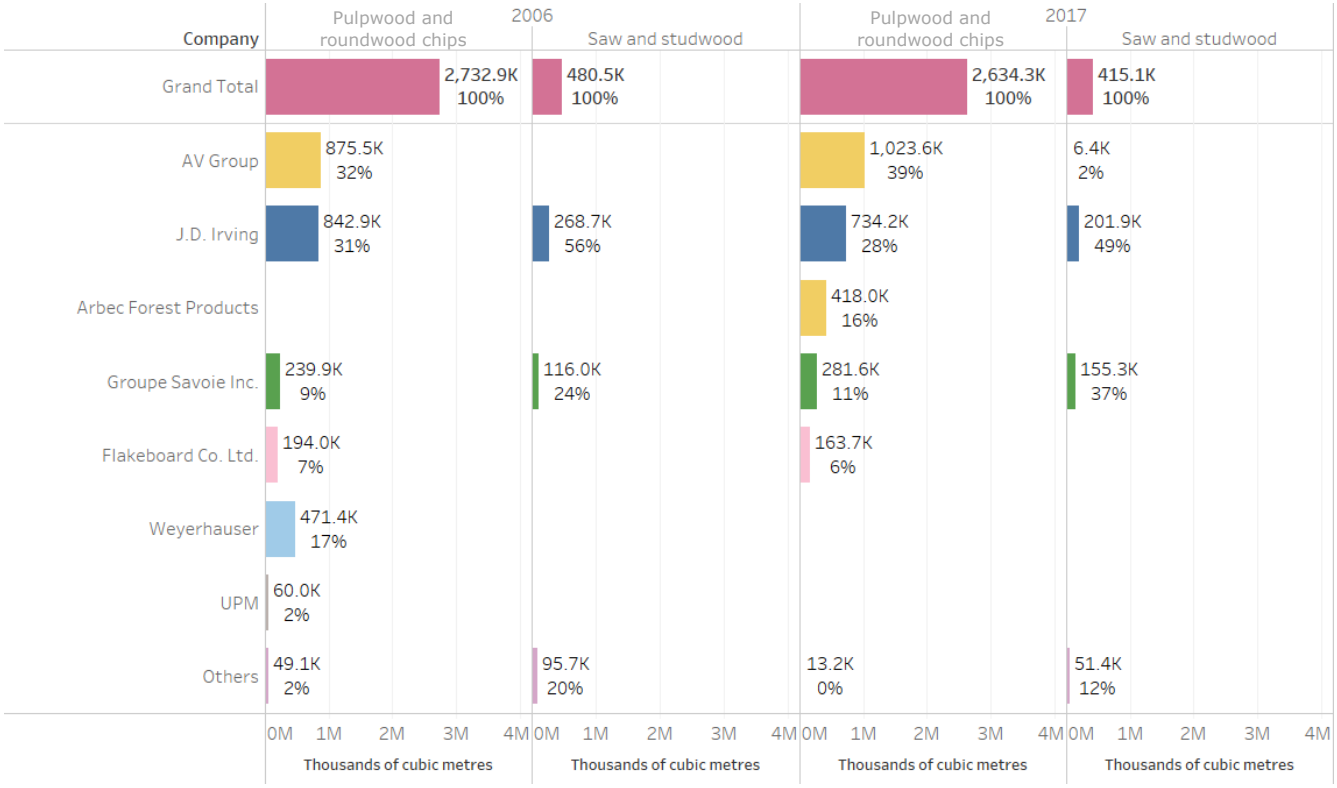
Hardwood market participants

Consumption of hardwood for saw products represents a small part of the hardwood consumed in New Brunswick, accounting for less than 15% of the total hardwood consumption in 2006 and 2017. The majority of hardwood saw products are produced by JDI and Groupe Savoie. Together they used more than 80% of the total hardwood supply for hardwood sawlog products in both 2006 and 2017.

AV Group, JDI and Groupe Savoie were the largest users of hardwood for pulp and board products in 2006 and again in 2017, except that Arbec Forest Products became the third largest user of hardwood for pulp and board products in 2017. In both 2006 and 2017 these three or four producers of hardwood forest products use from just over 70% to over 90% of hardwood used for pulp and board products.

The following chart represents the total volume of hardwood consumed by industry participants for saw products and pulpwood and boards in 2006 and 2017 by volume consumed.

Chart 57: Total volume of hardwood consumed by mills located in NB to produce forest products in 2006 and 2017 and by products, volume in thousands of cubic metres

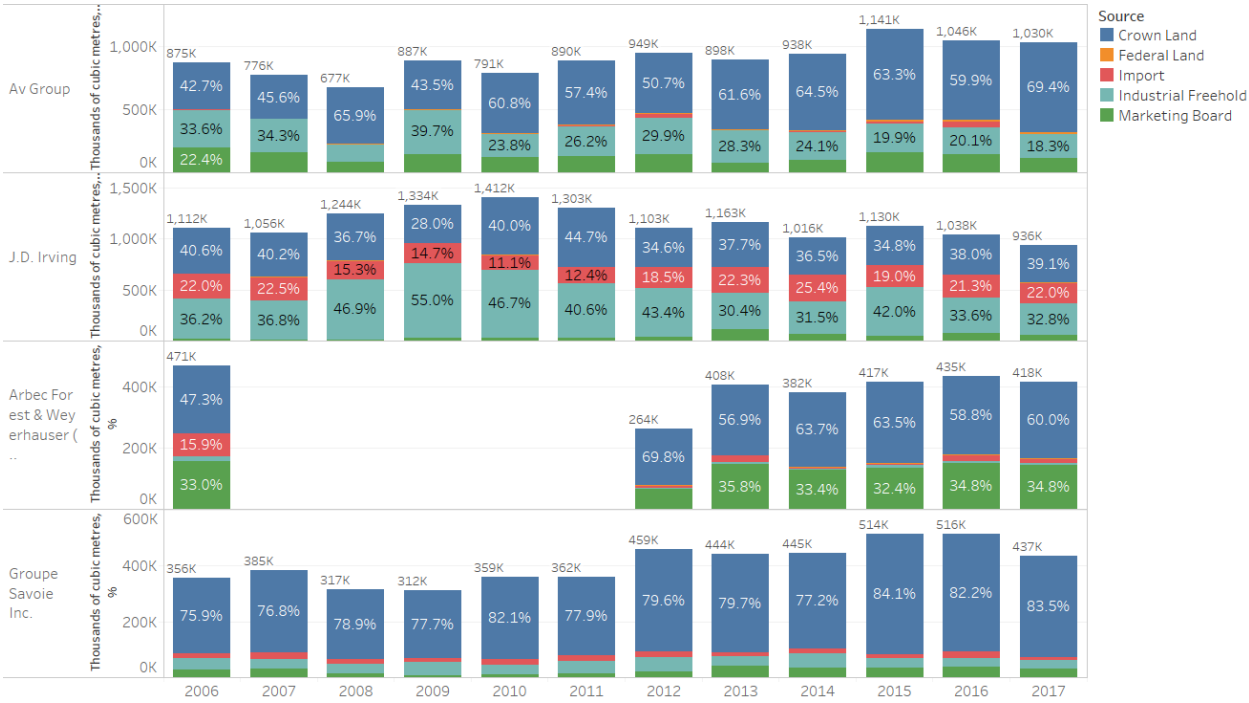


Source: Timber Utilization Survey

Hardwood

The following chart presents the use or consumption of hardwood saw products and pulp and board products by the selected top four companies. For the period 2006 through 2017, the chart shows by year the volume of wood by source of supply and as a portion of the total. As previously discussed, sources of supply include Crown Land, Federal land, private woodlots, industrial freehold, and imported wood from outside of New Brunswick. In the chart, the caption called marketing boards represents wood supply from private wood lots.

Chart 58: Use of hardwood by four largest market participants by source, All products, volume in thousands of cubic metres



Source: Timber Utilization Survey

AV Group is the largest user of hardwood from all sources of wood supply. AV Group sourced the majority of the hardwood it consumed from Crown Land. The proportion of wood supply from Crown Land was 42.7% of total in 2006 and 69.4% of total in 2017. AV Group sources Crown Land hardwood mainly from Crown Licenses 1 and 8 (AV Group Licensee) and Crown License 9 (Twin Rivers Licensee). The remainder of AV Group's hardwood timber supply is sourced from industrial freehold land. The proportion of wood supply from industrial freehold land was 33.6% of total in 2006 and 18.3% of total in 2017. Only a small proportion of total hardwood supply from industrial freehold land was owned by AV Group, as the majority of this wood supply was from industrial freehold land owned by J.D. Irving and Acadian Timber.

JDI is the second largest user of hardwood from all sources of supply. JDI sources hardwood from: Crown Land, industrial freehold and imports. During the period under review, the proportion of hardwood supply from Crown Land remained relatively stable at about 40% of total with the exception of 2009, when the volume of wood sourced from Crown Land dropped to 28% of total. The majority of wood consumed from Crown Land was sourced from Crown License 7 (JDI Licensee) and also almost all hardwood consumed from industrial freehold was from land owned by J.D. Irving. As well, JDI was the only company of the four largest consumers of hardwood which consistently imported a significant volume and portion of its wood supply from Maine. The proportion of hardwood imported from Maine by JDI remained relatively stable over the years at around 20% of total, with a drop in the volume of supply from Maine between 2008 and 2011 when the Canadian dollar appreciated in value relative to the United States dollar.

Arbec Forest Products sourced upward of 60% of its hardwood supply from Crown Land. The Crown Land hardwood was sourced mainly from Crown License 3 (Fornebu Lumber Company Licensee).

Group Savoie sourced the large majority of its hardwood supply from Crown Land. The proportion of total wood supply from Crown Land increased from 75.9% of total in 2006 to 83.5% of total in 2017. Groupe

Savoie's hardwood supply from Crown Land was mainly sourced from Crown License 1 (AV Group Licensee) and Crown License 9 (Twin Rivers Licensee).

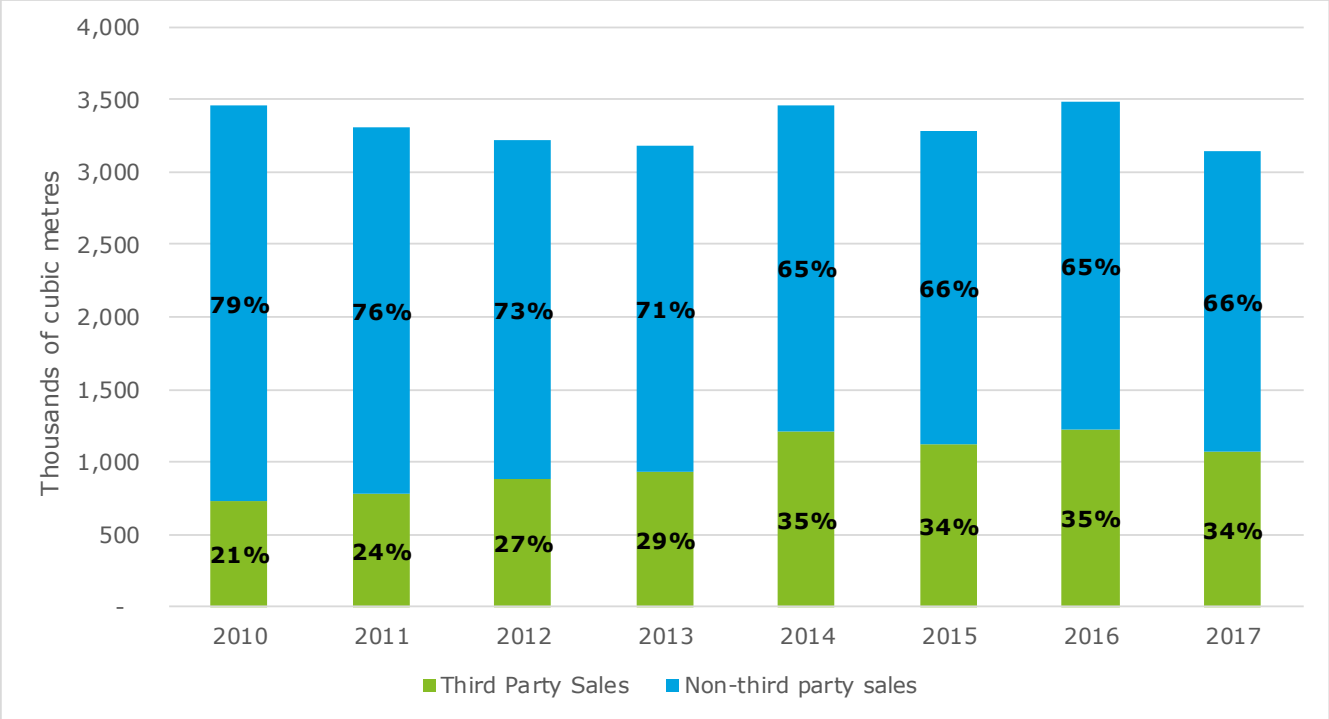
4.1.11 Third party sales from Crown Land

This section analyzes third party sales of hardwood and softwood from Crown Land during the period 2010 to 2017. Third party sales refers to wood harvested from Crown Land that is privately sold or bartered among Crown Licensees and Sub-licensees.

For the purposes of this analysis, we used third party transactions of wood harvested from Crown Land recorded by the Government of New Brunswick. The third party transactions are based on actual reported and reconciled scale data from receiving mills. However, the volume of wood harvested from Crown Land that is reported in the TUS is not reconciled to scale data. Therefore, there are discrepancies in the total volume of wood harvested from Crown Land from the TUS versus scale data.

In the following charts, we look at the proportion of third party hardwood and softwood sales during the period 2010 to 2017.

Chart 59: Proportion of third party sales, softwood, volume in thousand cubic metres



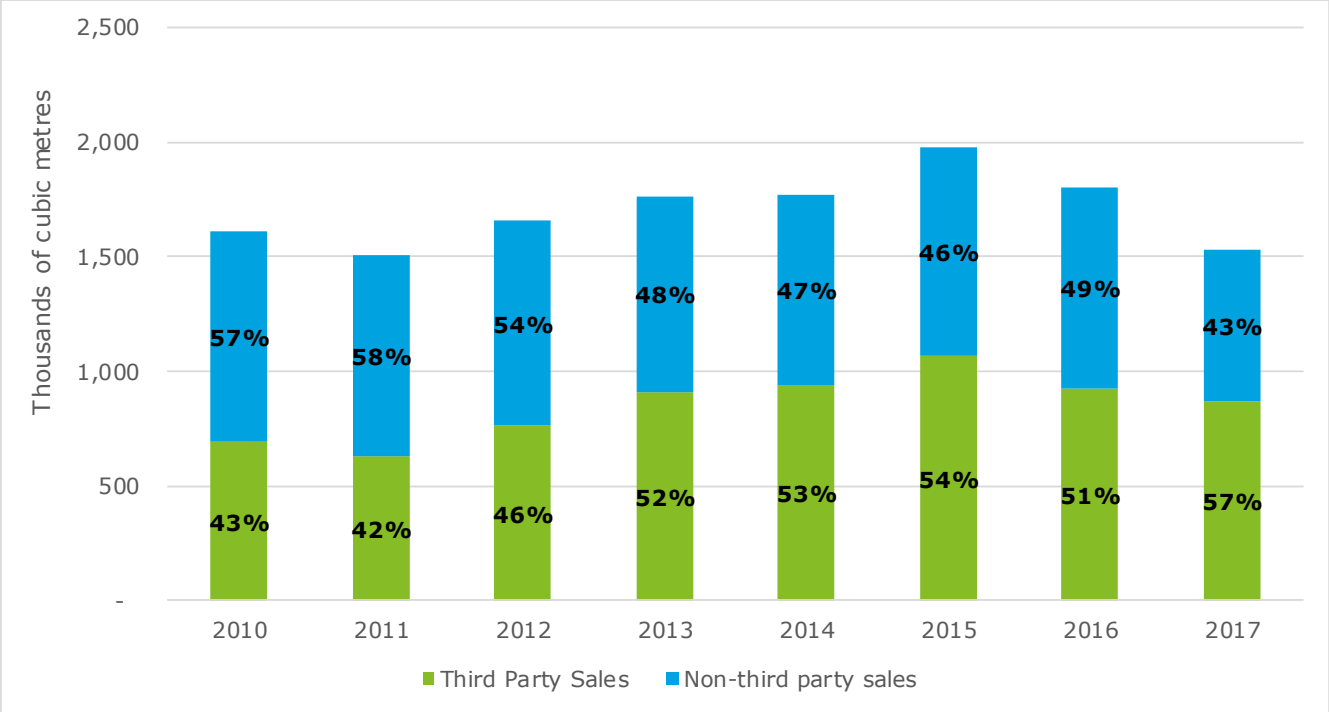
Source: Timber Utilization Survey and Government of New Brunswick

As shown in the chart above, on an annual basis more than 20% of the softwood harvested from Crown Land was traded between third parties during the period under review. This represents a significant portion of softwood from Crown Land consumed by the industry, which volume could impact softwood log prices between third party market participants. In particular, the price or cost attributed to harvesting, forwarding and transporting softwood logs from Crown Land is open to negotiation between third party market participants.

The proportion of softwood harvested from Crown Land that was sold or bartered between third parties increased from 21% (700 thousand cubic metres) in 2010 to 34% (1,100 thousand cubic metres) in 2017.

There was an increase in the proportion of third party sales from 29% (900 thousand cubic metres) in 2013 to 35% (1,200 thousand cubic metres) in 2014.

Chart 60: Proportion of third party sales, hardwood, volume in thousand cubic metres



Source: Timber Utilization Survey and Government of New Brunswick

More than 40% of the hardwood harvested from Crown Land was traded between third parties during the period under review. This proportion increases to more than 50% during the period from 2013 to 2017. This represents a significant portion of hardwood from Crown Land consumed by the industry, which volume could impact hardwood log prices between third party market participants. Similar to softwood logs, the price or cost attributed to harvesting, forwarding and transporting hardwood logs from Crown Land is open to negotiation between third party market participants. The proportion of hardwood harvested from Crown Land that was sold or bartered between third parties increased from 43% (700 thousand cubic metres) in 2010 to 57% (900 thousand cubic metres) in 2017.

4.2 Conceptual modelling framework

The goal of the econometric models developed in this section is twofold. First, we identify the key determinants of stumpage prices in the New Brunswick primary wood products industry. This means we aim at identifying all the variables that help explain how stumpage prices respond to different changes in market conditions. These may include transactional and macroeconomic variables that characterize the buyers-side (demand) and the sellers-side (supply) of the market for primary wood products in New Brunswick. Buyers of primary wood products are mills owned by wood products manufacturing companies and sellers of primary wood products are private woodlot owners.

Second, as a framework for our analysis, we test a number of hypotheses related to the New Brunswick market. These hypotheses have been developed through our meetings and interviews with representatives of the different segments of the market during our field trips: private woodlot owners, marketing boards, and independent contractors forest products manufacturers. We also took into account the empirical literature on

stumpage prices and government documentation in their development. Our working hypotheses can be summarized as follows:

- Hypothesis 1: There is at least one functioning market(s) for privately harvested wood in New Brunswick, where a market is defined as unrelated buyers and sellers exchanging a given product (a wood specie) for a given price (or equivalent consideration) within a given geographic location;
- Hypothesis 2a: Observed stumpage prices paid for wood purchased from private woodlots do not deviate from the price levels which would prevail in a competitive market for New Brunswick wood, where a competitive market is defined as a market with no concentration, no market power and prices at marginal cost;
- Hypothesis 2b: If stumpage prices differ from competitive levels, the direction of the deviation is negative, i.e., stumpage prices are lower than they would be in a competitive market, which is consistent with market power held by buyers rather than woodlot owners;
- Hypothesis 2c: The magnitude of the price deviations is not significantly different than the price deviations that occur in the overall economy and/or similar industries; and
- Hypothesis 3: Changes in the relative importance of Crown wood harvested (or Crown wood consumed by mills) in the defined markets have had no impact on private stumpage prices.

Hypothesis 1 is mainly a function of market definition, which is discussed in Appendix A. Hypotheses 2a, 2b and 3 aim at testing specific determinants of prices in the New Brunswick primary wood industry that have been raised during our field trips. As such, they take into account factors that are specific to New Brunswick and that are believed by industry players and other stakeholders to be significant in explaining private stumpage prices in the province.

Hypothesis 2c aims at validating the magnitude of these factors. This hypothesis proves especially important for the purpose of this report. Since most industries in industrialized countries tend to show some degree of price deviation from competitive levels, a significant part of this empirical work is to assess whether or not potential price deviations in the New Brunswick primary wood market are outside the range of what is observed domestically for other industries or for similar industries in other jurisdictions. In short, it is not sufficient to determine whether or not there are price deviations in the industry, it is equally important to determine whether such deviations, if found, are outside the norms of competitive pricing in other domestic and foreign markets.

In order to develop a workable statistical model for the purpose of testing our hypotheses, Deloitte developed a conceptual framework based on the underlying economic theory. We developed this conceptual framework of the key variables explaining stumpage prices based on the relevant literature, a practical view of the operation of the industry, as well as available data. Our baseline specification is:

$$S = f(M, I, T, B) + e.$$

In other words, stumpage prices are a function of macroeconomic variables, industry-specific variables indicative of the downstream demand for wood, transaction-level variables and any other variables which may drive price deviations. The definition of each element of this equation is provided below:

S is the observed stumpage prices for private woodlots.

M is a set of macroeconomic variables that may impact the demand and supply of wood. It can include real GDP, exchange rates, housing starts of target end-markets and the unemployment rate. Macroeconomic variables tend to impact both supply and demand for wood, either by increasing or decreasing demand for wood end products in which primary forest products are an input or by affecting business decisions of wood suppliers.

I is the set of variables reflecting changes in the demand for finished products of mills and downstream industries. Along with macroeconomic variables they may also capture changes in the demand for primary forestry products but they are more specific to the forest products industry. Therefore we experimented with end product price variables, such as the price of paper or OSB. It also includes total mill consumption, as a measure of overall market demand for primary wood products.

T is the set of transaction-level variables that are available to us. It includes contractor rates and trucking rates, as well as distance travelled from woodlot to destination mill and frequency of transactions over the period under review.

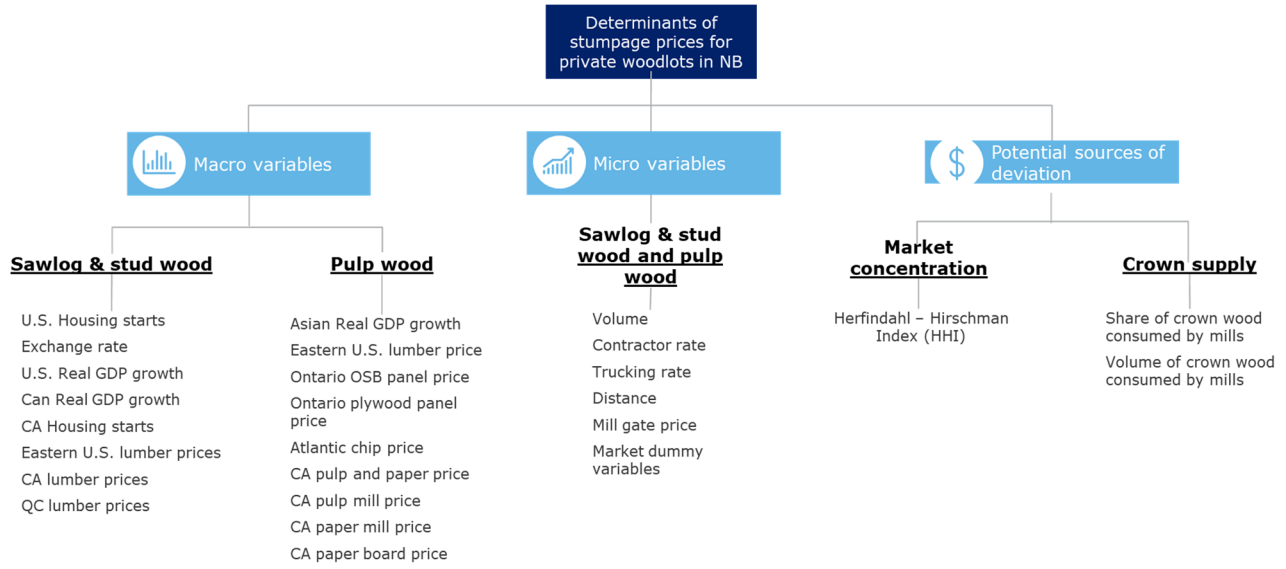
B is the set of variables that are likely to explain potential price deviations, such as measures of market concentration. We include the HHI in this category, as a measure of market concentration of wood product manufacturers, as well as metrics of Crown supply.

e is the error term of the regression, which represent the variations in stumpage price that are not explained by variables included in the regression. The error term is assumed to be random (i.e., exempt of any trend or baseline) and normally distributed.

4.3 Variable definition

In the process of specifying our models, we considered several different variables. The decision tree below presents our nomenclature for those potential variables. A full description of data preparation and a full set of descriptive statistics of the data included in the modeling database is available in Appendix A.

Chart 61: Nomenclature of possible variables for inclusion in the econometric modelling



Source: Deloitte Analysis.
Note: Where applicable, different specifications of each variable have been tested. These may include: levels, log, ratios, shares etc.

In addition, the table below summarizes our variable definitions included in our models.

Table 8: Econometric modelling variables definitions

Variable	Definition	Source and notes
Distance	Distance (KM) between the centroid of the map tile where PID is located and the mill to which wood is delivered.	Deloitte calculations.

Variable	Definition	Source and notes
Stumpage rate	Stumpage value divided by standardized volume in cubic metres.	Deloitte calculations using Marketing Board Database. In those cases where marketing boards provided stumpage rate (not volume), it was re-calculated by multiplying by the corresponding volume in original metric units to obtain stumpage value and then dividing by the standardized volume in cubic metres. Certain inconsistencies might exist in the definition of the stumpage rate or value across marketing boards. The intention was to construct a stumpage value or rate excluding any marketing board fees. However, the nature of the stumpage rate as provided in original datasets by the marketing boards was not entirely clear in all cases and might include certain fees paid by woodlot owners that ideally we would want to exclude. Efforts were made to clarify that but some uncertainties may exist. In any case, these measurement errors should be small in size (as are the fees) and should not impact on the results as they would be part of the error term of the model or would be captured by the market or marketing board dummies, as fee rates should be the same for all records within the marketing board dummies or markets.
Trucking Rate	Trucking value divided by the standardized volume in cubic metres.	Analogous notes as for the stumpage rate.
Contractor Rate	Contractor value divided by standardized volume in cubic metres.	Analogous notes as for the stumpage rate.
Mill gate rate	Mill gate value divided by standardized volume in cubic metres.	Analogous notes as for the stumpage rate.
Transaction volume	Standardized volume of the transaction, cubic metres.	Deloitte calculations using the conversion tables.
Frequency	Total number of deliveries made from a PID over the whole sample period for any product in the sample (Saw and Studwood; Pulpwood and roundwood chips) after outliers are removed.	Deloitte calculations using Marketing Board Database.
Product	1) Saw and Studwood 2) Pulpwood and roundwood chips.	Deloitte classification based on the standardized names of products in the Marketing Board Database.
Species	1) Softwood 2) Hardwood.	Deloitte classification based on the standardized names of species in the Marketing Board Database.
HHI	Herfindahl-Hirschman Index calculated by defined market, product and year.	Deloitte calculations using Timber Utilization Survey
Crown share	The share of the wood sourced from the Crown Land in the total mills' consumption volume, by defined market, product and year. The set of mills includes those mills which consumed their wood from private woodlot owners in the defined market. If the mills consumed their wood from private woodlot owners in more than one defined market they would appear in each of them.	Deloitte calculations using Timber Utilization Survey

Variable	Definition	Source and notes
Import share	The share of the imported wood in the total mills' consumption volume, by defined market, product and year. The definition of the set of mills is the same as for the Crown share.	Deloitte calculations using Timber Utilization Survey
Freehold share	The share of the wood sourced from industrial freehold land in the total mills' consumption volume, by defined market, product and year. The definition of the set of mills is the same as for the Crown share.	Deloitte calculations using Timber Utilization Survey
Private share	The share of the wood sourced from marketing boards in the total mills' consumption volume, by defined market, product and year. The definition of the set of mills is the same as for the Crown share.	Deloitte calculations using Timber Utilization Survey
Mill consumption	Volume of total consumption of mills from all sources (Crown Land, Federal land, import, industrial freehold, marketing board), cubic metres, by defined market, product and year. The definition of the set of mills is the same as for the Crown share.	Deloitte calculations using Timber Utilization Survey
Variables used in the regression analysis based on the aggregate database		
US Real GDP Growth, Average Q over Q	Average, by operating year, of quarter-over-quarter growth of US Real Gross Domestic Product chained dollars, seasonally adjusted at annual rates.	Deloitte calculations using the data sourced from US Bureau of Economic Analysis.
CA Real GDP Growth, Average M over M	Average, by operating year, of month-over-month growth of Canadian Real Gross Domestic Product, chained dollars, all industries, seasonally adjusted at annual rates.	Deloitte calculations using the data sourced from Statistics Canada, CANSIM table 36-10-0434-01.
Asian Real GDP growth	Growth of Emerging and Developing Asia Gross Domestic Product, constant prices, by calendar year.78	International Monetary Fund, World Economic Outlook Database, October 2018.
US Housing Starts	New Privately Owned Housing Units Started (total), monthly, not seasonally adjusted. Monthly data summed by operating year.	Deloitte calculations using the data sourced from the United States Census Bureau.
CA Housing Starts	Housing starts, Canada, total units, quarterly, not seasonally adjusted. Quarterly data summed by operating year.	Deloitte calculations using Statistics Canada's CANSIM table 34-10-0135-01.
Exchange Rate	The price of one Canadian dollar in terms of US dollars. Monthly data averaged by operating year.	Deloitte calculations using Statistics Canada's CANSIM tables 10-10-0009-01 and 33-10-0163-01.
Lumber Price, US and CA East mills, CAD	Average of weekly price of Eastern Spruce-Pine-Fir Std/#2&Better, Kiln-dried, Random Length – 2x4, by operating year. The price, originally reported in terms of US$ per MFBM, is expressed in Canadian dollars.	Deloitte calculations using the data sourced from Madison's Canadian Lumber Reporter.
CA Lumber Price, CAD	Average of the monthly price index of lumber and other wood products, Canada, by operating year.	Deloitte calculations using Statistics Canada's CANSIM table 18-10-0029-01.

[78]A caveat of using this variable is that it is available by calendar year. We matched calendar year to operating year, e.g., 2010 calendar year is matched to 2010/2011 operating year.

Variable	Definition	Source and notes
Lumber Price, Quebec, SW SPF, CAD	Average of the monthly price index of softwood lumber of spruce, pine and fir (except tongue and groove and other edge worked lumber), Quebec, by operating year.	Deloitte calculations using Statistics Canada's CANSIM table 18-10-0031-01.
Panel OSB Price	Average of weekly price of Oriented Strand Board Ontario, CAD per MSF, by operating year.	Deloitte calculations using the data sourced from Madison's Canadian Lumber Reporter.
Panel Plywood Price	Average of weekly price Canadian Softwood Plywood Toronto/Great Lakes Zone, CAD per MSF, by operating year.	Deloitte calculations using the data sourced from Madison's Canadian Lumber Reporter.
Atlantic CA Chips Price	Average of the monthly price index of wood chips, Atlantic region, by operating year.	Deloitte calculations using Statistics Canada's CANSIM table 18-10-0031-01.
Pulp and Paper Price	Average of the monthly price index of pulp and paper products, Canada, by operating year.	Deloitte calculations using Statistics Canada's CANSIM table 18-10-0029-01.
Pulp Mills Price	Average of monthly price index of output of pulp mills, by operating year.	Deloitte calculations using Statistics Canada's CANSIM table 18-10-0032-01.
Paper Mills Price	Average of monthly price index of output of paper mills, by operating year.	Deloitte calculations using Statistics Canada's CANSIM table 18-10-0032-01.
Paperboard Mills Price	Average of monthly price index of output of paperboard mills, by operating year.	Deloitte calculations using Statistics Canada's CANSIM table 18-10-0032-01.
Variables used in the regression for sensitivity analysis based on the disaggregate database		
Exchange Rate	The price of one Canadian dollar in terms of US dollars, monthly.	Deloitte calculations using Statistics Canada's CANSIM tables 10-10-0009-01 and 33-10-0163-01.
US Housing Starts	New Privately Owned Housing Units Started (total), monthly, not seasonally adjusted.	The United States Census Bureau.
Panel OSB Price	Weekly price of Oriented Strand Board Ontario, CAD per MSF, by operating year.	Madison's Canadian Lumber Reporter.

Note: "product" in this table means product groups used in the regression analysis: 1) Saw and Studwood 2) Pulpwood and roundwood chips.
Source: Deloitte Analysis.

4.4 Empirical results and implications

This section presents the results of our econometric analysis of the primary wood industry in New Brunswick. It starts with reviewing the preliminary correlation analysis across considered variables and selecting those to be included in the different regressions performed. We then review the results of the two main models, i.e. the sawlog and studwood and pulpwood and roundwood chips models. Finally, we review the results of a number of additional regressions performed to validate the main results obtained, and perform a sensitivity analysis through the inclusion of different variables and model specifications.

Depending on model specification, i.e. which variables were included in each regression, the scope of geographic coverage of our analysis changed because some markets had to be excluded when some variables were not available. This is especially the case for trucking and contractor rates in the Carleton-Victoria Marketing Board. It is also worth reminding the reader that there was no data from the Madawaska Marketing Board included in our models, given the paper format of their data collection. Nevertheless, any given model covers between 72% and 78% of all volumes transacted in New Brunswick (based on 2017 volumes by Marketing Board areas).

4.4.1 Sawlog and studwood model

Part of the modelling exercise involves "specifying" the model, i.e., selecting the subset of variables and functional form with the greatest explanatory power from a number of potential variables available. In this context, functional form refers to the possible transformation to the considered variables, such as calculating a ratio, taking its growth rate, applying a log transformation, etc. Each functional form can affect the statistical performance of the model, and thus needs to be carefully considered.

There are different ways to achieve that. For transaction level data (trucking and contractor rates, distance and frequency), the decision was made to include all those that were available in a specific-to-general approach. The specific-to general approach involved adding each variable one-by-one, assessing their contribution to the quality of the statistical results, and deciding whether they result in a significant improvement in the model, in which case the variable is kept in the equation. This approach relies on a number of factors, including the variable's statistical significance (i.e., is the variable taken alone sufficiently correlated with stumpage prices?) and contribution to the model's overall statistical performance (i.e., does the variable improve the model's explanatory power; or its ability to explain stumpage prices?). We decided on this course of action due to the relatively limited number of transaction-level variables obtained from marketing boards.

However, there is a much larger set of macroeconomic candidate variables, such as housing starts, GDP growth, unemployment rate and different end product price measures. Because the New Brunswick primary wood industry is integrated in the larger North American primary wood industry, these variables can be measured locally (i.e., New Brunswick), nationally (i.e., Canada or U.S.) or regionally (i.e., North East US). Each of these different variables are at risk of being correlated with each other, and their simultaneous inclusion in the main regression tends to problems of multicollinearity – spurious results from the correlation between two or more explanatory variables. As such, careful selection of variables for inclusion is warranted in order to ensure the reliability of the statistical results. At the same time, there are too many possible macroeconomic variables to test them one by one, in a specific-to-general approach.

To guide our model specification process, we therefore decided to conduct two preliminary analyses: (1) univariate regressions with each macroeconomic variable (i.e., how does each macroeconomic variable correlate with stumpage prices) and (2) correlation analysis of macroeconomic variables among themselves. The first analysis ensures we only keep variable candidates that are highly correlated with stumpage prices. The second analysis ensures that, among those explanatory variables that are correlated with stumpage prices, we select those that are less correlated to each other. In short, this allowed us to select variables that have both: (1) high correlation with stumpage prices and (2) low correlation with other selected variables. It is worth noting that neither of those analyses should be used to draw conclusions about the impact of one variable on stumpage prices, as they are meant to prepare the best model possible to do so and are only intermediary steps in the final model development.

In terms of microeconomic variables, i.e. those based on each transaction's characteristics, the pool of available data was much more restricted. In most cases, access was granted to the distance between the woodlot where trees were harvested and the mill where logs were delivered. The contractor and trucking rates applied to the transaction were also available for a significant number of transactions, but some marketing boards did not collect that information. As a result, those rates were only available for a sub-sample of the database. Given the limited number of micro-economic variables available, it was decided to use all those that were available for a specific set of transactions and to specify the models using a specific-to-general approach, i.e. adding each micro-economic variable one-by-one and assess their contribution to the model's performance. In some cases, we also reported models with less micro-economic variables included, but with a larger sample, reflecting the fact that some variables were not available for the whole database. Those models are essentially used to validate the fully specified model applied to a smaller number of transaction, assess the sensitivity of the results from excluding part of the sample and allowing comparisons across model specifications.

There are a several types of data that are reported with each table of statistical results. We provide a short description of these standard data terms below, and these definitions apply throughout the section. These are:

- Dependent (i.e., explained) variable: For all models, our dependent variable is stumpage prices associated with the transactions.
- Explanatory variable: variables that are likely to impact stumpage prices and are included in the model. Each variable corresponds to a row, and is labelled in the first column of the table.
- Equation: Each column corresponds to a different model (also called equation), with a different subset of variables. Typically, each equation is numbered in the first row of the table.
- Coefficients: each variable will have a coefficient which describes the statistical impact of this variable on stumpage rates. Coefficients are typically the first number reported in a table's cell that corresponds to the intersection of a variable and an equation. A few notes on how to interpret coefficients is warranted here:
    - The magnitude of the coefficient for one variable cannot be directly compared to the magnitude of the coefficient for a different variable. This is because a key assumption of OLS modeling is that each coefficient represents the impact of a variable with "everything else being equal", i.e., no change is allowed in other observed and unobserved variables. Doing so would require a different type of dynamic model and/or additional calculations;
    - Coefficients for the same variable across different models can be interpreted to refer to the response of this coefficient to different specifications of the model. This was routinely performed in our sensitivity analysis presented below. However, the variability of the coefficients on the same variable across models have little interpretative value;
    - Correlations are presented as a way to select the best candidate variables, not for interpretative purposes. They cannot be compared to coefficients in multiple variable regressions either. Coefficients should be used to interpret the impact of one variable on stumpage prices, not correlations; and
    - The proper way to compare full models is to rely on information criteria (AIC or BIC), and not on a single or a subset of coefficients. We provide more information on those statistics below. It is typically not recommended to use R^2 to undertake a reliable assessment of one model's performance relative to another.
- Statistical significance indicators: typically based on the number of stars added to the right-hand side of the coefficient. Statistical significance indicators provide information on the "strength" of the statistical correlation between the variable and stumpage prices. There are three standard levels of significance: 1%, 5% and 10%, corresponding to the odds of concluding that the variable statistically impacts stumpage rates when correct answer is that it does not (false positive). The lower the percentage, the less likely is a false positive. Hence, a variable significant at the 1% level will be deemed better than one significant at the 10% level. For the number of observations available in this analysis, we typically consider a 5% significance level to be the benchmark, i.e., we will consider variables as statistically significant if they are at the 1% or 5% level, but not at the 10% level. For the purpose of this report, we use the following coding:

– * Statistically significant at 10%
– ** Statistically significant at 5%
– *** Statistically significant at 1%

As a result, we will consider only coefficients with ** or *** as statistically significant and will disregard those with *.

- Standard errors: Standard errors are a measure of volatility for each coefficient and are critical in calculating statistical significance. They are reported within parentheses, right under the coefficient. All standard errors reported for regressions in this report are White robust standard errors to control for potential heteroscedasticity, a common statistical problem.
- Constant: it is customary to include a constant for each econometric equation. The constant is reported at the end of all explanatory variables, due to its limited interpretative value. The constant generally corresponds to the baseline value of stumpage prices, i.e., if all other explanatory variables are set to 0. Technically, the constant is the intercept of a 2 dimension graph of stumpage prices (Y axis) and an explanatory variable (X axis).
- Number of observations: for each equation, we report the number of observations used in the model. This helps assess the number of transactions analyzed for each reported equation.
- Adjusted R^2: The R^2 is a goodness of fit measure. It helps determine to what extent the model as a whole explains stumpage prices. Loosely interpreted, it can be viewed as the percentage of the variation in stumpage prices that is explained by the model. Hence, an R^2 of 0.23 may be interpreted as the model explaining 23% of the variations in stumpage prices. The basic R^2 tends to increase as variables are added to the model. The adjusted R^2 serves the same purpose but is statistically adjusted to plateau or decrease when too many statistically non-significant variables are added to the model. R^2 is a measure of goodness of fit that is model specific and should not be used to compare different models. We report this statistic only for multivariate regressions (more than 2 explanatory variables).
- Akaike Information Criterion (AIC): AIC is a statistic that allows comparison of different models' statistical performance, ranking them based on statistical performance and facilitating selection of a preferred model. The lower the AIC value, the better the model performance. We report this statistic only for multivariate regressions (more than 2 explanatory variables).
- Bayesian Information Criterion (BIC): BIC is an alternative statistic to AIC. Because it uses a different calculation method, it is useful to report both AIC and BIC together, as they can yield slightly different results. Typically, we would interpret consensus between AIC and BIC as a strong signal of statistical performance. We report this statistic only for multivariate regressions (more than 2 explanatory variables).
- Average Variance Inflation Factor (VIF): Average VIF is a statistic aimed at diagnosing the severity of multicollinearity issues in equations. It is generally considered that an Average VIF value greater than 10 is indicative of the presence of multicollinearity. Multicollinearity occurs when two or several explanatory variables are correlated, which can lead to instability in the statistical results, as well as spurious statistical results. We report this statistic only for multivariate regressions (more than 2 explanatory variables).
- Condition number: Condition number is another statistic aimed at diagnosing multicollinearity, but using a different approach than Average VIF. Similar to AIC and BIC, it is desirable to report both Average VIF and Condition number together. It is generally considered that a condition number value greater than 30 is indicative of the presence of severe multicollinearity. Consensus of diagnoses between Average VIF and condition number is desirable to reach a conclusion about the presence of multicollinearity. We report this statistic only for multivariate regressions (more than 2 explanatory variables).

The table below presents the results of preliminary univariate and bivariate (two variables only) regressions for the subset of observations of sawlog and studwood products with stumpage prices available. Conducting univariate regression analysis with stumpage prices as the dependent variable and each macroeconomic variable as explanatory variable may allow us to filter out some candidate variables. While statistical significance at this stage does not allow conclusions on the magnitude of the explanatory power of a specific variable, a non-statistically significant variable, or variable that shows counter-intuitive results at this stage can be excluded or further investigated. The results reported in this table are not meant to reach a conclusion on the impact of a variable on stumpage prices. It is aimed, as described above, to select the best variable candidates for the full statistical model. Equations 1 to 8 below show that, taken individually, each macroeconomic variable is statistically significant at the 1% significance level and has the expected sign.

An increase in end product prices, economic activity or construction activity in Canada or the US leads to an increase in stumpage prices due to increased demand. Inversely, an appreciation of the Canadian dollar (CAD) relative to the USD leads to a decrease in stumpage prices, as evidenced by the negative sign of the exchange rate variable. That is because an appreciation of the CAD relative to the USD makes Canadian wood relatively more expensive on American markets, which react by reducing their demand for Canadian wood (including New Brunswick), thus putting downward pressure on stumpage prices. Equations 9 to 12 show that including US housing starts, the macroeconomic variable with the highest correlation coefficient with New Brunswick stumpage prices, along with another macroeconomic variable somewhat changes the results. While the coefficient on US Housing starts remains mostly unchanged in terms of sign, magnitude and statistical significance, the results of the additional variables change. In Equation 9, the coefficient for the exchange rate remains significant at a standard 5% threshold, but changes sign and its magnitude in absolute value decreases significantly. In Equation 10 and 12, Canadian and US lumber prices change sign, which is a counter-intuitive result. Canadian lumber prices also turn out not to be significant. In Equation 11, the growth rate of US real GDP decreases in magnitude, but remains of the expected sign and significant. Given that these preliminary regressions are aimed at identifying best candidates for explanatory variables, and hence do not account for several factors at the same time, these results likely indicate that lumber prices are not a good standalone explanatory variable for explaining stumpage prices, and require additional variables to be added. Overall, this result, while counter-intuitive, is not a concern at this point in the analysis.

This variability in coefficients related to variables additional to US housing starts illustrate how dominant the impact of US housing market conditions is on demand for New Brunswick primary wood products. Hence, it was important to consider carefully the construct of our preferred model to avoid interactions between US housing starts and other potential explanatory variables.

Table 9: Univariate and bivariate regression results, sawlog and studwood product

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
US Real GDP Growth, Average Q over Q	0.07***										0.01***	
	(0.00)										(0.00)	
CA Real GDP Growth, Average M over M		0.04***										
		(0.00)										
ln (US Housing Starts)			0.27***						0.28***	0.28***	0.25***	0.29***
			(0.01)						(0.01)	(0.01)	(0.01)	(0.01)
ln (CA Housing Starts)				0.85***								
				(0.03)								
ln (Exchange Rate)					-0.51***				0.07**			
					(0.02)				(0.03)			
ln (Lumber Price, US and CA East Mills, CAD)						0.28***						-0.06***
						(0.02)						(0.02)
ln (Lumber Price, Quebec, SW SPF, CAD)							0.32***					
							(0.02)					

ln (CA lumber price, CAD)								1.21***		-0.07		
								(0.05)		(0.07)		
Constant	2.73***	2.78***	0.96***	-1.64***	2.79***	1.13***	1.34***	-2.78***	0.87***	1.23***	1.09***	1.20***
	(0.01)	(0.01)	(0.05)	(0.19)	(0.01)	(0.10)	(0.11)	(0.25)	(0.07)	(0.28)	(0.06)	(0.09)
Observations	15,256	15,256	15,256	15,256	15,256	15,256	15,256	15,256	15,256	15,256	15,256	15,256

Source: Deloitte Analysis.
Note: * Significant at 10%, ** Significant at 5%, *** Significant at 1%. Standard deviations reported in parentheses. For panel data methodologies with large number of observations, significance is typically assessed at 5% and 1%. The model is estimated using OLS estimation with weighted observations.

Mixed results from adding more than one macroeconomic variable were expected, given the strong correlation between them, as demonstrated in the following table. As for the preceding table, the table below is part of a preliminary analysis leading to the core modelling and should not be used to interpret specific impacts of independent variables on stumpage prices. Its purpose is to help select the best explanatory variables and avoid statistical modelling issues in the model development. The results highlight the high correlation between US housing starts and all other macroeconomic variable candidates for inclusion in the main regression, with correlation coefficients ranging from 0.38 to 0.71, in absolute value. As such, the decision was made to include only US housing starts as a macroeconomic explanatory variable in the sawlog and studwood regressions.

Table 10: Macroeconomic variables correlation matrix

	US Real GDP Growth, Av Quarterly	CA Real GDP Growth, Av Monthly	US Housing Starts	CA Housing Starts	Exchange Rate	Lumber Price, US and CA East Mills, CAD	Lumber Price, Quebec, SW SPF, CAD	CA lumber price, CAD
US Real GDP Growth, Av Quarterly	1.00							
CA Real GDP Growth, Av Monthly	0.81 0.00	1.00						
US Housing Starts	0.57 0.01	0.38 0.12	1.00					
CA Housing Starts	0.41 0.09	0.26 0.30	0.46 0.05	1.00				
Exchange Rate	-0.22 0.39	-0.15 0.56	-0.67 0.00	0.14 0.58	1.00			
Lumber Price, US and CA East Mills, CAD	0.48 0.04	0.39 0.11	0.59 0.01	0.23 0.37	-0.68 0.00	1.00		
Lumber Price, Quebec, SW SPF, CAD	0.42 0.08	0.41 0.09	0.47 0.05	0.19 0.45	-0.57 0.01	0.96 0.00	1.00	
CA lumber price, CAD	0.46 0.05	0.33 0.18	0.71 0.00	0.27 0.29	-0.75 0.00	0.96 0.00	0.88 0.00	1.00

Source: Deloitte Analysis.

The next table below present the results of six different regressions developed as part of the main approach presented in the previous section, i.e., with the HHI variable included as part of the main regression. The main difference between the regressions, other than their specification, is that equations 1 to 4 include data from CV, while equations 5 and 6 do not, because trucking and contractor rates were not provided by CV. Adding those variables in the model meant that the CV data needed to be excluded. We report results from models with and without CV data to help evaluate whether their exclusion significantly changes the results obtained. This is because there is a trade-off between having the most data available across markets, and hence including CV, versus having the best specified model (excluding CV but including additional transactional-level input variables, such as trucking and contractor rates). If the coefficients common to both

groups of regressions (1 to 4 and 5-6) are relatively stable in their sign, magnitude and statistical significance, it is worth favouring the latter group of regressions, because they provide more information on which factors impact stumpage prices, without bearing a significant cost as a result of losing CV data.

It is worth noting that most explanatory variables, as well as the dependent variable (stumpage price), are included in the model using a logarithmic transformation (ln). This is for two reasons. First, taking the log of a variable has the effect of "flattening" it, i.e., it makes the variable more linear. This is desirable because the linearity of relationships between variables is a key assumption of Ordinary Least Square models, which are used for this analysis. Taking the log of a variable hence tends to increase statistical performance of the model.

Second, taking the log on both dependent and explanatory variables facilitates the interpretation of the coefficients. In log-log regressions, as those reported below, coefficients can be interpreted as a percentage change in the dependent variable resulting from a 1% change in the explanatory variable. For example, taking the coefficient of US Housing starts in Eq. 6 below, we can say that an increase of 1% in US Housing Starts would lead to an increase of 0.06% in New Brunswick stumpage rates. It is worth noting this interpretation holds true for marginal (i.e., very small) changes in the value of explanatory variable. Estimating the impact on stumpage prices of a larger incremental change in the value of an explanatory variable would require different calculations. Also, dummy variables (that take the value 0 or 1 depending on a specific characteristic) are typically not taken in log.

The table below shows the main regressions for the sawlog and studwood model, which may serve to interpret factors impacting sawlog and studwood stumpage prices using Eq. 6. Equation 6 is the iteration including the most explanatory variables, with the statistically significant ones showing expected results in terms of sign and magnitude. US housing starts (0.06) and Contractor rate (0.15) are both statistically significant and of positive, as expected. US housing starts are a measure of the end market impact on sawlog and studwood: an increase in demand from the end market should positively impact stumpage rate, reflecting tighter end market conditions. As described in previous sections, the contractor rate can also be an input into the sawlog and studwood model, and as such an increase in contractor rate may filter through to stumpage prices. An increase of 1% in US Housing Starts or the Contractor rate will result in an increase of 0.06% and 0.15% in stumpage rates, respectively.

The number of times a private woodlot owner sold wood on the market over the whole period under consideration (frequency, 0.02) also has a small positive effect on stumpage prices: an increase of 1% in the frequency of transactions of a woodlot owner over the whole period of the analysis would result in an increase of 0.02% in stumpage rates paid to this woodlot owner. This can be interpreted as the price premium woodlot owners that are better informed on current market conditions are able to secure from their buyers, relative to the stumpage price secured by a woodlot owner who has done relative few transactions (i.e. a less informed woodlot owner).

Total mills wood consumption (0.14) in a given market for a given year has a large, positive and statistically significant impact on stumpage prices. This was also expected, since an increase in wood consumption would increase demand for sawlog and studwood. All other factors remaining unchanged, i.e. no immediate increase in supply of those products since the market takes time to adjust, this would lead to an increase in stumpage price. An increase of 1% in total mills wood consumption results in an increase of 0.14% in stumpage prices. This variable measures the impact of overall increased demand from mills: as demand increases, upward pressure is put on stumpage prices by mills that compete to buy their primary input.

The coefficient on HHI (-0.27) is negative, statistically significant and relatively stable across all regressions. An increase in market concentration on the demand side for wood, at the forest product company level, results in a decrease in stumpage prices. Section 5 below explains this result in further detail, summarizes this impact and analyzes its consequences. Trucking rate (-0.06) is also statistically significant and of

expected sign – a 1% increase in trucking rate per cubic metre, which can be interpreted as an increase in travelling distance, decreases stumpage prices by 0.06%. While the magnitude of this result may seem small relative to others, it is worth emphasizing that it applies to each cubic metre of a transaction, which can include several thousand cubic metres.

As is customary for panel data regressions, a set of dummy variables has been added for each market defined in section 4.2.2, as well as a constant. Dummy variables take the value 0 or 1, depending on a specific characteristic. For example, the variable YSC SW will be equal to 1 for each transaction involving softwood originating from YSC. It will be 0 otherwise.

While dummy variables have limited statistical explanatory power themselves, they are included to control for market-specific conditions that are constant over time and that would not be otherwise modelled through other included variables. Dummy variables have to be interpreted as the differential of stumpage rate relative to the benchmark market, here defined as the market for softwood in SNB. For example, hardwood in SNB and YSC has a price premium of $0.49 relative to softwood in SNB, the dummy variable representing the price differential between the two markets, on average. The benchmark for price differentials using dummy variables is SNB, because it is the excluded dummy variable. Similarly, softwood in YSC trades at a price that is similar to softwood in SNB – while the coefficient is different from 0 (at a value of -0.01), it is not statistically significant. While it is also customary to include time-based dummy variables in panel regressions, it was decided to omit them in this case, given their high correlation with macroeconomic variables already included.

One desired characteristic to highlight from this set of regressions is the persistent statistical significance of coefficients on target variables (HHI, transactional-level rates and US housing starts) across all regressions, and their relatively stable value. Those features underline the robustness of the model to different specifications, i.e., the model tends to provide consistent results for target variables even when other variables are included in the model.

Table 11: Main equations including HHI, sawlog and studwood model

	(1)	(2)	(3)	(4)	(5)	(6)
ln (US Housing Starts)	0.19***	0.15***	0.15***	0.15***	0.14***	0.06**
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
ln (total mill consum)	0.03***	0.06***	0.04***	0.04***	0.06***	0.14***
	(0.00)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
HHI	-0.10***	-0.22***	-0.23***	-0.24***	-0.26***	-0.27***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln (Distance)			-0.00	-0.00		
			(0.00)	(0.00)		
ln (Frequency)				0.01***	0.02***	0.02***
				(0.00)	(0.00)	(0.00)
ln (Trucking Rate)					-0.04***	-0.06***
					(0.01)	(0.01)
ln (Contractor Rate)						0.15***
						(0.02)
YSC SW		-0.09***	-0.09***	-0.08***	-0.11***	-0.01
		(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
YSC and SNB HW		0.20***	0.02	0.02	0.11	0.49***
		(0.07)	(0.08)	(0.08)	(0.10)	(0.12)
NTH		-0.12***	-0.09***	-0.10***	-0.12***	0.15**
		(0.02)	(0.03)	(0.03)	(0.04)	(0.07)
CV		0.08***	0.12***	0.13***		
		(0.01)	(0.01)	(0.01)		
Constant	1.17***	1.07***	1.40***	1.32***	1.28***	0.35
	(0.08)	(0.14)	(0.16)	(0.16)	(0.18)	(0.22)
Observations	14,034	14,034	10,950	10,950	9,699	9,215
Adjusted R-squared	0.08	0.12	0.13	0.14	0.14	0.17

	(1)	(2)	(3)	(4)	(5)	(6)
BIC	10427.34	9734.48	6323.80	6305.42	6954.43	6361.91
AIC	10397.14	9674.08	6258.09	6232.40	6889.81	6290.62
Average VIF	1.48	14.91	14.05	12.61	16.98	21.04
Condition number	2.17	14.29	14.70	14.70	16.13	19.50
F p-val		0.00	0.00	0.00	0.00	0.00

Source: Deloitte Analysis.
Note: * Significant at 10%, ** Significant at 5%, *** Significant at 1%. White-robust standard deviations reported in parentheses. For panel data methodologies with large number of observations, significance is typically assessed at 5% and 1%. The model is estimated using OLS estimation with weighted observations. F p-value is the p-value of the F test of the joint statistical significance of the market dummy variables.

We note that mill gate price is not included as an explanatory variable in the table above. The reason is straightforward. Since the listed explanatory variables include several of the inputs into mill gate prices (transportation cost & distance, contractor cost, and frequency) as well as downstream factors impacting mill gate prices (housing starts and total market demand for wood), by including mill gate price we would in fact lead to a double counting factors that impact stumpage rates. Technically, the coefficients of such a "double-counting" model, may be misleading because of high correlation between mill gate prices and its inputs and influencing factors. This would result in elevated volatility of results, lower statistical reliability of the models and overall lower interpretative value of the results. We decided on the disaggregated approach (i.e. preferring to include the inputs to mill gate prices) rather than the mill gate price itself, because it provides a more detailed view of the impact of the different factors impacting stumpage price and, as such, provides a more intuitive answer to the questions analyzed in this report. Results when adding mill gate prices were generally stable and robust, however, some alternative specifications of the model showed more variability to the inclusion of mill gate prices.

Among the equations presented in the table above, Equation 6 is the preferred one from a number of perspectives. Among the regressions conducted, equation 6 is the equation including the most explanatory variables, while still having statistically significant coefficients with the expected signs and magnitudes based on economic theory. This is a desirable feature of a sound model, since it can be explained by theory rather than by mere statistical performance. It is also the equation that maximizes the adjusted R2 and it is among the set of three regressions that minimizes the AIC and BIC, two statistics that respectively assess goodness-of-fit and allow us to rank models based on their statistical performance. While Eq. 3 and 4 perform better on the AIC and BIC, we maintain our preference for Eq. 6 on the basis that it is a theoretically grounded approach and performs well statistically (i.e. the overall results are well-behaved in terms of both the sign and statistical significance of the coefficients). AIC and BIC are known to penalize for the addition of extra variables to a model and it may be the case that the model in Eq. 6 is penalized due to the higher number of variables it contains.

When it comes to collinearity, a double test was applied using two potential statistical diagnosis indicators: the VIF and the condition number, because each test provides a slightly different statistical measurement of the performance of the model. Some tests also perform better under certain circumstances than others. Hence, running more than one test is desirable to provide a better understanding of statistical results. The decision rule retained was as follows:

- If both VIF and condition number led to a conclusion of collinearity, the model was rejected;
- If both VIF and condition number led to a conclusion of no collinearity, the model was retained; and
- If there was no consensual diagnosis (i.e. tests results diverged), the model was also kept given it passed at least one test.

There are some indications of collinearity in Eq. 6, as evidenced by the VIF above 10, but this applies to all alternative regressions. Moreover, the condition number remains below 30, which implies that the two collinearity statistics do not converge on the diagnostic test of whether or not collinearity is present in Eq. 6. While collinearity should be avoided, the theoretical grounding for Eq. 6 still makes it preferable given that all other equations also have similar diagnostic test results on this issue.

An important comparison has to be made between equations 6 and 4, because equation 4 includes data from CV that is not included in equation 6. Overall, significant differences in results from those two equations may signal stumpage prices dynamics in CV that are not captured in the preferred model. In equations 4 and 6, the coefficient on HHI remains significant and of similar value, and so does the coefficient on frequency. However, the coefficients on U.S. housing starts and total mill consumption move in different directions. The coefficient on U.S. Housing starts decreases, while the coefficient associated with total mill consumption increases in magnitude. This shows a potential substitution in the statistical effects captured by each variable, which may be expected because the US housing market and total demand for primary wood products in New Brunswick likely follow similar cycles. When US Housing Starts increase, it is likely that New Brunswick mills react by increasing production to supply the US housing market. Despite these issues, both coefficients remain statistically significant at standard levels and of positive sign. Overall, the general consistency of coefficients between both regressions leads to us to conclude that the exclusion of CV from equation 6 may not significantly bias our statistical results.

Another comparison worth making to assess the model's sensitivity to different specifications is between equations 5 and 6, which incrementally add transaction level variables. Equation 5 adds the trucking rate over the variables included in Eq. 4 and equation 6 further adds the contractor rate. Each addition improves the model's statistical performance, as reflected by the increase of the adjusted R2, but the most significant single addition is the contractor rate. Moreover, the coefficients for US housing starts and HHI, as well as all the coefficients for variables common to the two regressions, do not change significantly in value and remain statistically significant, other than the potential substitution between housing starts and mill consumption.

In order to push the analysis further, we also tried a number of additional alternative specifications and estimation techniques, which are reported in the next table. It is important to emphasize that those additional equations are meant to "stress-test" the results of our preferred equation from the table above, i.e., test whether the results are robust to changes in some of our baseline assumptions. Those additional regressions are not meant to provide alternative statistical results but rather to validate those from Eq. 6 above, and potentially highlight under which conditions they may need to be caveated. As such, results from the table below should not be used to explain stumpage price responses to a change in the explanatory variables. It is aimed at validating our core results presented above.

To facilitate comparisons, equation 6 from results reported above is reported in the second column of Table 11. In equation 2*, we added volume of transactions as an explanatory variable, to assess whether the size of a transaction affects stumpage prices. This may be consistent with volume-based discounting. The associated coefficient is negative, as expected, and statistically significant. It also changes the magnitude of

certain other coefficients, notably US housing starts and HHI, but their sign remains consistent with theory and their coefficient is still statistically significant.

Equation 3* substitutes US housing starts by US lumber prices expressed in CAD. Substituting US housing starts for lumber prices does increase magnitude of the HHI coefficient. However, HHI and housing starts are correlated. As such, it is likely that the HHI variable is capturing a part of the macro component from lumber prices. Adding both lumber prices and US housing starts (equation 4*) leaves the regression mostly unchanged for other coefficients, but in both 3* and 4* the coefficient on lumber prices is negative and significant, a counter-intuitive result which may indicate additional statistical relationships are unaccounted for in these models. Because US Housing starts provide more intuitive and consistent results than lumber prices, and because of the results for lumber prices explained above, it is was decided to use US housing starts as the preferred explanatory variable.

Finally, equation 6* omits the market dummy variables, which leads to both HHI and total mill consumption coefficients decreasing significantly in magnitude. Our interpretation is that the HHI coefficient reflects the dynamics of HHI within markets, not differences across them. Therefore, market dummies should be controlled for in the model to capture the latter. In Equation 12*, we substitute market dummy variables for dummy variables based on marketing boards' territories and wood species, separately. Again, results for other coefficients remain mostly unchanged from the preferred regression, with the exception of coefficients on housing starts and mill consumption in Eq. 12*. Overall, we conclude from these additional specifications that the model remains consistent using different variables and functional forms, both in terms of significance and magnitude.

We also ran a sensitivity analysis based on estimation techniques, since different techniques may lead to different results depending on the variables' underlying statistical distribution. Essentially, the purpose of the sensitivity analysis is to assess whether the results obtained from the main model change if different variables or different forms of variables (i.e. growth rate, level, log, etc.) are included. This is what is called "robustness check" of the model and is a standard procedure of model development.

Equation 5* ran the preferred regression, but using clustered standard errors. While this estimation method may not impact the value of coefficients, it may impact their statistical significance. Clustered standard errors are designed to account for the cases where observations in a data set are related to each other, as could the case within a market area in this study. Clustered standard errors aim at controlling for heteroscedasticity, a common statistical problem in regression analysis. While using a different estimation method (here, clustered standard errors) is not properly speaking a sensitivity analysis, obtaining significantly different results under different estimation methods may be indicative of statistical issues to be resolved. In this case, however, only the coefficient on US housing starts loses some explanatory power, becoming non-statistically significant.

Another potential concern is endogeneity, which happens when the dependent and at least one explanatory variables are determined simultaneously. Endogeneity can be likened to a "feedback effect" between two variables. This is why our main regression excludes transaction-level volume, price and volumes traded: an increase in volume may depress prices, while lower prices may incent more buying and impact volumes traded. The direction of this relationship is not straightforward.

One way to control for endogeneity is to use instrumental variable regressions. Those involve finding a third variable or a set of variables that is highly correlated with the concerned explanatory variable, but is not as correlated with the dependent variable. In this instance, we may instrument the volume variable with some exogenous and relevant variables.

Equations 9* to 11* report the results of different instrumental variables for volume, in order to control for endogeneity. Theoretically, instrumental variable methods should be used when one explanatory variable (X)

is correlated with other explanatory variables (Y) in the model. It involves identifying a third variable (Z) that is correlated with X, but uncorrelated with the set of variables Y, hence removing the problem of endogeneity in the model.

Equation 9* uses distance as an instrument for volume, as is it assumed larger volumes are more expensive to transport on longer distances, hence explaining the correlation. Eq. 10* uses the exchange rate as an instrument, assuming larger volumes would be produced under more favourable terms of trade with the US market. Finally, Eq. 11* uses both, which is another approach to instrumental variables methods. In these cases, results vary more than in other regressions performed as part of the sensitivity analysis, but the coefficient on HHI remains negative and statistically significant. The coefficients of other variables vary considerably, many becoming not statistically significant in some instrumental variable regressions. This is not unusual for instrumental variable regressions, which tend to be less stable than Ordinary Least Square typical regressions. That being said, instrumented regressions should be interpreted with care, as results are sensitive to the choice of an instrument and there is substantial ambiguity with regards to defining proper instruments. As such, we report those regressions for information purpose only. Overall, the consistent behaviour of the coefficient on HHI gives us confidence in our main model.

Table 12: Sensitivity analysis on main equation including HHI

	(6)	(1*)	(2*)	(3*)	(4*)	(5*)	(6*)	(7*)	(8*)	(9*)	(10*)	(11*)	(12*)
	OLS	OLS	OLS	OLS	OLS	OLS clustered SE	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	OLS
ln (US Housing Starts)	0.06**	0.24***	0.06**		0.12***	0.06	0.21***	0.06**	0.10**	0.06**			0.05**
	(0.03)	(0.01)	(0.03)		(0.03)	(0.04)	(0.01)	(0.03)	(0.04)	(0.03)			(0.03)
ln (Lumber Price, US and CA East Mills, CAD)				-0.16***	-0.20***								
				(0.03)	(0.03)								
ln (total mill consum)	0.14***		0.13***	0.25***	0.17***	0.14***	0.04***	0.11***	0.04	0.11***	0.27***	0.16***	0.13***
	(0.02)		(0.02)	(0.02)	(0.02)	(0.04)	(0.00)	(0.03)	(0.06)	(0.03)	(0.06)	(0.01)	(0.02)
HHI	-0.27***	-0.18***	-0.27***	-0.29***	-0.22***	-0.27***	-0.11***	-0.30***	-0.27***	-0.30***	-0.27***	-0.33***	-0.28***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.03)	(0.02)	(0.04)	(0.02)	(0.02)
ln (Frequency)	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.01***	0.05***	0.01***	-0.03	0.01**	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.02)	(0.00)	(0.03)	(0.00)	(0.00)
ln (Trucking Rate)	-0.06***	-0.06***	-0.06***	-0.05***	-0.05***	-0.06***	-0.09***	-0.00	-0.05***	-0.00	-0.07***	-0.00	-0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
ln (Contractor Rate)	0.15***	0.16***	0.14***	0.15***	0.15***	0.15***	0.12***	0.01	0.05	0.01	0.29***	0.01	0.14***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.05)	(0.02)	(0.10)	(0.02)	(0.02)
YSC SW	-0.01	-0.18***	-0.03	0.13***	0.03	-0.01		-0.01	-0.13*	-0.01	0.16*	0.05**	
	(0.03)	(0.01)	(0.03)	(0.02)	(0.03)	(0.05)		(0.04)	(0.08)	(0.04)	(0.08)	(0.02)	
YSC and SNB HW	0.49***	-0.25***	0.38***	1.01***	0.65***	0.49**		0.31**	-0.67	0.31**	2.16**	0.54***	
	(0.12)	(0.01)	(0.12)	(0.08)	(0.12)	(0.19)		(0.16)	(0.63)	(0.15)	(0.99)	(0.10)	
NTH	0.15**	-0.01	0.14*	0.32***	0.25***	0.15		0.16**	0.05	0.16**	0.29**	0.22***	
	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)	(0.11)		(0.07)	(0.10)	(0.07)	(0.13)	(0.06)	
Softwood													-0.58***
													(0.12)
NTH MB													0.14*
													(0.07)
YSC MB													-0.17***
													(0.03)
YSC MB & SW													0.15***
													(0.04)
ln (Transaction volume)			-0.02***					0.02	-0.26*	0.02	0.37	0.03	
			(0.00)					(0.03)	(0.14)	(0.03)	(0.25)	(0.03)	
Constant	0.35	0.84***	0.56***	0.15	0.56**	0.35	0.70***	0.96***	2.59**	0.96***	-2.87	0.71***	1.05***
	(0.22)	(0.12)	(0.22)	(0.19)	(0.22)	(0.35)	(0.12)	(0.30)	(1.22)	(0.30)	(2.06)	(0.27)	(0.14)
Observations	9,215	9,642	9,215	9,215	9,215	9,215	9,215	7,704	9,215	7,704	9,215	7,704	9,215
Adjusted R-squared	0.17	0.21	0.17	0.17	0.17	0.17	0.14						0.17

	(6)	(1*)	(2*)	(3*)	(4*)	(5*)	(6*)	(7*)	(8*)	(9*)	(10*)	(11*)	(12*)
BIC	6361.91	6733.41	6300.98	6328.81	6314.48	6361.91	6672.81	4439.08	11235.28	4438.52	16525.84	4491.74	6315.09
AIC	6290.62	6668.84	6222.57	6257.52	6236.06	6290.62	6622.91	4362.63	11156.86	4362.07	16454.55	4422.24	6236.67
F p-val	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00

Source: Deloitte Analysis.
Note: * Significant at 10%, ** Significant at 5%, *** Significant at 1%. White-robust standard deviations reported in parentheses. For panel data methodologies with large number of observations, significance is typically assessed at 5% and 1%. The model is estimated using OLS or 2SLS estimation with weighted observations. F p-value is the p-value of the F test of the joint statistical significance of the market dummy variables.

Eq. 12 was included to evaluate the impact of not distinguishing between hardwood and softwood by running different models for each, and rather treat them as part of the market definition detailed in the appendix. Those two equations hence include a dummy variable for "softwood" that is equal to 1 if the transaction involved softwood and 0 otherwise, as well as dummy variables for the geographical markets, regardless of the species involved in the transaction. The coefficient to the "softwood" variable is negative and statistically significant in both equations, indicating the lower price of softwood relative to hardwood for saw products. Indeed, some hardwood saw products are sought after and trade at high prices, which are reflected to some extent in the price of their inputs. This is intuitive and was expected. The other notable result is the other target coefficients (housing starts, HHI, trucking rate, contractor rate, mill consumption and frequency) do not change in sign and do not change significantly in magnitude when controlling for hardwood and softwood rather than by markets, as defined for the purpose of the analysis. We interpret this result as indication that the model we develop is robust to both specifications, i.e., gives consistent results whether we distinguish transactions based on market or species involved in the transaction. This is also a further signal that our market definition intuitively makes sense in the context of the New Brunswick primary wood products' market.

4.4.2 Pulpwood and roundwood chips model

The approach we took for developing the pulpwood model is similar to the approach described above for the sawlog and studwood model. Given the limited number of transaction based variables we had, we decided to adopt a specific to general approach in determining which one to include in the regression. In the case of the pulpwood model, as was the case for the sawlog and studwood model, we have a number of macroeconomic variables we could add. By contrast with the sawlog and studwood model, however, the macroeconomic variables to be included in the pulpwood model are mostly end product prices, with some notable exceptions such as Asian real GDP growth. Indeed, Asia is a significant end market for wood pulp and one would expect economic growth in Asia to increase global demand for wood pulp. As such, we conducted a set of univariate regressions to identify best candidate variables for inclusion.

The table below presents the results of preliminary univariate and bivariate (two variables only) regressions for the subset of observations of pulpwood and roundwood chips products, with stumpage prices available. The results reported in this table are not meant to reach a conclusion on the impact of any variable on stumpage prices. It is aimed, as described above, to select best candidate variables for the full statistical model.

As shown below, there is no single macroeconomic variable that has strong explanatory power for stumpage prices for pulpwood and roundwood chips. One reason for this might be that the end products for pulpwood are very diverse including textile, paper, and boards. For the purposes of modelling, we picked exchange rates and OSB panel prices as the main macroeconomic explanatory variables, because they showed high statistical significance, as well as an intuitive sign and magnitude.

Table 13: Univariate regression results, pulpwood and roundwood chips product

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
US Real GDP Growth, Average Q over Q	0.00														
	(0.00)														
CA Real GDP Growth, Average M over M		-0.00													
		(0.00)													
RGDP_Asian_gr			-0.02***												
			(0.00)												
ln (US Housing Starts)				0.02											
				(0.01)											
ln (CA Housing Starts)					-0.07										
					(0.05)										
ln (Exchange Rate)						-0.16***									
						(0.03)									
ln (Lumber Price, US and CA East Mills, CAD)							0.09***								
							(0.02)								
ln (Lumber Price, Quebec, SW SPF, CAD)								0.08**							
								(0.04)							
ln (panel osb price)									0.08***						
									(0.01)						
ln (panel plywood price)										0.11***					
										(0.03)					
ln (atlantic CA chips price)											0.03				
											(0.06)				
ln (pulp and paper price)												-0.10			
												(0.10)			
ln (pulp_mills price)													-0.12*		
													(0.07)		
ln (paper_mills price)														0.20**	
														(0.09)	
ln (paperboard_mills price)															-0.40***
															(0.10)
Constant	2.21***	2.22***	2.33***	2.09***	2.58***	2.18***	1.66***	1.81***	1.75***	1.55***	2.06***	2.67***	2.77***	1.27***	4.05***
	(0.01)	(0.01)	(0.03)	(0.08)	(0.25)	(0.01)	(0.14)	(0.17)	(0.07)	(0.19)	(0.27)	(0.46)	(0.32)	(0.41)	(0.44)
Observations	9,820	9,820	9,820	9,820	9,820	9,820	9,820	9,820	9,820	9,234	9,820	9,820	9,820	9,820	9,820

Source: Deloitte Analysis.
Note: * Significant at 10%, ** Significant at 5%, *** Significant at 1%. White-robust standard deviations reported in parentheses. For panel data methodologies with large number of observations, significance is typically assessed at 5% and 1%. The model is estimated using OLS estimation with weighted observations. F p-value is the p-value of the F test of the joint statistical significance of the market dummy variables.

Since it is likely that the different price indices are highly correlated one with the other, we also conducted a correlation analysis in order to identify the best candidate variables for inclusion. As a reminder, we aim to select the variables with the highest explanatory power for stumpage prices, but that are not strongly correlated with other explanatory variables, as this would result in multicollinearity. As for the preceding table, the table below is part of a preliminary analysis leading to the core modelling and should not be used to interpret specific impacts of any variables on stumpage prices. Its purpose is to help select the best explanatory variables and avoid statistical modelling issues in the model development. As shown in the table below, most price indices are highly correlated. We then decided to keep only the OSB panel price index, despite the good results also shown by the plywood panel price index in the table above. However, as shown below, OSB panel and plywood panel are highly correlated (0.81) and including both would have led to statistical problems.

Table 14: Univariate regression results, pulpwood and roundwood chips product

	output price of paperboard mills, Canada	output price of paper mills, Canada	output price of pulp mills, Canada	price of pulp and paper products, Canada	price of chips, Atlantic Canada	price of plywood panels, Ontario	price of OSB panels, Ontario	price of SW SPF lumber, QC	Lumber Price, US and CA East Mills, CAD
Output price of paperboard mills, Canada	1.00								
Output price of paper mills, Canada	0.36 0.14	1.00							
Output price of pulp mills, Canada	0.72 0.00	0.56 0.01	1.00						
price of pulp and paper products, Canada	0.82 0.00	0.78 0.00	0.88 0.00	1.00					
Price of chips, Atlantic Canada	-0.75 0.00	-0.30 0.23	-0.66 0.00	-0.69 0.00	1.00				
Price of plywood panels, Ontario	0.29 0.28	0.10 0.72	0.28 0.29	0.29 0.27	-0.50 0.05	1.00			
Price of OSB panels, Ontario	-0.03 0.92	0.08 0.74	0.21 0.41	0.15 0.56	-0.43 0.08	0.81 0.00	1.00		
Price of SW SPF lumber, QC	0.35 0.15	0.47 0.05	0.38 0.12	0.50 0.03	-0.61 0.01	0.74 0.00	0.65 0.00	1.00	
Lumber Price, US and CA East Mills, CAD	0.25 0.32	0.50 0.04	0.36 0.14	0.47 0.05	-0.60 0.01	0.79 0.00	0.76 0.00	0.96 0.00	1.00

Source: Deloitte Analysis.
Note: * Significant at 10%, ** Significant at 5%, *** Significant at 1%. For panel data methodologies with large number of observations, significance is typically assessed at 5% and 1%.

The next table presents the results of the regressions for the pulp model. These results are used to estimate the impact of explanatory factors on pulpwood and roundwood chips stumpage prices, using Eq. 6. As for the sawlog and studwood model, many explanatory variables are taken in log, for the same reasons as explained above, which is increased statistical performance and ease of interpretation.

The major drivers of pulp private stumpage prices are HHI (-0.56), which shows a statistically significant and negative coefficient, as expected. An increase in market concentration lowers private stumpage prices, an indication that market concentration is associated with bargaining power of the mills. The impact of HHI is also more prominent in the pulpwood regression than in the sawlog and studwood regressions, with a value almost twice as important as in the previous model. This will impact price deviation estimates calculated and reported in the next section, but is also intuitive. There are fewer pulpmills in New Brunswick than sawmills, and their operations are typically of a larger scale, given the sizable investments required to produce wood pulp. Since there are fewer larger players in the pulpwood and roundwood chips segment in the market, market concentration is higher than in the sawlog and studwood segment.

The second most important determinant of pulp private stumpage prices is the exchange rate (-0.22): an increase of 1% in CAD value against USD leads to a decrease of 0.22% in stumpage prices. Again, it is expected that when the CAD appreciates relative to USD, Canadian and New Brunswick wood become less competitive on US markets compared to US wood. This explains the negative coefficient associated with exchange rate: an appreciation of CAD leads to downward pressure on stumpages prices, given the decrease in US demand for Canadian wood.

As shown in the table, the coefficient on OSB panel price index (0.07) is positive and statistically significant, as expected. The OSB panel price index is a measure of the end market conditions for pulp and paper: an increase in demand from the end market leads to higher stumpage prices, reflecting tighter end market conditions. An increase of 1% in the end-product OSB panel price leads to an increase of 0.07% in stumpage prices.

The coefficient on total mill consumption (-0.03) is also statistically significant and negative in the pulpwood model, in contrast to the sawlog and studwood model, which is a less intuitive result. It may reflect increased competition and substitution of supply away from pulpwood towards sawlog and studwood in tight market conditions. For the negative coefficient associated with total mill consumption, an increase of 1% in consumption leads to a decrease of 0.03% in pulpwood and roundwood chips stumpage prices. While remaining statistically significant across all regressions, these coefficients vary more in value than corresponding coefficients in the sawlog and studwood model. The coefficient on the trucking rate (-0.07) remains negative, statistically significant and stable in the pulpwood model.

Compared to the sawlog and studwood model, the coefficient for frequency (-0.01) turns negative in the pulpwood model but remains statistically significant at the 5% threshold. One possible explanation for the change in sign may be that, given the relatively limited number of pulp mills in New Brunswick, asymmetry of information between mills and woodlot owners may be more limited. As such, transacting more frequently in the market may not provide the same benefit as for sawlog and studwood. Also, contrary to the previous model developed for sawlog and studwood, the contractor rate turns out not to be statistically significant in the pulpwood model.

As is customary for panel data regressions, and as was done for the sawlog and studwood model, a set of dummy variables was added to each market defined in section 4.2.2, as well as a constant. While these have limited statistical explanatory power by themselves, they are included to control for market-specific conditions that would not otherwise be modelled through other included variables. While it is also customary to include time-based dummy variables in panel regressions, it was decided to omit them in this case, given their high correlation with macroeconomic variables already included.

Table 15: Main equations including HHI, pulpwood and roundwood chips model

	(1)	(2)	(3)	(4)	(5)	(6)
ln (OSB CAD price)	0.06***	0.07***	0.06***	0.06***	0.05***	0.07***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
ln (Exchange Rate)	-0.40***	-0.36***	-0.34***	-0.31***	-0.24***	-0.22***
	(0.04)	(0.04)	(0.06)	(0.06)	(0.04)	(0.04)
ln (total mill consum)	-0.04***	-0.01*	-0.03**	-0.02*	-0.04***	-0.03***
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
HHI	-0.49***	-0.50***	-0.50***	-0.50***	-0.52***	-0.56***
	(0.02)	(0.03)	(0.05)	(0.05)	(0.03)	(0.04)
ln (Distance)			0.01	0.01		
			(0.01)	(0.01)		
ln (Frequency)				-0.02***	-0.01**	-0.01**
				(0.01)	(0.00)	(0.00)
ln (Trucking Rate)					-0.06***	-0.07***
					(0.01)	(0.02)
ln (Contractor Rate)						0.03
						(0.02)

	(1)	(2)	(3)	(4)	(5)	(6)
YSC SW		0.03	-0.10	-0.08	-0.12**	-0.05
		(0.04)	(0.07)	(0.07)	(0.06)	(0.06)
YSC and SNB HW		-0.03**	-0.06**	-0.06**	-0.01	-0.04**
		(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
NTH		0.05***	-0.14***	-0.13***	0.01	0.08
		(0.01)	(0.03)	(0.03)	(0.02)	(0.05)
CV		0.32***	0.25***	0.24***		
		(0.04)	(0.05)	(0.05)		
Constant	2.49***	2.13***	2.28***	2.33***	2.86***	2.55***
	(0.08)	(0.13)	(0.22)	(0.22)	(0.20)	(0.23)
Observations	8,600	8,600	4,242	4,242	6,452	5,842
Adjusted R-squared	0.13	0.16	0.18	0.19	0.11	0.13
BIC	6930.86	6610.73	4086.93	4078.75	4963.22	4259.10
AIC	6895.56	6547.20	4023.40	4008.87	4895.49	4185.70
Average VIF	1.19	5.00	3.86	3.59	5.56	5.75
Condition number	1.78	8.61	7.00	7.00	9.90	11.00
F p-val		0.00	0.00	0.00	0.04	0.01

Source: Deloitte Analysis.
Note: * Significant at 10%, ** Significant at 5%, *** Significant at 1%. White-robust standard deviations reported in parentheses. For panel data methodologies with large number of observations, significance is typically assessed at 5% and 1%. The model is estimated using OLS estimation with weighted observations. F p-value is the p-value of the F test of the joint statistical significance of the market dummy variables.

Again, Equation 6 appears as a preferred option over other regressions. It is comprehensive in terms of transaction-level variables and it is also among the best performers in terms of the AIC, although some models that include CV data perform better. Nevertheless, the exclusion of CV does not change the significance and magnitude of the comparable coefficients, as evidenced by a comparison of Equation 6 and Equation 4.

Similar to our sawlog and studwood model, we performed additional regressions to stress-test our pulpwood model behaviour under different specifications and estimation methods. Essentially, the purpose of the sensitivity analysis is to assess whether the results obtained from the main model change if different variables or different forms of variables (i.e. growth rate, level, log, etc.) are included. This is what is called "robustness check" of the model and is a standard procedure of model development. The results reported in the table below aim to validate our core modelling results and are not meant to provide additional or alternative interpretations to the factors impacting stumpage prices. Essentially, we tested the model's reaction to the addition of transaction volumes, different price indices among those identified at the beginning of this section, a change in dummy variables definition from markets to marketing boards and species separately as well as for estimation methods as highlighted in the sawlog and studwood section. Instruments used for the pulpwood model sensitivity analysis are distance and the Canadian pulp and paper price index with distance.

As shown in the table below, the coefficient for HHI does not show significant variations in its value, with the notable exception of the result in instrumental regressions. The coefficients for other key explanatory variables (OSB price index, total mill consumption and exchange rate) show more variations in magnitude than what was the case for the sawlog and studwood model. However, they generally remain statistically significant and of the expected sign, which generally reinforces our confidence in the results and conclusion, even though the magnitude of the impact of each variable on private pulp stumpage may show a wider potential range.

Table 16: Sensitivity analysis equations, pulpwood and roundwood chips model

	(6)	(1**)	(2**)	(3**)	(4**)	(5**)	(6**)	(7**)	(8**)
	OLS	**OLS**	**OLS**	**OLS**	**OLS cluster SE**	**2SLS**	**2SLS**	**OLS**	**OLS**

	(6)	(1**)	(2**)	(3**)	(4**)	(5**)	(6**)	(7**)	(8**)
ln (OSB CAD price)	0.07***	0.07***	0.03**	-0.02	0.07***	-0.02	0.04	0.08***	0.08***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.01)	(0.02)
ln (Exchange Rate)	-0.22***	-0.22***	-0.30***	-0.14***	-0.22***	-0.40***	-0.24***	-0.21***	-0.10**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.06)	(0.08)	(0.09)	(0.04)	(0.04)
ln (pulp and paper price)			-1.71***						
			(0.12)						
ln (paperboard mills price)				-2.21***					
				(0.12)					
ln (total mill consum)	-0.03***	-0.03**	-0.01	-0.01	-0.03**	-0.04*	-0.03	-0.03***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.00)	(0.01)
HHI	-0.56***	-0.54***	-0.47***	-0.49***	-0.56***	-0.79***	-0.36***	-0.50***	-0.71***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.09)	(0.09)	(0.03)	(0.03)
ln (Frequency)	-0.01**	-0.00	-0.01	-0.00	-0.01	-0.05**	0.08***	-0.01**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.02)	(0.02)	(0.00)	(0.00)
ln (Trucking Rate)	-0.07***	-0.06***	-0.06***	-0.05***	-0.07***	-0.25***	-0.16***	-0.08***	-0.03*
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)	(0.04)	(0.01)	(0.01)
ln (Contractor Rate)	0.03	0.03*	0.04**	0.05***	0.03	-0.11***	0.05	0.02	-0.06***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.02)	(0.01)
YSC SW	-0.05	-0.03	0.01	0.01	-0.05	-0.11	-0.10		
	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.12)	(0.13)		
YSC and SNB HW	-0.04**	-0.03*	-0.04**	-0.05***	-0.04*	-0.09**	0.10**		
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)		
NTH	0.08	0.10*	0.10**	0.13**	0.08	0.04	0.36***		
	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.08)	(0.08)		
Softwood									0.18***
									(0.02)
NTH MB									0.43***
									(0.05)
YSC MB									0.25***
									(0.01)
YSC MB & SW									-0.30***
									(0.06)
NTH MB & SW									-0.57***
									(0.09)
ln (Transaction volume)		-0.03***				0.12	-0.39***		
		(0.00)				(0.08)	(0.06)		
Constant	2.55***	2.53***	10.25***	12.79***	2.55***	3.78***	3.88***	2.41***	2.46***
	(0.23)	(0.23)	(0.58)	(0.59)	(0.26)	(0.42)	(0.50)	(0.13)	(0.21)
Observations	5,842	5,842	5,842	5,842	5,842	3,018	3,018	5,842	5,842
Adjusted R-squared	0.13	0.14	0.16	0.18	0.13			0.13	0.19
BIC	4259.10	4205.38	4050.66	3895.75	4259.10	4259.10	4259.10	4251.06	4055.04
AIC	4185.70	4125.31	3970.59	3815.68	4185.70	4185.70	4185.70	4197.68	3968.29
F p-val	0.01	0.03	0.02	0.00	0.10	0.00	0.00	0.00	0.00

Source: Deloitte Analysis.
Note: * Significant at 10%, ** Significant at 5%, *** Significant at 1%. White-robust standard deviations reported in parentheses. For panel data methodologies with large number of observations, significance is typically assessed at 5% and 1%. The model is estimated using OLS or 2SLS estimation with weighted observations. F p-value is the p-value of the F test of the joint statistical significance of the market dummy variables.

As for the sawlog and studwood model, we tested the sensitivity of our results to the distinction between species in our pulpwood and roundwood chips model. Two results that warrant attention are those of Eq. 8**. That regression was included to evaluate the impact of not distinguishing between hardwood and softwood by running different models for each, and rather treating them as part of the market definition detailed in the appendix. Hence, that equation includes a dummy variable for "softwood", that is equal to 1 if the transaction involved softwood and 0 otherwise, as well as dummy variables for the geographical markets, regardless of the species involved in the transaction. The coefficient for the "softwood" variable is positive and statistically significant in both equations, indicating a higher price for softwood relative to hardwood for pulpwood products. This is intuitive and was expected. In this case, other target coefficients (housing starts, HHI, trucking rate, contractor rate, mill consumption and frequency) do not change in sign, but they show

more variation in magnitude when controlling for hardwood and softwood rather than by markets, as defined for the purpose of the analysis. Despite this, we evaluate the model to be robust to both specifications, mainly because there are no counter-intuitive results obtained from changing our control variable from markets to species.

4.4.3 Models based on hardwood and softwood

The models we developed in this section are all product-based, i.e., distinguish between sawlog and studwood and pulpwood and roundwood chips products. However, they do not distinguish between hardwood and softwood within these product categories. There were two main reasons for this. First, the type of wood and the use made of it are closely related. Generally speaking, sawlog and studwood are made of softwood, while pulpwood and roundwood chips show more of a mix. Hence, by differentiating on a product basis, the models tend to also differentiate based on the type of wood.

The other reason relates to data availability. The relatively low number of transactions recorded using hardwood limited our capacity to perform more granular models. This was an especially important consideration for hardwood sawlog and studwood, where running a separated model would involve having only a few hundred observations in two markets: SNB (428 observations) and YSC (568 observations). While still possible to obtain statistical results on such limited number of observations, they would likely be volatile and sensitive to model specification, which may have undermined their accuracy.

Nevertheless, the question of whether wood type would impact the effect of market concentration on stumpage prices is legitimate. An effective way to test for this is to add a variable known as an interaction term between the wood type (hardwood/softwood) and HHI into each of the sawlog and studwood and the pulpwood and roundwood chips models. In short, the variable HHI-HW would take on the value of the HHI variable if the wood type is hardwood and 0 otherwise. Inversely, the variable HHI-SW would take on the value of the HHI variable if the wood type is softwood and 0 otherwise. This allows us to obtain a coefficient for the HHI variable that is specific to each wood type and product without having to run four different set of models (i.e., one per wood type and product type). As such, it allows us to achieve the desired result without compromising the quality of the statistical results due to the lack of data nor segmenting the dataset in two sub-samples (hardwood/softwood). The results of this analysis can be summarized as follows:

- Sawlog and studwood hardwood: small negative but not statistically significant coefficient, i.e., for hardwood saw material, market concentration is not a good statistical predictor of stumpage prices;
- Sawlog and studwood softwood: small negative and statistically significant coefficient (-0.25), i.e., for softwood saw material, market concentration has a small negative impact on stumpage prices, with a magnitude that is in line with the overall impact for both wood types taken together (-0.26);
- Pulpwood and roundwood chips hardwood: negative and statistically significant coefficient (-0.56), i.e., for hardwood pulp, market concentration has a negative impact on stumpage prices, with a magnitude that is the same as the overall impact for both wood types taken together (-0.56); and
- Pulpwood and roundwood chips softwood: negative and statistically significant coefficient (-0.44), i.e., for softwood pulp, market concentration has a negative impact on stumpage prices, with a magnitude that is lower than the overall impact for both wood types taken together (-0.56).

In summary, accounting for wood type in the models developed does not alter the results significantly, other than for hardwood saw material which becomes non-significant and softwood pulp that returns a slightly smaller coefficient than for the overall model. For the two other product and wood types (softwood saw material and hardwood pulp), once we take into account the standard deviation associated with each coefficient, there is no statistical difference between the disaggregated impacts and those calculated for the

overall model only based on product types. As such the impacts reported in the next section on the direction and magnitude of price deviations will use the coefficients listed above.

4.4.4 Crown wood supply regressions

Part of our modelling also involve attempting to assess the impact a change in Crown wood supply may have on private stumpage prices. The goal of this additional modelling exercise was to determine whether a change in AAC or in other determinants of Crown supply may influence private stumpage prices. Overall, we have not found empirical evidence to the effect that the share of crown wood relative to other sources has impacted positively or negatively private stumpage prices.

In order to perform this analysis, we tried several different variables of Crown wood supply. The different variables listed below were calculated for each product (softwood/hardwood), for each market and each year. We calculated the following variables:

- Crown wood consumption as a share of the total consumption of mills

  This variable captures demand-side impact of Crown wood on private stumpage price. This variable is calculated using TUS data on mills' consumption of wood from different sources.

- Crown wood supply as a share of the sum of Crown and private wood supply

  This variable measures competition between Crown wood and private wood on the supply side of the market. This variable is calculated using TUS data for private wood supply and Scale data for Crown wood supply.

- Crown wood supply as a share of the sum of Crown and private wood supply and consumption of imported and freehold wood

  This metric mixes consumption and supply data in the market, however it enables us to control for imported and freehold wood in the denominator. The metric is calculated using TUS data on freehold and imported wood consumption, TUS data on private supply and Scale File data on Crown supply.

We experimented with different variations of these variables in our preferred regression, as detailed above. However, there were several limitations to this analysis, in terms of data reliability, empirical results and interpretation of them.

The literature is relatively mute on whether the relative size of crown wood supply in a market affects private stumpage prices. We performed this analysis because changes in AAC and Crown wood supply was sometimes mentioned by some stakeholders as having an impact on private stumpage. However, supply of public wood per se is not a typical determinant of private stumpage in the literature on primary wood markets. Specifically, Klepacka et alt. identify a number of different factors, among which figure transportation and logging costs, economic and housing market cycles as well as manufacturing costs (and associated profits). In terms of regulatory factors impacting private stumpage prices, the paper highlights environment and land preservation policies and sales mechanisms among others. Finally, the authors list a number of characteristics specific to sales that may impact stumpage.[79]

There were also significant improvements to TUS data collection over the period of study, notably aligning measurement of TUS variables more consistently with deliveries of wood rather than wood consumption and aligning timing of the reporting with fiscal years. While data improvements are desirable over time, this also implies that the structure of variables using TUS is subject to changes during the analysis period. In addition to the change in TUS data measurement over time, our analysis also showed that the gap between scale data and TUS data narrowed very significantly over time. This makes using both sources together methodologically challenging, since some of the results may be driven by the closing of the measurement gap rather than by actual market conditions.

One main highlight of the table below is that the regressions using Crown supply variables are essentially using only two markets over 10 years of data. This, combined with the lack of variability of Crown supply across transactions, means there are only 20 observations available for modelling of Crown supply impacts. Typically, the Law of Large numbers requires a minimum of 100 observations to ensure reliable statistical results from regressions. This is a limitation that applies only to Crown supply regressions because other regressions exploit the full range of transactional details.

Table 17: Aggregated database, counts of observations with non-missing stumpage, contractor and trucking rates, by marketing board and product, for all years

Product	Marketing board	Counts
Pulpwood and roundwood chips	CV	0
Pulpwood and roundwood chips	NTH	70
Pulpwood and roundwood chips	SNB	3,767
Pulpwood and roundwood chips	YSC	2,005
Saw and Studwood	CV	0
Saw and Studwood	NTH	46
Saw and Studwood	SNB	5,703
Saw and Studwood	YSC	3,893

Source: Deloitte Analysis

The range of results from the models for Crown wood supply was significantly more volatile than for other variables, pointing to the lack of consistency in the modelling results for this variable. For this reason, we had no basis for favouring one of those models over another. In particular, the models were highly sensitive to the inclusion/exclusion of the beginning and end years of available data. This is due to the lack of sufficient observations described above: since there are a limited number of observations, the addition or inclusion of any data point weighed significantly on the results.

[79] Op. cit., note 18.

As such, we have not found empirical evidence to the effect that the share of crown wood relative to other sources has impacted private stumpage prices either positively or negatively. Given the limitations listed above, this document does not report specific results for our Crown wood supply analysis.

5 Synthesis of empirical analysis and industry information

This chapter summarizes our analytical findings, provides an interpretation of the results and places them in the broader context of New Brunswick's primary forest industry and other industries.

5.1 Description and structure of the primary forest products market in New Brunswick

The primary forest products market in New Brunswick is diverse and complex due to a number of factors beginning with the diversity of the natural resource endowment (i.e., the forest), as well as the complexity of the industry structure and regulatory framework.

The New Brunswick forest type involves a diversified set of species growing alongside each other in a more heterogeneous mix than usually seen in other parts of North America. The Acadian forest, which covers the vast majority of the New Brunswick territory, is characterized by up to 20 different species growing in the same areas, with approximately 60% being softwood and 40% hardwood. New Brunswick also has some boreal forest growing at the province's north western border with Quebec.

In addition to a heterogeneous species mix, the New Brunswick primary forest industry is also characterized by different types of land ownership, each of which is subject to different laws, regulations and policies. In terms of private ownership, a large number of private woodlot owners rely on and make use of relatively small woodlots, a large portion of which are only sporadically active in the wood industry. By contrast, large industrial forest products manufacturers also own land, referred to as industrial freeholds, and actively harvest wood from their lands. In terms of public ownership, the most significant area of land is owned by the Province of New Brunswick, while the federal government also owns small areas of land in the province.

Independent of land ownership, harvesting wood from the forest and bringing it to a mill to be transformed involves a number of activities that may be performed by different industry actors. Typically, the value chain of wood production involves:

- Harvesting, i.e., the activity of identifying timber, cutting it and bringing it to a loading area for transportation;
- Transporting, i.e., loading the wood from its harvesting location to the roadside (sometimes called "forwarding") and then onto a truck and for transportation to the buying mill;
- Contracting, i.e., identifying a buyer for the wood supplied and agreeing on the terms of the sale – a step which can also be done prior to or concurrently with harvesting and transportation; and
- Converting, i.e., manufacturing the timber into different converted wood products.

At each stage of the value chain, there are several industry actors that can perform a specific set of activities. Harvesting and transporting may be performed by the same (vertically integrated) contractor or separate contractors, including the woodlot owner. For example, contractors may either be independent of both the mill owner and woodlot owner; or they may be contracted to work directly for the mill owner. Similarly, truckers may be independent of the woodlot owner, contractor and the mill; or they may be subcontracting to the independent contractor (or the mill).

Private landowners can either harvest their own wood, hire an independent contractor to harvest it on their behalf or sell directly to a mill, in which case a mill-hired contractor harvests the wood on behalf of the mill. Outside of the latter case where a mill-hired contractor harvests the wood (i.e., direct-to-mill transactions), the private woodlot owner has three other options for selling the wood: (1) deliver it to the mill and obtain the mill gate spot price, (2) sell it through a marketing board contract with a mill, or (3) sell it to an independent contractor, who acts as an intermediary before reselling the wood to one or more mills. In all of these cases, the stumpage price received by the private woodlot owner is a market price, i.e., a price negotiated between entities acting on an arms' length basis (a seller and buyer which are independent and under separate ownership and control). There are many sellers of private wood as well as multiple buyers (i.e., contractors). However, there are typically only a limited number of end buyers or end users (or conversion facilities) to which any woodlot owner can sell their wood within their respective market area.

In the case of land owned by forest products manufacturers (industrial freehold), the landowner will most likely hire a contractor to harvest its wood and deliver it to one of its own forest products manufacturing facilities. In this case, the price exchanged between the selling landowner and buying mill is not a market price, but rather a transfer price between related parties. However, the forest products manufacturer which owns the land may also opt to sell its wood to a third party, either another landowner or a mill. In this case, the third party may hire a contractor to harvest and transport the wood to its mill. In this case, the price paid is a market price, (or a barter transaction on market terms), provided that the parties are independent in terms of ownership and control. However, this third-party transaction price is more akin to a mill gate price than to a stumpage price.

In the case of Crown Land, the government grants a license or a sub-license to a forest products manufacturer in exchange for a royalty in dollars per cubic metre, for each cubic metre harvested on its land. As per the current regulations, royalties must be based on the fair market value of the standing timber. However, Crown royalties are administered prices because the royalty rates are set by the government. Nonetheless, it is possible to set these Crown royalties at rates representing fair market values for the given species, based on the results of private stumpage surveys carried out by the Forest Products Commission.

On Crown Lands, a Licensee or a Sub-licensee will hire and pay a contractor to harvest wood on its License or Sub-license area. The contractor then delivers the wood to a mill owned by the Licensee/Sub-licensee, in which case the transaction is characterized as a transfer price since the License/Sub-license and the mill are owned by the same entity. If the contractor is asked to deliver the wood to a third party (i.e., a mill that is owned by a different Licensee/Sub-licensee), the transaction is a market price (or equivalent barter transaction) at the mill gate.

Several other features of the industry add to its complexity. Among these is the process for the allocation of Crown Licenses by the Government of New Brunswick. The Crown Licenses were assigned some time ago and or reassigned most recently as a result of structural changes in the sector. Licensees and Sub-licensees are required to harvest their annual wood allocation and meet other obligations relating to stewardship of the forest land. The Government of New Brunswick can increase the annual wood allocation (expressed as the "annual allowable cut" or AAC) as a policy lever to secure private sector investments in the province's mills – either to increase productive capacity or plant efficiency. For example, the Government of New Brunswick increased the AAC in 2014 primarily for softwood from four Crown Licenses in exchange for investment commitments from the relevant forest product manufacturers, as described in section 4.1.6. Another feature

of the New Brunswick forest products industry is its dependence on downstream markets for converted wood products which are mainly in the US. This also means that the New Brunswick primary forest products market is sensitive to US economic cycles, especially those driven by the US housing market. This was evidenced by the devastating impact of the 2008-09 recession on the industry, which was preceded by the sharp decline in the US housing market in 2007. Not only was there a precipitous drop in wood production and consumption across New Brunswick during this period, but the recession also resulted in a consolidation of the province's forest products manufacturing facilities.

At the same time, the industry has been subject to structural changes, some of which were caused by downstream markets. For example, long-term demand for softwood pulp has been steadily declining as the market for paper has been cannibalized by online publications. Other structural changes, such as the decline in the number of woodlot owners which harvest their own wood and the accompanying rise in the number of independent contractors over recent decades, are more localized in nature. However, in the case of both cyclical and structural changes in the New Brunswick forest product products industry, the Government of New Brunswick is not the initiator or driver of these trends. At most, it may be responding to some of the trends (as in the case of the 2014 increase in the AAC in order to secure additional mill investments).

5.2 Issues examined

This report addresses the following key issues in its synthesis of empirical analysis and industry information in the New Brunswick market.

First, we assess whether the private stumpage market in New Brunswick reflects a single, homogenous market or two or more distinct regional markets. A market is defined as unrelated buyers and sellers exchanging a given product (a wood specie) for a given price (or equivalent consideration) within a given geographic location. A defined market yields a set of market prices that are a crystallization of the supply and demand forces operating at a point in time and may be recognized as such by buyers and sellers of the good transacted. This does not mean that prices in the market need to be stable over time, but rather that transaction prices should accurately reflect supply and demand conditions, and changes therein, for the relevant product in the relevant area at a given point in time. As described below, we have identified six distinct marketplaces for private wood across New Brunswick.

Second, at the heart of the analysis in this report is the issue of whether the stumpage prices paid to private woodlot owners in New Brunswick are indicative of market prices (i.e. transacted private stumpage prices) that prevail in a competitive market (defined as a market with no concentration, no market power and prices at marginal cost). Several potential sources of deviations may exist in the market for private stumpage. Based on our assessment of the market and scope of work agreed for this report, we have examined in detail the concentration of ownership among the mills in the Province. The underlying theory is that concentrated ownership among the mills can lead to reduced competition for the purchase of private stumpage and hence, a reduction in private stumpage prices relative to competitive-market levels. We conducted the analysis based on the regional markets identified.

Third, we examined whether or not the New Brunswick private stumpage market has price deviations that are greater in magnitude than those found in North America and for similar industries. The idea here is that competitive markets are not common or prevalent in practice. Hence, the need to set the results of the price deviations for private stumpage in the wider context of price deviations found in other industries.

Fourth, we examined whether or not the increase in the relative importance of Crown wood observed in selected parts of the primary wood industry in New Brunswick over the last decade or so has had an impact on private stumpage prices in the Province.

5.3 Methodology

This section provides a summary of our analytical approach, database and statistical methodology, including:

- A summary of why a comparison of private stumpage prices in New Brunswick to those in neighboring jurisdictions was not deemed feasible;
- A summary of the process for defining the relevant market(s) for stumpage prices in New Brunswick;
- Preparation of the largescale microdata base; and
- Econometric modelling approach.

Comparison of New Brunswick stumpage prices to those in other jurisdictions

We examine each of these topics in turn, beginning with why we did not pursue a comparison of private stumpage prices in New Brunswick to those in other potentially comparable jurisdictions. There are several potential comparator candidates for the New Brunswick primary forest products market, including Nova Scotia, Maine, Quebec and British Columbia. Nova Scotia and Maine share similar forest composition, and are both geographic neighbours to New Brunswick. Quebec is also adjacent to New Brunswick and has a large forestry sector. Lastly, British Columbia has the largest forest products sector in Canada, with a large supply of softwood timber relative to other species.

While each of the jurisdictions reviewed has some similarities to the New Brunswick primary forest products market, we felt it was not possible to clearly identify and fully control for all the differences in regulation, wood species, wood quality and unit harvesting costs across any of these jurisdictions. Hence, we chose not to undertake a statistical comparison of private stumpage prices across jurisdictions, but focused instead on a time-series and cross-sectional analysis within New Brunswick, where the regulatory regime and market structure has remained largely unchanged over the last two decades.

Definition of private stumpage markets in New Brunswick

The starting point for the statistical analysis of the administrative datasets collected from marketing boards involved assessing whether the Province as a whole could be considered as a single, homogeneous market for private stumpage, or if the Province consists of several distinct markets. Interviews with various stakeholders suggested that market conditions vary significantly across the Province, and our initial analysis of transaction level data rejected the hypothesis that the entire Province can be characterized as a single market for private stumpage.

The market definition was a data-driven process, based on observed private stumpage transactions. The analysis was performed on available microdata for the period from January 1, 2010 to December 31, 2017 (i.e., post-recession to avoid major changes in industry structure over the time period). The key factors used to assess the geographic component of market definitions were as follows:

- The number of mills to which woodlot owners in each geographic zone (or "map tile") have sold their wood to, as an indicator of the selling choices available to sellers (referred to as "selling opportunities");
- The average distance in kilometres between the origin and destination of wood for individual deliveries weighted by volume; as a measure of the mills' catchment area (referred to as "distance"); and
- Access to export opportunities to mills in the US, Quebec and Nova Scotia.

In order to address the product dimension of market definition, we considered the first two factors for all private stumpage transactions, as well as for transactions involving softwood and hardwood separately. In addition, our analysis considered potential export markets for each marketing board area as well as proximity to the main road network to factor in differences in transportation costs and mill catchment areas.

Another dimension taken into account in market definition was the product type – both sawlog and studwood or pulpwood and roundwood chips. However, by taking account of the wood specie (softwood or hardwood), we in effect largely control for the product dimension in our analysis. This is because wood species and product type are highly correlated. In New Brunswick, about 83.2% of hardwood is consumed by pulp mills and 76.2% of softwood is consumed by sawmills, according to the TUS.

In summary, our preliminary analysis suggested that there are six distinct markets:

- The North Shore (NSH) market, which is primarily a hardwood market;
- The Carleton-Victoria (CV) market, a combined hardwood and softwood market;
- The Northumberland (NTH) market, a combined hardwood and softwood market;
- A single softwood market for the York-Sunbury-Charlotte (YSC) marketing board area;
- A single softwood market for the Southern New Brunswick (SNB) marketing board area; and
- A combined YSC/SNB market for hardwood.

Preparation of the largescale microdata base

The preparation of a microdata set of private stumpage price transactions was undertaken based on the legacy administrative data collected from the marketing boards. Six out of seven marketing boards provided access to their data, namely, North Shore Forest Products Marketing Board (NSH), Northumberland Woodlot Owners Association (NTH), South Eastern NB Forest Products Marketing Board (SENB), Southern New Brunswick Forest Products Marketing Board (SNB), York Sunbury Charlotte Forest Products Marketing Board (YSC), and Carleton-Victoria Wood Producers Association (CV). Data records from The Office de vente des produits forestier du Madawaska were not collected since these were in paper format only.

For each transaction, we asked the marketing boards to provide information on geographic origin of the wood in terms of the Parcel Identifier Number (PID), or an anonymized version thereof, the name of the mill where the wood was shipped, the specie, wood product, volume of wood, measurement unit, price, rates or values (stumpage, contractor, trucking, administration fees, mill gate), date of the transaction and transportation certificate number. The data request covered the 2000-2017 period.

A significant part of the database preparation involved standardizing the data obtained from the different marketing boards to ensure comparability and relevance to our analysis. One critical step in this preparatory work was to aggregate the data received to ensure that the data consisted of transactions. That is, a transaction was defined as all wood deliveries under the same negotiated stumpage prices (i.e., under the same contract). We avoided treating multiple wood deliveries as separate transactions. The marketing board database had 462,807 individual deliveries, after removal of redundancies and inaccuracies. Aggregation into transactions resulted in 101,258 records, with 28,377 of these with stumpage values and 72,881 without.

The last step in the data preparation involved weighting the subset of transactions with stumpage prices in order to ensure that this subset of data is broadly representative and not a biased representation of the overall marketing board transactions data collected.

To our knowledge, this is the first time such a database has been developed using legacy marketing board administrative and other data.

Econometric modelling approach

Our econometric modelling approach involved estimating a standard supply equation for timber, with stumpage prices as dependent variables and a number of explanatory variables. In other words, the econometric analysis was intended to explain variations in private stumpage prices both over time and across different markets. Three sets of explanatory variables were used: macroeconomic determinants,

transaction-level variables and potential sources of price deviations. The supply equation was estimated separately for (i) sawlog and studwood and for (ii) pulpwood and roundwood chips.

Several macroeconomic explanatory variables were considered. For the sawlog and studwood model, U.S. housing starts were retained as the macroeconomic variable with most explanatory power. For the pulpwood and roundwood chips model, the OSB panel price index and the exchange rate were retained as explanatory macroeconomic variables. These macroeconomic variables were chosen following several sensitivity analyses, including univariate regressions, correlation analyses and other sensitivity analyses.

The selection of the transaction-level variables was based on a different approach, given the limited number of variables. A specific-to-general approach was adopted, consisting of adding one transaction-level variable at a time and assessing changes in sign of the coefficients (i.e., direction of impact), magnitude and statistical significance. We also tested different specifications for some variables, such as substituting distance for trucking rate. The following transaction-level variables were added to our models: frequency of transactions, contractor rate and trucking rate. The dependent variable, stumpage prices, is also a transaction-level variable.

Finally, we added variables that allowed us to undertake a statistical assessment of our hypotheses regarding price deviations. For buyer market concentration, we relied on the Herfindahl-Hirschman Index (HHI) by defined market and by date (year) of the transaction. We also tested several variables capturing changes in the relative importance of crown wood supply by defined market as a possible contributor to price deviations (assuming substitutability between Crown and private wood sources).

5.4 Results of econometric and related analyses

The first part of our analysis sought to examine whether there is at least one defined market for privately harvested wood in New Brunswick, where a market is defined as unrelated buyers and sellers exchanging a given product (a wood specie) for a given price (or equivalent consideration) within a given geographic location.

As described above, the results of our analysis indicate that we have six distinct marketplaces for private wood across New Brunswick, as defined in Appendix A and further described in section 4.1.5. These markets for private wood are distinct not only in a geographic sense, but also in the sense of providing a potentially different balance of supply and demand for private wood; different selling choices for woodlot owners; different export markets and different approaches to wood harvesting (e.g., Madawaska has a higher proportion of woodlot owners harvesting their own wood). Our review indicates that private wood volumes (including exports) in each of the defined markets have tended to be very pro-cyclical over time. That is, private wood production has risen significantly during the cyclical upswing, when end market demand for wood products is rising, and has dropped significantly during downturns. This is the case for every defined market we examined above, with the exception of softwood pulp in YSC and SNB, where the impact of structural changes in downstream demand for wood has dominated any cyclical changes. Hence, this suggests that private woodlot production is very sensitive to changes in end market demand for wood products. It also implies that market prices for private stumpage are likely to incorporate the impact of changes in end market demand for wood products.

These markets have been subject to a number of structural changes over the decades, including a decline in the tendency of woodlot owners to harvest their own wood, and the increased prevalence of independent contractors, as well as other important changes driven by end market uses for converted wood products (e.g., the recent decline in demand for softwood pulpwood). All of these changes have affected the structure of the private woodlot markets, but the type of impacts differ. For example, the increased prevalence of independent contractors, who act as arbitrage agents in their respective markets (i.e., buying and selling wood to maximize their profits), have the effect of offsetting any price discrepancies and potentially even

increasing the geographic breadth of market as they search out profit opportunities. On the other hand, the decline in softwood pulpwood demand has had a major impact on softwood pulp volumes and prices.

Market Concentration Analysis

We conducted an econometric analysis to assess market concentration in the market for private stumpage in New Brunswick, and its potential impact on private stumpage prices in the six regional markets. We determined that the impact of market concentration resulted in price deviations for sawlogs and studwood (i.e., from -2.5% to -11.0%) that are much lower in magnitude than comparable deviations for the Canadian and US economies overall (53% and 78%, respectively), as well as comparable industries globally. In the case of pulpwood and roundwood chips, our analysis shows current levels of market concentration that are considerably higher than those exhibited for sawlogs and studwood. These higher concentration levels – when compared to those in competitive markets – result in larger price deviations (i.e. -14.8% to -38.4%) than for sawlogs and studwood, but these are still within the range of price deviations observed economy-wide in North America.

The two tables below report the results of price deviations due to market concentration. The first table reports the results for sawlogs and studwood by defined market. Column A shows the HHI index, which shows the degree of market concentration for each defined market in the last year for which market share data was available (2017-18). The higher the ratio, the greater the concentration levels. Column B shows the typical range for HHI in a competitive market. The difference between Columns A and B shows how the private stumpage markets in New Brunswick differ from the competitive ideal. For example, the YSC-SW and SNB-SW markets exhibit the largest departures from the competitive ideal in terms of market concentration on the buy side. When these differences in the HHI index are run through the regression equations for sawlogs and studwood, the resulting impacts on stumpage prices are shown in the last column. (Results are also differentiated for wood type – i.e., softwood and hardwood). Specifically, stumpage rates were 3.8% to 11.0% lower as a result of the higher market concentration (compared to an HHI benchmark of 0.15 for a competitive market); and 2.5% to 9.6% lower when an HHI competitive benchmark of 0.2 is used. However, it is important to place these results in context, because few markets approach the competitive ideal in practice. In fact, as discussed in section 2.5.4, the results of recent studies which examined price deviations across all sectors found price deviations in the order of 53% for Canada and 78% for the US respectively. In addition, price deviations in the US rose over time as well – from 18% in 1980 to 67% in 2014. By comparison, we consider the price deviations reported above to be very small in magnitude.

It is also worth noting that the levels of market concentration have changed significantly over time when compared to 2002-03 – rising in the case of NTH, YSC-SW and SNB-SW, but declining in the case of YSC-SNB-HW and unchanged for CV. We know that market concentration has generally risen in most sectors of the economy in Canada and in other developed economies, but this has not necessarily been the case in all private stumpage markets for sawlogs and studwood in New Brunswick.

Table 18: The implications of changes in market concentration for the stumpage rate: sawlog and studwood model

Market area	HHI 2002/03	HHI 2017/18 (A)	HHI Competitive (B)	Difference (A – B)	Coefficient	Impact on stumpage rate, %
CV – SW(*)	0.44	0.44	0.20 to 0.15	0.24 to 0.29	-0.25	-6.1 to -7.5
CV - HW(*)	0.44	0.44	0.20 to 0.15	0.24 to 0.29	Statistically not significant	N.A.
NTH – SW(*)	0.16	0.30	0.20 to 0.15	0.1 to 0.15	-0.25	-2.5 to -3.8
NTH – HW(*)	0.16	0.30	0.20 to 0.15	0.1 to 0.15	Statistically not significant	N.A.

YSC-SW	0.25	0.56	0.20 to 0.15	0.36 to 0.41	-0.25	-9.4 to -10.8
SNB-SW	0.26	0.57	0.20 to 0.15	0.37 to 0.42	-0.25	-9.6 to -11.0
YSC-SNB-HW	0.41	0.26	0.20 to 0.15	0.06 to 0.11	Statistically not significant	N.A.

(*) Note that CV and NTH are defined as two distinct markets, each comprising both softwood and hardwood. Hence, the HHI values for the softwood and hardwood components are identical for each market – i.e., these are two markets and not four. However, we reported the impacts on stumpage prices separately for softwood and hardwood, where the results are statistically significant.
Source: Deloitte Analysis.

The next table reports a similar set of results, but for our pulpwood and roundwood chips models. In this case, the HHI indices show considerably higher levels of market concentration than those exhibited for sawlogs and studwood. As a result, the impacts on price deviations are also considerably higher – with stumpage prices lower between 18.1% and 38.4% under the 0.15 competitive HHI threshold and between 14.8% and 35.5% lower with the 0.2 threshold. There are several points to consider about these results.

First, the magnitude of the price deviations remains well within the range of price deviations observed economy-wide across North America, as noted above, or in similar industries worldwide. For example, the average price markup found in the European industry of wood, paper products and printing sector ranges from 20% in France to 138% in Ireland.[80] Secondly, pulp mills have historically been much more capital intensive than saw mills, thereby drawing a greater share of wood in their respective market areas. This is also reflected in the fact that concentration levels did not rise by as much in relative terms between 2002-03 and 2017-18 when compared to the sawlog and studwood sector. In fact, market concentration actually declined slightly for two of the five markets examined over the period (CV and YSC-SNB-HW). Thirdly, the increase in market concentration over the period under consideration was driven by structural changes in the end-market demand for softwood pulpwood, which in turn led to the closure of pulp mills and higher market concentration in the affected market areas.

Table 19: The implications of changes in market concentration for the stumpage rate: the pulpwood and roundwood chips model

Market area	HHI 2002/03	HHI 2017/18 (A)	HHI Competitive (B)	Difference (A – B)	Coefficient	Impact on stumpage rate, %
CV-SW(*)	0.76	0.73	0.20 to 0.15	0.53 to 0.58	-0.44	-26.3 to -29.1
CV – HW(*)	0.76	0.73	0.20 to 0.15	0.53 to 0.58	-0.56	-34.6 to -38.4
NTH-SW(*)	0.53	0.71	0.20 to 0.15	0.51 to 0.56	-0.44	-25.2 to -28.0
NTH – HW(*)	0.53	0.71	0.20 to 0.15	0.53 to 0.58	-0.56	-33.1 to -36.9
YSC-SW	0.62	0.89	0.20 to 0.15	0.69 to 0.74	-0.44	-35.5 to -38.5
SNB-SW	0.51	0.88	0.20 to 0.15	0.68 to 0.73	-0.44	-35.1 to -38.1
YSC-SNB-HW	0.49	0.45	0.20 to 0.15	0.25 to 0.30	-0.56	-14.8 to -18.1

(*) Note that CV and NTH are defined as two distinct markets, each comprising both softwood and hardwood. Hence, the HHI values for the softwood and hardwood components are identical for each market – i.e., these are two markets and not four. However, we reported the impacts on stumpage prices separately for softwood and hardwood, where the results are statistically significant.
Source: Deloitte Analysis.

Notwithstanding the evidence of price deviations noted above, it is also important to recall that our review of the evolution of private wood volumes (including exports) in each of the defined markets (section 4.1.5) found that private wood supply in each of these markets has tended to be very pro-cyclical over time. That is, private wood production has risen significantly during the cyclical upswing, when end market demand for

[80] Chrysovalantis Amountzias. Pricing Decisions and Competitive Conduct across Manufacturing Sectors. 2019.

wood products is rising, and has dropped significantly during downturns. This is the case for every defined market we examined, with the exception of softwood pulp in YSC and SNB, where the impact of structural changes in downstream demand for wood has dominated any cyclical changes. This suggests that private woodlot production is very sensitive to changes in end market demand for wood products. It also implies that market prices for private stumpage are likely to incorporate the impact of changes in end market demand for wood products.

We also examined whether the relative importance of Crown wood in the defined markets had an impact on private stumpage prices. The empirical literature on the determinants of private stumpage prices is relatively mute on this issue. We did not find any explicit references indicating that changes in the relative importance of Crown wood supply (relative to other sources of wood supply) would be expected to have a positive or negative impact on private stumpage prices.[81] Yet, given that the relative importance of Crown wood supply increased over time in a number of the defined markets, including: NSH hardwood, the NTH market, the YSC softwood market and the SNB softwood market, as indicated in section 4.1, we proceeded to test whether we could identify any influence of this factor on private stumpage prices. We constructed several variables representing the relative importance of Crown wood supply, including:

- Crown wood consumption/total mill consumption;
- Crown supply (harvest)/(Crown wood + private supply); and
- Crown share of total wood supply.

We introduced these variables into the two stumpage price models discussed above and tested for alternative specifications. However, we could not find any evidence to the effect that this factor had a clear positive or negative impact on private stumpage prices in New Brunswick. We note that this finding may not be conclusive, but it is consistent with the literature on private stumpage prices.

[81] For example, see A.M. Klepacka et al. Stumpage prices: A Review of Influential Factors. International Forestry Review, vol 19(2). 2017.

6 List of acronyms

AAC Annual Allowable Cut
ADMT Air dried metric tonnes
AIC Akaike Information Criterion
BIC Bayesian Information Criterion
CAD Canadian dollar
CAGR Compound Annual Growth Rate
CV Carleton-Victoria Wood Producers Association
ERD New Brunswick Department of Energy and Resource Development
FFM Forest Management Manual
FMA Forest Management Agreement
FX Foreign and market determinants influencing terms of trade
GDP Gross Domestic Product
HHI Herfindahl–Hirschman Index
HW Hardwood
JDI J.D. Irving, Limited
LMF License Management Fee
MAD Office de vente des produits forestier du Madawaska
MB Marketing Board
MFBM (FBM) Thousand board feet
NAFP North American Forest Products
NSH North Shore Forest Products Marketing Board
NTH Northumberland Woodlot Owners Association
OSB Oriented Strand Board
PID Parcel Identifier Number
PWO Private Woodlot Owner
PWSS Private Woodlot Stumpage Survey
QA Quality and Assurance
SENB South Eastern NB Forest Products Marketing Board
SFJP Spruce, Fir, Jack Pine
SNB Southern New Brunswick Forest Products Marketing Board
SPF Spruce Pine Fir
SUB Price of potential substitute goods
SW Softwood
TC Transportation Certificate
TUS Timber Utilization Survey
UNEM Unemployment rate
USD United States dollar
VEP Volume of Each Product
YSC York Sunbury Charlotte Forest Products Marketing Board

7 Glossary

AAC Volume of timber allowed for harvesting from each Crown License annually. The volume is measured in cubic metre and set for five years periods

Acadian forest Dominant forest in the Province of New Brunswick

Administered price Stumpage price set by the Government of New Brunswick

Boreal forest within the larger boreal zone of Canada

Contractor Individuals or companies cutting stumpage and producing timber, working as intermediate between woodlot owners and mills

Cord Unit of measurement that corresponds to a well-stacked woodpile 4 feet (122 cm) high, 8 feet (244 cm) wide, and 4 feet (122 cm) deep; or any other arrangement of linear measurements that yields the same volume[82]

Crown Land means all or any part of the lands vested in the Crown that are under the administration and control of the Minister and includes any water upon or under the surface of such lands.[83]

Cubic metre Unit of measurement that corresponds to the volume of 1 metre high, 1 metre wide and 1 metre deep

Federal Crown Land An area of productive land, suitable for forestry owned by Canada

Forest land An area of land covered by at least 10% of tree canopy, spanning on more than 0.5 ha and with trees growing to a height of more than 5 metres[84]

Hardwood Trees whose leaves are not persistent and fall off at the end of a defined growing season or during a period of temperature or moisture stress. Also refers to the wood produced by these trees.[85]

Hectare Land measurement unit equals to 2.471 acres

Herfindahl–Hirschman Index Measure of the size of firms in relation to the industry and an indicator of the amount of competition among them

Industrial freehold Land owned by private forest products manufacturers

License A Crown timber license issued under section 28, and includes a timber license continued as a Crown timber license under subsection 27(4) [86]

Licensee The holder of a Crown License. Typically, a forestry company managing Crown Land for an agreed period of 25 years under provincial government oversight[87]

Log Trunk or large limbs of a felled tree. Used for log homes, solid wood and pulp products[88]

Lumber Wood processed in a sawmill[89]

Marketing board Wood producers organization formed in an area to sell their product

Primary forest products any unmanufactured product of forest trees of hardwood or softwood species, and wood chips and biomass produced at or on the harvest site, but does not include coniferous trees cut for sale as Christmas trees, and products from the sap of maple trees[90]

[82] Ministry of Forests and Range. Glossary of Forestry Terms in British Columbia. March 2008.
[83] Crown Lands and Forests Act, SNB 1980, c C-38.1.
[84] Natural Resources Canada. How much forest does Canada have?
[85] Natural Resources Canada. Glossary.
[86] Crown Lands and Forests Act, SNB 1980, c C-38.1.
[87] Idem.
[88] Natural Resources Canada. Glossary.
[89] Natural Resources Canada. Glossary.
[90] Forest Products Act, RSNB 2012, c 105.

Private woodlot All forest land except: forest land owned by the Crown; forest land owned by a person whose principal business is the operation of a wood processing facility, unless the main function of the wood processing facility is the production of wood chips and biomass at or on the harvest site; and forest land consisting of an aggregate area of at least 100,000 ha which is owned by the same person or persons[91]

Pulp mills Mills primarily engaged in manufacturing wood fibre into pulp

Pulpwood Logs or wood chips reduced to individual wood fibres by chemical or mechanical means for the manufacture of a variety of paper and paperboard products[92]

Royalties The amount prescribed by regulation that is payable to the Crown for timber harvested on Crown Lands, or for any other resource prescribed by regulation that is extracted, harvested or taken from Crown Lands[93]

Sawmills Mills primarily engaged in converting logs and studwood into lumber products

Silviculture Practices aimed at ensuring wise harvesting of forest resources: conservation, regeneration, reforestation, cutting, etc.[94]

Softwood Coniferous trees, usually evergreen having needles or scale-like leaves[95]

Species Group of individuals that possess common characteristics and are capable of producing fertile progeny[96]

Stumpage Price paid for a standing tree

Sub-license a Crown timber sub-license issued under section 41 of the Act.[97]

Sub-licensee The holder of a Crown timber sub-license

Timber all trees of any species or size whether standing, fallen, cut or extracted [98]

Transfer price Price at which a division from a company sells goods and services to another division of the same company

Trucker Individuals or companies loading the wood from the roadside, delivering it to the mill gates, producing, and delivering the Transportation Certificate

[91] Idem.
[92] United States Department of Agriculture. Definition of Terms.
[93] Crown Lands and Forests Act, SNB 1980, c C-38.1
[94] Natural Resources Canada. Glossary.
[95] United States Department of Agriculture. Definition of Terms.
[96] Natural Resources Canada. Glossary.
[97] Crown Lands and Forests Act, SNB 1980, c C-38.1
[98] Crown Lands and Forests Act, SNB 1980, c C-38.1

Appendix A: Data sources and data preparation

Qualifiers to this analysis

Data sources

Marketing boards

Deloitte worked with seven New Brunswick Marketing boards in the province to acquire transactional data from their operations, i.e., a set of information for each transaction in which a marketing board or a mill was involved. This data has been used extensively in our analysis, for the following purposes: weighting of data, market definition, and econometric analysis and modelling presented in section 4.2 of the report.

For each transaction, marketing boards were requested to provide information on geographical origin of wood in terms of Parcel Identifier Number (PID), name of the mill where the wood was shipped, specie, wood product, volume of wood, measurement unit, price rates or values (stumpage, contractor, trucking, administration fees, mill gate), date of the transaction and transportation certificate number. The data was requested for as long period as possible, typically the 2000-2017 period.

Six out of seven marketing board provided access to their data, namely, North Shore Forest Products Marketing Board (NSH), Northumberland Woodlot Owners Association (NTH), South Eastern NB Forest Products Marketing Board (SENB), Southern New Brunswick Forest Products Marketing Board (SNB), York Sunbury Charlotte Forest Products Marketing Board (YSC), and Carleton-Victoria Wood Producers Association (CV). We did not use data of The Office de vente des produits forestier du Madawaska because the Board keeps records of transactions in paper form.

However, systems transition over the time period covered impaired the capacity of some marketing boards to provide uniform data sets. In some instances, geographical localisation and some input prices were not tracked consistently across the full period. In other instances, marketing boards were not able to provide data for the full time period requested, for example because of a transition from paper to electronic data collection in the 2000-2017 time span. The table below provides a summary of data provided by each marketing board.

Table 20: Data received from marketing boards as of March 29, 2019

	NSH	YSC	NTH	SNB	SENB		CV
Period covered	**2017–2018**	**2000–2018**	**1999–2018**	**2000–2018**	**2003–2017**	**2017–2019**	**2003–2017**
Date of Transaction (payment or scaling)	✓	✓	✓	✓	✓	✓	✓
Product	✓	✓	✓	✓	✓	✓	✓
Species	✓	✓	✓	✓	✓	✓	✓
Volume	✓	✓	✓	✓	✓	✓	✓
Measurement unit	✓	✓	✓	✓	✓	✓	✓
Mill gate value/rate	✓	✓	✓	✓	✓	✓	✓
Trucking value/rate		✓	✓	✓	✓		
Contractor value/rate		✓	✓	✓	✓		
Stumpage value/rate		✓	✓	✓	✓		✓
Marketing board fees		✓	✓	✓	✓		
Mill	✓	✓	✓	✓	✓	✓	
Map tile*	✓	✓	✓	✓		✓	✓
Anonymized PID*	✓	✓	✓	✓		✓	✓
number of observations**	8,976	191,044	111,092	222,932	83,496	5,116	92,487

Source: Deloitte analysis, based on data provided by marketing boards.
Note: * Map tile and Anonymized PID were created by the New Brunswick Forest Product Commission using PIDs included in marketing boards' datasets. Deloitte provided methodological guidelines for this work but did not have access to PIDs, except from SNB (however, the SNB dataset used in the analysis included only anonymized PID). See Data Preparation section below for more details.
** Observations in this table include transactions identified by transportation certificate, load slips or invoice numbers but may also include adjustments (e.g., additional payments or corrections) for some other transactions. The number of observations reported in this table is the counts of rows in the datasets received from the marketing boards excluding duplicates, i.e., identical rows. See Data Preparation section for details.

Forest products mills

In addition to marketing boards, Deloitte also reached out to most mills with operations of regional importance in the province. The data request was similar to what was asked from marketing boards, i.e., providing transactional data on geographical origin of wood in terms of Parcel Identifier Number (PID), name of the mill where the wood was shipped, specie, wood product, volume of wood, measurement unit, price rates or values (stumpage, contractor, trucking, administration fees, mill gate), date of the transaction and transportation certificate number. The data was requested for the 2000-2017 period. Mill provided data was used in a number of our analyses, including for comparative and preliminary triangulation purposes (section 4.2.1) and for stumpage prices analysis (section 4.4).

Mills covered by our data request represented almost 95% of mill buying activity in terms of 2017 volumes. The table below provides an overview of key variables available in the datasets provided by mills.

Table 21: Data received from mill as of Feb 27, 2019

	Crabbe and Sons	Delco	NAFP	Fornebu	JDI	Twin Rivers	Chaleur	Arbec	AV Group	Group Savoie
Period	**2006–2019**	**2008–2017**	**2018**	**2010–2018**	**2006–2017**	**2011–2018**	**2014–2018**	**2012–2019**	**2008–2019**	**2018–2019**
Transaction-level data	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Private transactions	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Crown transactions		✓		✓	✓	✓	✓			
Freehold transactions		✓	✓	✓	✓	✓				
Date of scaling		✓	✓	✓	✓	✓	✓	✓	✓	✓
Product		✓	✓	✓	✓	✓	✓	✓	✓	✓
Species			✓	✓	✓	✓	✓	✓	✓	✓
Volume	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Measurement unit	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mill gate value	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trucking value		✓				✓				
Contractor value		✓								
Private stumpage value					✓					
Marketing board fees						✓			✓	
Mill	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Private PID				✓	✓		✓	✓		
Marketing board	✓		✓		✓	✓		✓	✓	✓
Gross number of observations	5,803	43,258	2,937	72,453	706,184	124,921	166,634	45,570	65,525	791

Source: Deloitte analysis, based on data provided by mills.
Note: Fornebu also provided an additional file of aggregated data. To ensure comparability, only transactional data characteristics are reflected in the table above.

Private Woodlot Stumpage Survey

The project also used transactional data from the Private Woodlot Stumpage Survey conducted by the New Brunswick Forest Product Commission. Dataset from this survey was provided by the Government of New Brunswick for the 2014-2018 period and included more than 60 thousand transactions. The Private Woodlot Stumpage Survey data was utilized for comparison and validation of our dataset (section 4.2.3) and for stumpage prices analysis (section 4.4).

Timber Utilization Survey

Another significant source of data for the purpose of the analysis presented in this report is the Timber Utilization Survey (TUS) conducted annually by the New Brunswick Department of Energy and Resource Development. This survey tracks the volume of wood production in the province, from the landowner

(including land ownership type) up to the end market product (i.e., products of different mills), i.e., from timber consumption to wood products manufacturing. TUS data was used in the following analyses: macroeconomic determinants of New Brunswick primary wood industry (section 2.5) and TUS data analysis (section 4.3). It was also used as an input to generate data such as HHIs by geographical areas and products as well as identifying entries/exits from the wood industry for different products, which fed into our econometric analysis (section 4.2.5).

This survey is essentially a census of large mills sourcing wood from Crown Land. It includes mills sourcing more than 500 cubic metres of wood from Crown Lands. Therefore, the survey does not include small mills and some larger mills that do not source wood from Crown Land. Nevertheless, it captures almost all wood consumption in the province. The volume of wood produced but not captured in TUS is deemed to be marginal by the Government of New Brunswick.

TUS data was used to calculate the Herfindahl-Hirschman Index, a metric of market concentration, for the econometric analysis. TUS data was also instrumental in our analysis of the NB primary wood industry. TUS data was used for the following purposes:

- Map the overall structure of the industry as this survey shows flows of wood from sources to all large mills for different species and products;
- Assess which mills were active on an annual basis and to identify mill closures over time -- this analysis helped to develop mill classification in the preparation of transaction-level data, identification of local markets, analysis of concentration of consumption on certain mills;
- Analysis of the dynamics of the primary forest products market – in the econometric modelling, this analysis helped to test changes in market conditions; and
- Analysis of the structure and dynamics output of mills.

The wood consumption data in the TUS dataset provided to Deloitte covers the period from 2000 to 2017. There was a significant shift in the industry as the number of mills covered by the survey decreased from 65 to 36 over that period.

While export transactions are not covered by TUS, the Government of New Brunswick provided Deloitte exported data on volume over the 2008-2018 period, following the TUS data structure. This export data complemented the TUS data to provide more accurate statistics of volume of production of primary forest products shipped to mills in the province, to other provinces and the US.

Crown wood supply data

The Department of Energy and Resources Development (ERD) also provided Deloitte with a file of transaction-based data on Crown wood supply from 2004-2005 to 2017-2018. This dataset comprised extensive data on source of Crown wood supply, destination of delivery, as well as species and products delivered. This data was used as an input to our econometric analysis (section 4.2.5), to develop a number of different measures of Crown wood supply to be included in our regression analysis.

Macroeconomic data

In addition to transaction-level data, we augmented the econometric analysis database with macroeconomic variables deemed of interest because of their impact either on the sawlog or pulp market, as demonstrated in the macro-economic environment section above. For the sawlog market, our understanding from our exchange with the industry is the market is regional, across North Eastern America, i.e., Maine, Nova Scotia, Quebec and New Brunswick. In the case of pulp, however, the market is global with pulp being shipped to US, Asia and Europe. As such, some global macro-economic indicators have been included as well. Macro-economic indicators also include wood end product price indices for the relevant markets. In each case, we collected data at the lowest possible frequency in terms of time, to match the transactional nature of the industry data as much as possible. The table below lists macroeconomic variables and their sources

Econometric Analysis of Stumpage Prices

Marketing board data preparation

As detailed above, data used for the purpose of conducting this review comes from a wide array of sources, including operational transaction-level data of marketing boards. This data was not originally recorded by mills and marketing boards with the purpose of performing statistical analysis and modelling. As such, data needed extensive review and preparation in order to ensure its accuracy and relevancy to the modelling performed as part of this project.

The data preparation steps undertaken can be summarized under the following areas:

- Anonymization of the origin of wood (PID);
- Standardization of measurement units, product and species names, destination mill names;
- Alignment of data fields;
- Removal of redundant and unreliable observations;
- Aggregation of data to reflect contractual transaction (as opposed to deliveries);
- Data weighting to make it representative of the population; and
- Calculation of distances from wood origin to destination mill.

Anonymization of the origin of wood (PID)

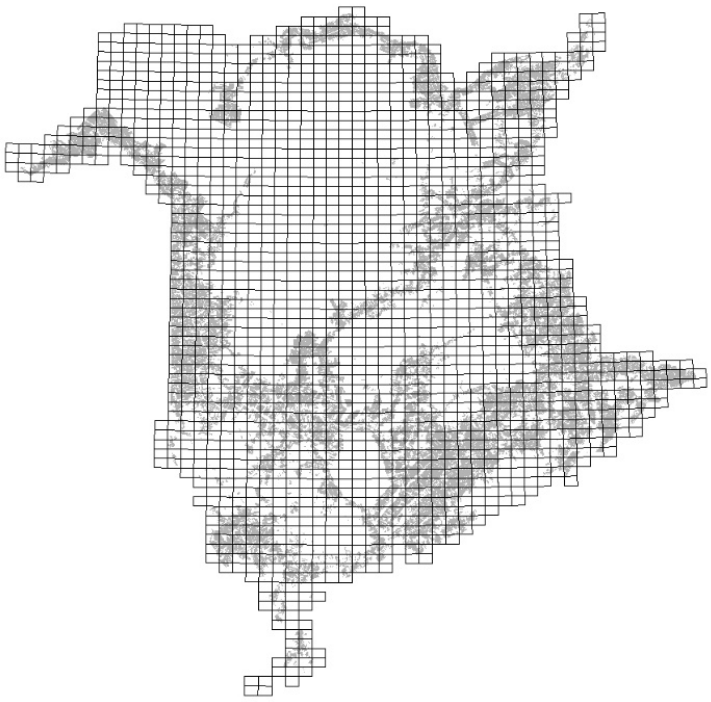
As stated in previous sections, there are more than 40,000 private woodlot owners in New Brunswick, making them relatively small industry agents, in terms of volume of production and of individual land area occupied. This specific aspect of the industry structure raised early on the question of confidentiality of the inputs provided. At the data collection stage of the project, some industry players required that inputs from individual woodlot owners be made anonymous in order to acquire their agreement to share the transactional data. As such, Deloitte and ERD worked jointly to develop an anonymization process that would allow to retain sufficient geographical information for the econometric analysis to be relevant while also responding to the industry's considerations. The methodology adopted is described as follows:

- Each PID was grouped into 1,899 larger map tiles containing an average of 84 PID each (average size of tile being 5.6 X 7.6km (4275 ha). The number of PID by map tile varies between 1 and 468. The figure below illustrates map tiles distribution across New Brunswick's territory;
- ERD produced a lookup table linking each PID to the corresponding map tile and provided this lookup table to the New Brunswick Forest Product Commission. To protect confidentiality of information, Deloitte was not provided the lookup table;
- Marketing boards sent their original data to the New Brunswick Forest Product Commission;
- On reception of a marketing board dataset, NB Forest Product Commission used ERD's lookup table to link PIDs to map tiles;

- NB Forest Product Commission also generates a unique random and non-geolocated unique identifier for each PID to differentiate the activities of different woodlot owners without sacrificing from data privacy;
- Once the map tile link established and the unique identifier generated, the NB Forest Product Commission performed a quality assurance process to ensure all tasks performed provided the expected result. On successful completion of this QA step, NB Forest Product Commission then erased PIDs from the dataset and send it to Deloitte; and
- Upon reception of the anonymized dataset, Deloitte performed an additional QA process to ensure compliance with its data quality standards.

This process was retained for several reasons. First and foremost, it complied with the requests of industry to keep individual private woodlot owner information confidential. It also reached several desirable outcomes from an analytical perspective. On one hand, the map tiles were small enough to keep the geographical information relevant to the planned modelling of the data. On the other hand, the unique identifier also provided a view on a group of transactions from the same seller to analyze the extent of diversification this seller had in terms of options for buyers. However, because the link between map tiles and unique ID was the PID, and the PID was erased from the dataset, the two could not be linked and, as such, specific information of private woodlot owners was kept confidential.

Chart 62: Map tiles distribution in New Brunswick's territory



Source: Government of New Brunswick, Department of Energy and Resource Development, 2019.

Data standardization: species, products, mill, and volumes

On reception of the anonymized datasets, and following due diligence on data quality, Deloitte started the data standardization process. Data received showed numerous inconsistencies across data providers. For example, the species and products are not coded the same way across marketing boards and mills. The same also applies to unit of measurement – volume of wood can be measured in different units (cords, FBM,

cubic metres, etc.) The conversion factors that help to convert from one unit into another vary by species and product.

Deloitte worked closely with each mill and marketing board to acquire a detailed understanding of the data provided. This process involved a number of iteration with each of the mills and marketing boards, where questions were sequentially submitted and answered. Once Deloitte acquired sufficient understanding of the data acquired, it worked with the NB Forest Product Commission to apply knowledge from the overall industry perspective on the data received.

On completion of this review and knowledge acquisition step, the Deloitte team proceeded to standardization. Every marketing board has a different products/species codes recorded in their systems. As such, they needed to be decoded and standardized, so the same product/species are recoded following a consistent convention.

Species and products were classified in several groups listed in the table below. Those groups were created based on a) the review of the data in TUS that showed which species and products are most important from the commercial perspective b) feasibility given the classification in the marketing boards datasets – if some species and products were grouped together, e.g., Red and Jack Pine, in marketing board or mill datasets we included them together in our groups. The same process was applied to the classification of products. Standardized detailed products were classified into three larger groups: 1) Saw and Studwood; 2) Pulpwood and roundwood chips; and 3) Other. The classifications were reviewed by the ERD.

Table 22: Product and species classifications for marketing boards and mills data

Species group	Share in 2017 consumption in TUS
1. Spruce, Fir, Jack Pine, White Pine, Red Pine	62.8%
2. Cedar	2.8%
3. Other softwood	2.1%
4. Poplar	8%
5. Other hardwood	24.2%
6. Mixed	0.1%

Product groups	Share in 2017 consumption in TUS
1. Saw and studwood	62.5%
2. Pulpwood and roundwood chips	37.4%
3. Other	0.2%

Source: Deloitte analysis, based on 2017 Timber Utilisation Survey.

Similarly, in the original data, destination mills' names are recorded with various coding conventions by different marketing boards. In order to standardize the mills names, an iterative process was conducted and mills names were recoded following a consistent convention across all data sources.

Finally, different transactions were recorded using different measurement units commonly used by the industry, such as tons, cubic metres, thousand board feet, etc. Measurement unit conversion factors from a unit to another were used to denominate all transactions in a unique measurement unit. In order to do so, we collected measurement unit conversion factors from the Forest Products Commission as well as from some marketing boards. In some instances where a conversion unit was not available for a specific pair of units in a specific marketing board, we developed a conversion factor based on assumptions drawn from

other similar conversion factors. For the purpose of this report, it was decided cubic metre was the appropriate measurement unit to be used.

Alignment of data fields

Another aspect of data preparation related to the nature of data fields collected. Once we confirmed the nature of the data received from each source and ensured their uniformity at the transaction level, we worked on aligning variables definitions, i.e., ensuring that all variables collected from different sources had comparable definitions. One example of this may be the definition related to trucking rates. Some marketing board may record trucking rates as total cost of trucking or others as cost per cubic metre. Deloitte ensured that all variables included in the database had a comparable definition as much as that was feasible given available information. Some inconsistency may remain.

Removal of redundant and unreliable observations

The next step in the data preparation process involved sorting through existing transactions and identify redundant, inaccurate or irrelevant observations. The identification of redundant transactions included:

- *Removing individual PIDs linked to multiple tile maps.* Because of the structure of ownership of some PIDs, notably with ownership of roads and other infrastructure, some PIDs were linked to more than one map tile. This multiplied the number of transactions, since each map tile referenced led to the recording of a transaction, even though only one transaction really occurred. As a business rule, within the duplicate records, the record with smallest map tile number is considered as a representative for that woodlot and all other duplicated records are removed;
- Data received from some sources included exact duplications and blank rows which were deemed to be data redundancies during the data preparation process. Those duplicate records are filtered out from the analysis; and
- Some marketing boards recorded the adjustments/corrections in their data as separate records (with negative volumes and prices). These records were filtered out from the data as these adjustments/corrections are recorded for operational purposes and are not representative of the buying and selling intentions through the transaction. We also removed the original transaction record, as it was not possible to distinguish original transactions from potential positive value adjustments.

The table below shows the rules applied for each marketing board for identifying the redundant and unreliable information:

Table 23: Identification of redundant and unreliable rules, by marketing board

Marketing Board	Rules
NSH	All records of a single slip number for which at least one of the records has negative values of quantity or any of the price rates
YSC	All records of a single slip number for which at least one of the records has negative values of quantity or any of the price rates
NTH	All records of a single slip number for which at least one of the records has negative values of quantity or any of the price rates
SNB	1. Transportation certificate is blank/missing 2. All records of a single transportation certificate for which at least one of the records has negative values of volume or negative values of any of the price rates
SENB (2003-2017)	All invoices that have more than 1 record (e.g., if invoice repeats several times, set adjustment=1 for all records of that invoice, not just for duplicates), except when a stumpage rate is recorded for each observation.
CV	All records of a single slip number for which at least one of the records has negative values of quantity or any of the price rates

SENB (2017-2019)	All records of a single slip number for which at least one of the records has negative values of quantity or any of the price rates
NTH (2000-11, 2014-18)	All records of a single slip number for which at least one of the records has negative values of quantity or any of the price rates

Inaccuracies identified represented a relatively marginal number of observations and for the most part revolved around the following reasons:

- Miscoding of some product types: some products showed a coding that could not be interpreted;
- Some records that could not be matched with an anonymized PID, destination mills, unit of measures are filtered out as their origin information could not be captured in the original data provided; and
- Transactions with no volumes.

Further analysis following the steps described above highlighted the presence of values for some variable that had limited explanatory power for the purpose of this analysis and/or were apparently counter-intuitive to a rational commercial behaviour. Those abnormal values included, for example: stumpage price and mill gate prices beyond values reasonably expected, volumes beyond reasonably expected values, etc. These observations, albeit small in number, were having a disproportionate effect on the distribution of observations for our variable of interest.

We attempted at remediating those observation by using standard distributional outliers filtering methods, including methods based on inter-quantile calculations. However, the impact of those observations on the distribution was sufficiently significant to remain present after those methods were applied. As such, we applied the following filtering rules:

- Remove observations with values below the first percentile and above the 99th percentile for stumpage price, contractor rate, trucking rate and mill gate price, across species and products; and
- Remove observations where volume is above the 99th percentile of volume distribution.

While not as specific as standard inter-quantile outlier identification approaches, these filtering rules had the desired effect of removing extreme values while also minimizing the number of observations removed.

All redundant observations were removed from the database in order to avoid double counting and bias in the analytical results. As for inaccuracies, Deloitte worked with data providers and the NB Forest Product Commission to resolve and keep as many observations as possible, as well as to validate its assumptions in terms of rates, prices and volumes that constituted abnormal values. All irreconcilable inaccuracies and abnormal values were removed from the database, but those represented a very marginal number of observations.

Another source of data attrition was an operational decision to focus the analysis on the bulk of the market transactions, and exclude transactions that were composed of species and products accounting for a marginal amount of volume produced every year. While the analysis may lose in terms of granularity from such a decision, it also gains in accuracy and the precision of the results obtained. While these transactions may not be material to the market interactions, their impact on the modelling results may be magnified and, as such, induce a bias in the conclusions reached from the statistical analysis.

As such, it was decided to limit the statistical modelling to transactions involving:

- Hardwood or softwood (i.e., exclude mixed species); and
- Sawlog and studwood or pulpwood and roundwood chips (i.e., exclude all other products).

Standardization all mills' names was not feasible due to the large number of different combinations present in the datasets received. Standardized mill names were important to identify mills of destination, as well as to calculate distance between where the wood was harvested and where it was delivered. Our descriptive analysis using TUS data allowed to establish that the top 25 producing mills in 2017 accounted for 84% of the total purchase of wood. As such, in regressions that make use of the variable Distance, as well as for markets' definition, we decided to analyze only transactions involving those mills. We reviewed the production data of mills and ensured that this selection of mills was representative of mill ownership groups, species (hardwood versus softwood) and geographic regions. The table below lists the mills that were included in our analysis.

- Arbec Forest Products;
- AV Cell Inc.;
- Chaleur Sawmills Associates;
- Delco Forest Products Ltd.;
- Devon Lumber Co. Ltd.;
- Eric Goguen & Sons Ltd.;
- Flakeboard – St. Stephen;
- Fornebu Lumber Company Inc.- Bathurst Sawmill;
- Groupe Savoie Inc.;
- H. J. Crabbe & Sons Ltd.;
- JDI – Chip Plant – Sussex;
- JDI – Grand Lake Timber;
- JDI – IP&P;
- JDI – Russell & Swim Mill;
- JDI – Sawmill – Sussex;
- JDI – St. Leonard;
- JDI – Utopia Mill;
- JDI (Doaktown);
- JDI Veneer;
- Junction Lumber Products Inc.;
- Littles Lumber (Ashmore – Harvey);
- North American Forest Products (NAFP);
- Shaw Resources;
- Twin Rivers Paper Company Inc. – Edmundston Mill; and
- Twin Rivers Paper Company Inc. – Plaster Rock Mill.

The different data cleaning and preparation methods applied to this dataset resulted in and attrition of 6% of the gross number of observations. The next table summarizes the data removed because of redundancy and inaccuracy.

Table 24: Data attrition due to redundancy, inaccuracy and marginal species and producers

	SNB	SENB (2017-2019)	SENB (2003-2017)	YSC	NTH (2012-2014)	NTH (1999-2011 2014-2018)	NSH	CV
Gross number of observations	231,477	5,117	83,123	249,498	7,173	105,560	8,976	92,511
Redundancies identified & removed (duplicates and adjustments)	57,046	910	20,311	59,204	1,641	6,331	0	24
Irreconcilable inaccuracies (removed) (no map tile or destination mill, no product name, only positive volumes)	11,710	4,206	62,812	67,339	525	23,126	6,483	43,900
Net number of observations	162,712	1	0*	122,995	5,007	76,103	2,493	48,587
Net observations as % of gross	70.3	0.0	0.0	49.3	69.8	72.1	27.8	52.5

Source: Deloitte analysis.
Note: * SENB (2017-2019) dataset contains anonymized PID information but no stumpage, SENB (2003-2017) contains stumpage but not the anonymized PID information. Therefore, in the data aggregation, this data set resulted in zero records.

Calculating distance between mill and map tiles

The distance between each mill and map tile was calculated using the straight line distance between the mill and each map tile centroid. The map tile centroid, or geometric center of the tile, served as a proxy to determine the average distance to each mill for PIDs within a given map tile. The straight line distance was computed using the Haversine formula, which determines the shortest distance between two points on a sphere based on their latitude and longitude coordinates.

Observations aggregation

The original data received was arranged by transportation certificate (TC) or slip number, which corresponds to deliveries of wood. Each delivery date was also provided. The first step of aggregation was then to re-arrange the chronological sequencing around the fiscal year, from April to March, since this chronology corresponds more closely to the wood harvesting season.

Since it was likely more than one delivery per season occurred under the same contract, and those stumpage prices are determined at the contracting stage rather than at the delivery stage, the final step of aggregation was to group deliveries of wood in what was more likely to correspond to contractual agreements between a wood producer and a mill. In order to do so, we established a number of rules to group observations.

Species were also aggregated. Following the nomenclature presented in table 8 above, we grouped "Spruce, Fir, Jack Pine, White Pine, Red Pine", "cedar" and "other softwood" in the "Softwood" broad specie. Similarly, we grouped "poplar" and "other hardwood" under the broad specie "Hardwood". The "mixed" category was discarded from observations.

Still following the nomenclature showed in table 8, and for the purpose of the analysis detailed in following sections, the category "sawlog and studwood" was used for the "Sawlog" product variable, while the category "Pulpwood and roundwood chips" was used for the "pulpwood" variable. The category "other" was discarded. Those groupings were discussed and validated with the New Brunswick Forest Products Commission.

Before aggregating the observations, we ensured that the transactions:

- Originated from the same anonymized PID and were delivered to the same mill;
- Involved the same specie (hardwood or softwood);
- Had the same type of product (sawlog and studwood or pulpwood and roundwood chips);
- Occurred in the same fiscal year;
- Had the same county; and
- Had the same stumpage rate (rounded to the dollar).

When numerical variables for the different deliveries to be grouped were not of the same value, for example sometimes contractor rate differed from a delivery to another, they were aggregated using a weighted average based on the share of the volume each delivery had. Transactions where stumpage rate differ across deliveries were not aggregated.

The records without stumpage price were also grouped following the same dimensions. The transaction based marketing board database had 462,807 individual transactions after removal of redundancies and irreconcilable inaccuracies. Aggregation resulted in 101,258 records 28,377 of them with stumpage value populated and 72,881 of them without.

Data weighting

The last step of data preparation involved calculating weights for the observations used in the regression analysis. Weighting was made necessary because the transactions with stumpage prices are only a subset of all the transactions data we collected. Hence, the purpose of the weighting was to ensure that the subset of transactions with stumpage prices was not biased but rather broadly representative of the overall marketing board transactions we collected. The following steps were undertaken in normalizing the distribution of the observation with stumpage reported:

- Run a logistic regression where the dependent variable equals 1 if stumpage rate is reported in the dataset and 0 otherwise;
- Using regression results, predict probability of reporting stumpage rate for each observation;
- Divide the observations in quintiles, based on the ty distribution of predicted probabilities;
- Calculate the share of observations with stumpage reported within each quintile; and
- Calculate the inverse of the share computed in the previous step. The result of this calculation is the weight applied to observations. An alternative calculation of weights where weights are inverse of the average predicted probability within each quantile was also considered. The weights calculated in the two ways were close in most cases and our judgement was that the former method is better.

There was a major limitation to that methodology. In the development of the logistic regression, the contractor rate was identified as a statistically significant variable to explain the probability of reporting stumpage. However, contractor rates were not provided for transactions in the Carleton-Victoria Marketing Board. Therefore we had to calculate weights on the basis of the logistic regression without the contractor rate leading to lower explanatory power of the model and hence poorer predicted probabilities. However this shortcoming could not be avoided, given the reliance of the model on the data provided.

The table below summarizes weights obtained using each approach described above.

Table 25: Weights calculated using two alternative normalization approaches

Product	Quintile	Weight based on the share of the records with reported stumpage by quantile of predicted probabilities	Weight based on mean probability by quantile of predicted probabilities
Sawlog	1	5.9	5.8
	2	4.0	4.0
	3	3.2	3.3
	4	2.9	2.8
	5	2.2	2.2
Pulp	1	9.6	9.5
	2	5.7	5.7
	3	4.1	4.2
	4	3.4	3.4
	5	2.5	2.5

Definition of Primary Forest Products Market(s)
In order to perform the required statistical analysis, there is a need to define the relevant geographic markets for private woodlot producers. The market definition analysis was a data-driven process, based on observed transactions. As such, the initial step involved ensuring the analysis was conducted on a relatively complete and homogenous dataset across marketing board areas. One of the core concept of this analysis is substitutability, as detailed in section 2.4.1. A key assumption under this analysis is wood supply from a woodlot can be substituted by wood supply from another woodlot nearby from the mills' perspective, i.e., there is demand substitutability. On the other hand, as described in section 2.2.1, wood supply can also be substituted as evidenced by the several different possible uses of the forest. If a woodlot is not being harvested for timber, it may serve recreational, touristic or preservation purposes, for example.

Under those assumptions, we performed an analysis of the available data and decided to perform the market definition analysis on the period ranging from January 1, 2010 to December 31, 2017. Several factors motivate that decision:

- The 2010 cut-off period was selected because it is our best estimate of a structural break in the marketplace. The period prior to 2010 was characterized by an acute recession in the US (i.e., the end market for many sawmill and pulp mill products) and a period in which a larger number of mills were in operation. The period from 2010 onwards is both more representative of current market conditions and shows more stability in data observed. For example, volumes traded from 2009 to 2010 grew by more than 20%, while post-2010 the growth rate stabilized at a more sustainable level, around 5% year over year; and
- Overall, this time period comprised 58% of transactions data (75,000) and 63% of volume (2.26 mil cu. m) as well as transactions involving 22 mills;
- As noted in Table 5 above, we obtained data for all years over this time period for YSC, SNB, SENB, NTH and CV. However, we only had partial time coverage for NSH (2017). Nevertheless, the 2010-17 period had comprehensive data from most of the most significant marketing boards in the province; and

- Finally, Arbec, a significant market player in the wood pulp segment re-entered the New Brunswick market in 2013. As such, the time period under study had to include this re-entry to be fully representative of current market conditions.

The key factors we have used in establishing market definitions are as follows:

- The number of mills each map tile has sold to in the past, as an indicator of the selling choices available to woodlot owners (referred to as "selling opportunities"); and
- The average distance in kilometres between the origin and destination of wood for transactions weighted by the volume of the transaction; as a measure of the mills' catchment area (referred to as "distance").

In order to address the product dimension of market definition, we considered those two factors for all transactions as a whole, as well as for transactions involving softwood and hardwood separately. In addition, our analysis considered potential export markets for each marketing board area as well as proximity to the main road network to factor in its impact on transportation costs and a mill's catchment area.

Another dimension that may have been taken into account in market definition is the end product manufactured with the wood consumed – either sawlog and studwood or pulpwood. However, it is our opinion that controlling for the wood specie (softwood or hardwood) at least partly controls for the end product dimension in our analysis, for several reasons. The first reason is wood species and end product manufactured are highly correlated. In New Brunswick, according to the TUS, about 83.2% of hardwood is sent to pulp mills and 76.2% of softwood is sent to sawmills. These proportions are potentially even higher in the regressions presented in the following sections, since the niche productions using high value-added hardwood, such a veneer, are excluded from our analysis given their small share of wood transactions relative to their high value-added. Another reason we deem this decision analytically sound is the interconnection between the two end products market through sawmill residue valorization by pulp mills: sawmills tend to sell their unused wood fibre to pulp mill for further transformation. This makes the end product markets interconnected. Finally, as will be showed in the econometric results section, the variables used to control for market-specific factors in our regressions are statistically significant, which is a sign that the retained market delineation add explanatory power to our analysis.

We developed a number of hypotheses with regard to potential definitions of the New Brunswick primary forest products markets. Based on the variables listed above and our analysis of market evolution over the 2010-2017 time period, our working hypotheses can be summarized as follows:

- The province of New Brunswick as a whole is not a single primary forest products market, because it is not is characterized by important differences in selling opportunities;
- The North Shore Marketing Board area is a distinct wood market;
- The Carleton-Victoria Marketing Board area is a distinct wood market;
- The Northumberland Marketing Board area is a distinct wood market; and
- The Southern New Brunswick and YSC Marketing Boards areas are one distinct market.

No hypothesis currently covers the nature and scale of the South Eastern New Brunswick Marketing Board area. Part of the challenge with SENB data received for this project is the data that has sufficient geographical information to be included in this analysis only covers one year and a very limited number of observations. As such, it was excluded from our analysis.

Hypothesis 1: The province of New Brunswick is a single, homogenous wood market.

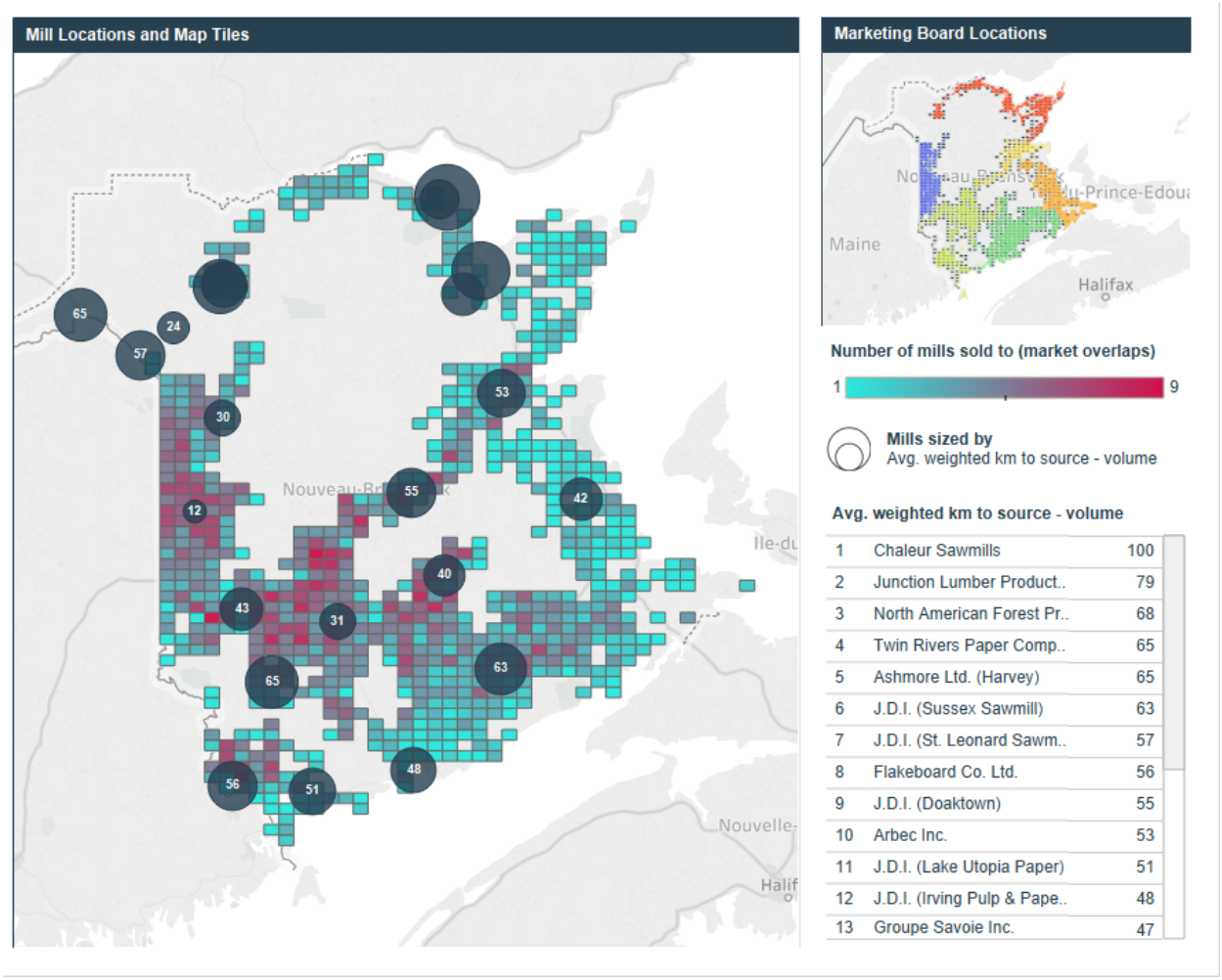
We reject this hypothesis based on important differences in selling opportunities from a region to another, as well as differences in average distances for wood shipments across regions. Moreover, some regions show other distinct features that suggest evidence of distinct regional wood markets within New Brunswick.

Our first working hypothesis is related to the New Brunswick territory as a whole. Our goal was to confirm or not whether New Brunswick as a whole was not a homogenous wood market, i.e., whether or not there were two or more relatively homogenous wood markets on New Brunswick's territory.

From a selling opportunities perspective, there is heterogeneity across the province, with some areas having access to more mills than others, as show in the map below. This is evidenced by the relatively higher selling opportunities in the west and south-west areas of the province, corresponding to the Carleton-Victoria, and YSC Marketing Board areas respectively. Another factor to take into account is also the distinct access to foreign markets some marketing boards may have, but not others. This is especially the case for the Carleton-Victoria Marketing Board's access to mills in Maine. The stumpage prices (in Canadian currency) secured by woodlot owners with access to foreign mills (i.e., in Maine) are directly affected by variations in the CAD/US exchange rate.

In addition, about 60% of mills source their wood from an average distance between 40 and 70 kilometres. Given the geographical footprint of New Brunswick, that implies some woodlot owners will not be able to access the same critical mass of mills to sell their wood, especially those located in remote areas or the periphery of the province. It is also worth noting that the greatest number selling opportunities appear to be at the juncture of Highway-2 and Highway-8, within the area of the Carleton-Victoria and YSC marketing boards, and to a lesser extent the Southern New Brunswick Marketing Board area.

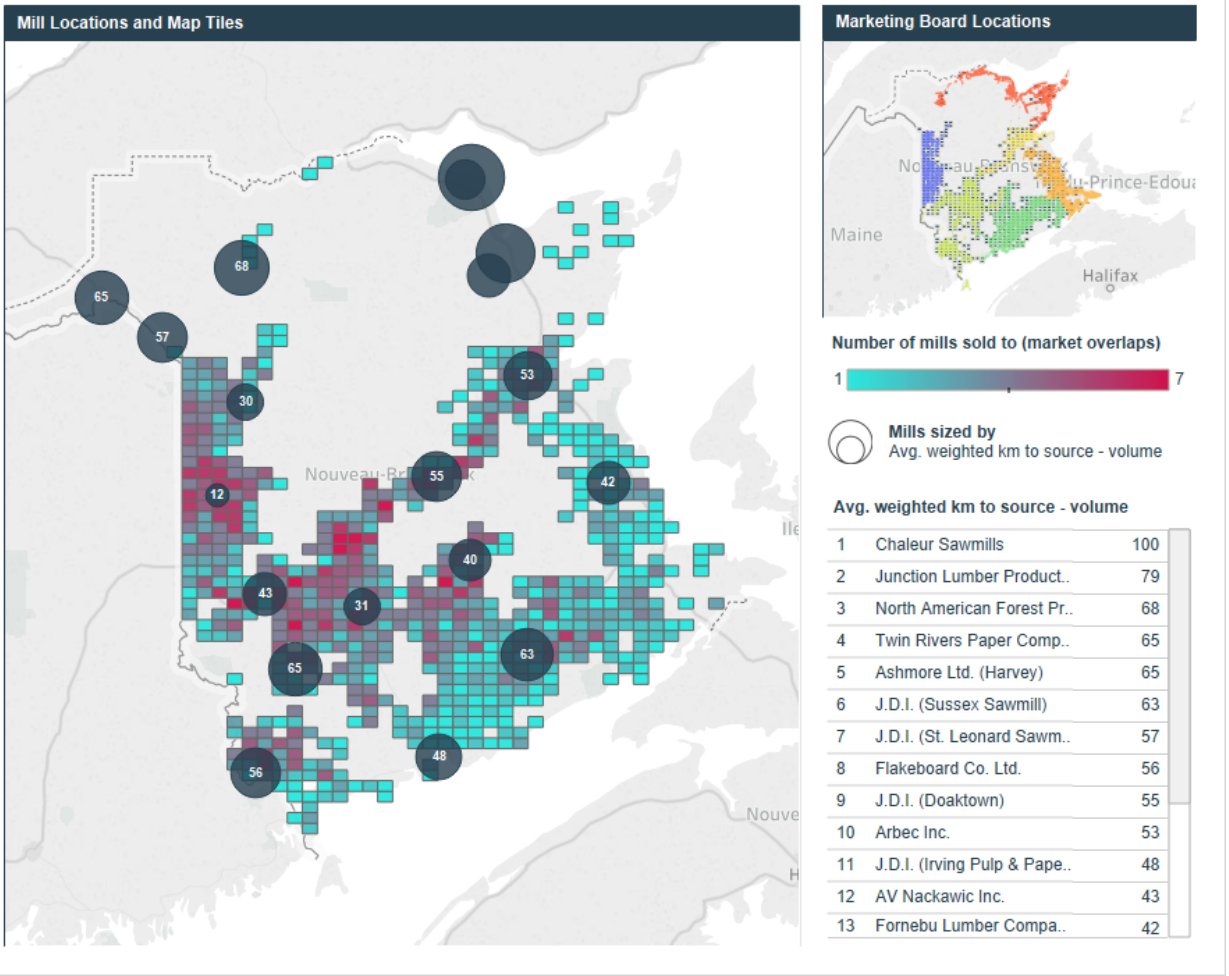
Chart 63: New Brunswick wood market, all species, 2010-2017



Source: Deloitte analysis.

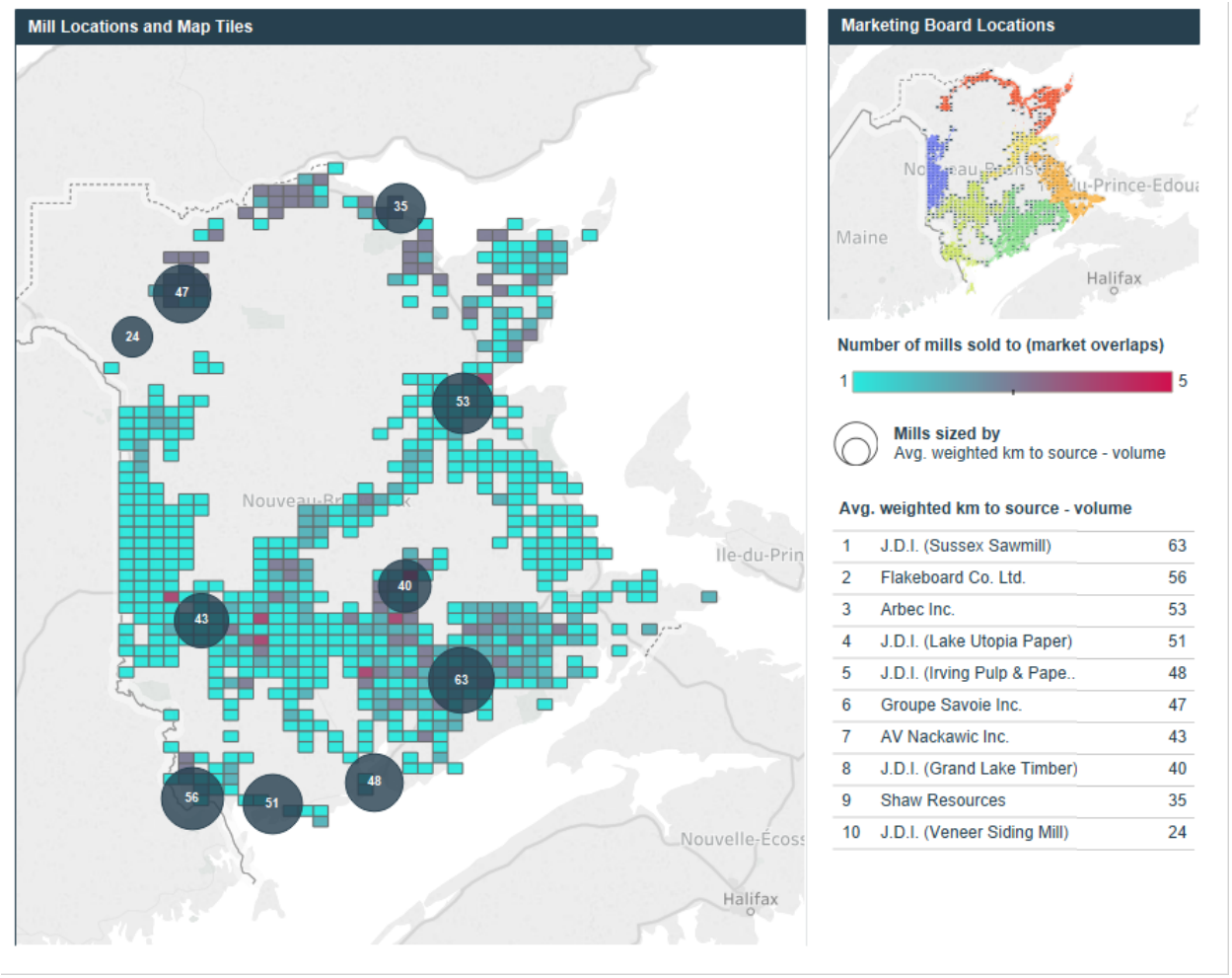
From a species perspective, it is worth noting that some regions seem to have distinct pattern of trade. This is especially the case for the North Shore Marketing Board area, which seems relatively absent from the softwood trading space, as illustrated in the map below. It also appears that hardwood has reduced selling opportunities relative to softwood, except in the NSH area and to a lesser extent in the SNB area.

Chart 64: New Brunswick wood market, softwood, 2010-2017



Source: Deloitte analysis.

Chart 65: New Brunswick wood market, hardwood, 2010-2017



Source: Deloitte analysis.

Ruling out the hypothesis of a single provincial homogenous market raised the question of potentially distinct regional markets in the province. One potential hypothesis is that each marketing board areas represent a single relatively homogenous market. In order to validate this working hypothesis, we conducted an analysis similar to the one described above for New Brunswick, but for each marketing board area individually.

Hypothesis 2: The NSH marketing board area is a distinct market.

We cannot reject the hypothesis that NSH marketing board area is a distinct market, based on its remote geographical location and distinct wood commerce based mostly of hardwood. As such, our working hypothesis to treat NSH as a distinct market area. However, this results is driven by data available to perform our analysis. While there is softwood harvested in NSH, the vast majority of transactions included in the data provided by the marketing board involved hardwood. As such, we decided to consider the hardwood market segment only for NSH, given limited data availability.

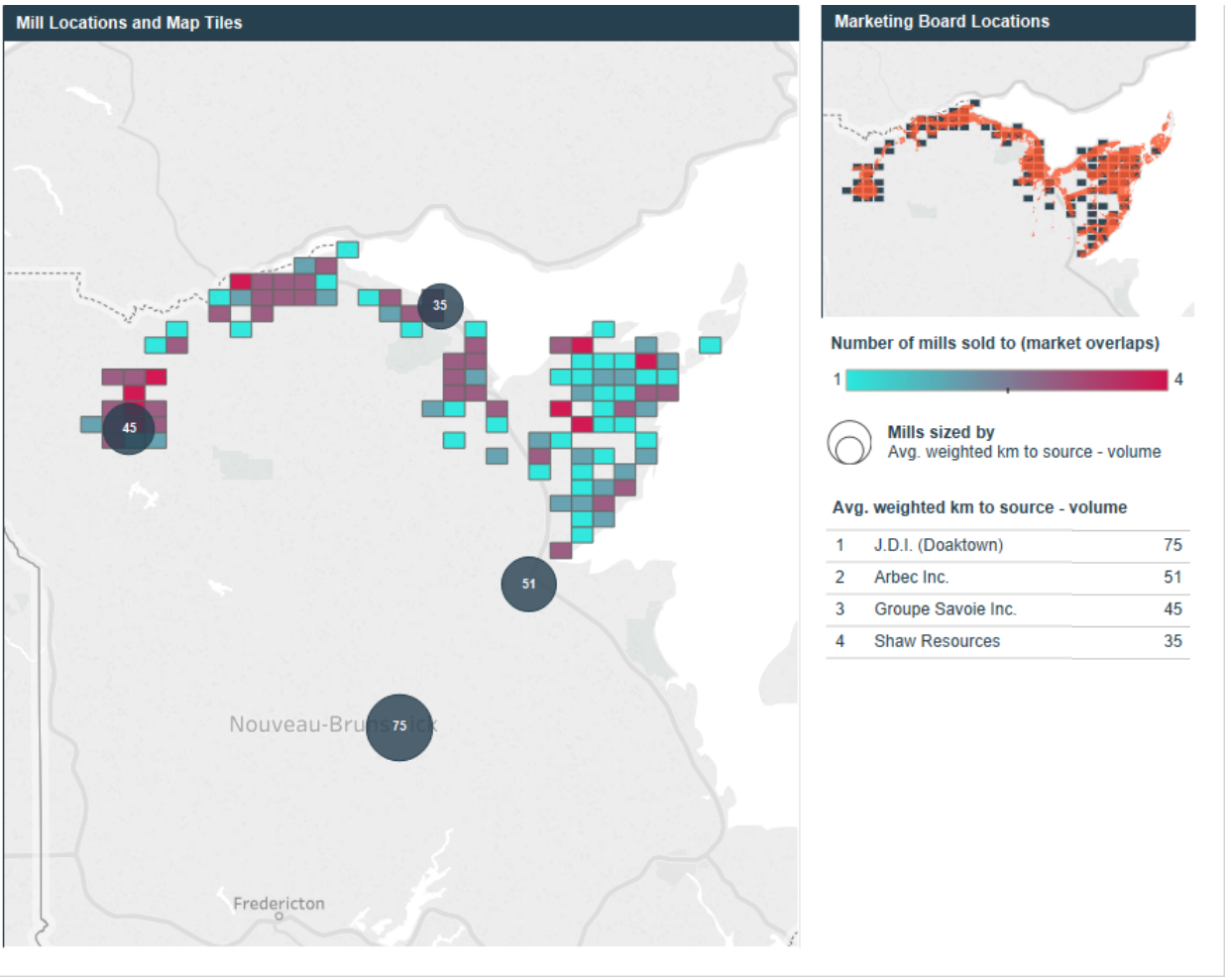
The North Shore Marketing Board is located at the extreme North portion of the province. It is relatively isolated from other areas of the province, mainly by the bulk of the Crown Land area located to the south. It is also an area that is served by Highway-17 and Highway-11, which connects to Highway-8 near Bathurst. This is the main NSH road connection to the rest of the province. The relative isolation and self-dependency

of the NSH marketing board area with regards to wood transactions is also illustrated by the much narrower range of average distances from wood origin to its destination, roughly between 35 and 50 kilometres if we exclude the only mill outside of the area (based on its unique transaction pattern).

The NSH woodlot owners are located close to the Province of Quebec, but the area seems to remain a net importer of wood, rather than an exporter of wood to Quebec. As such, proximity to another provincial market does not constitute a distinctive factor for NSH.

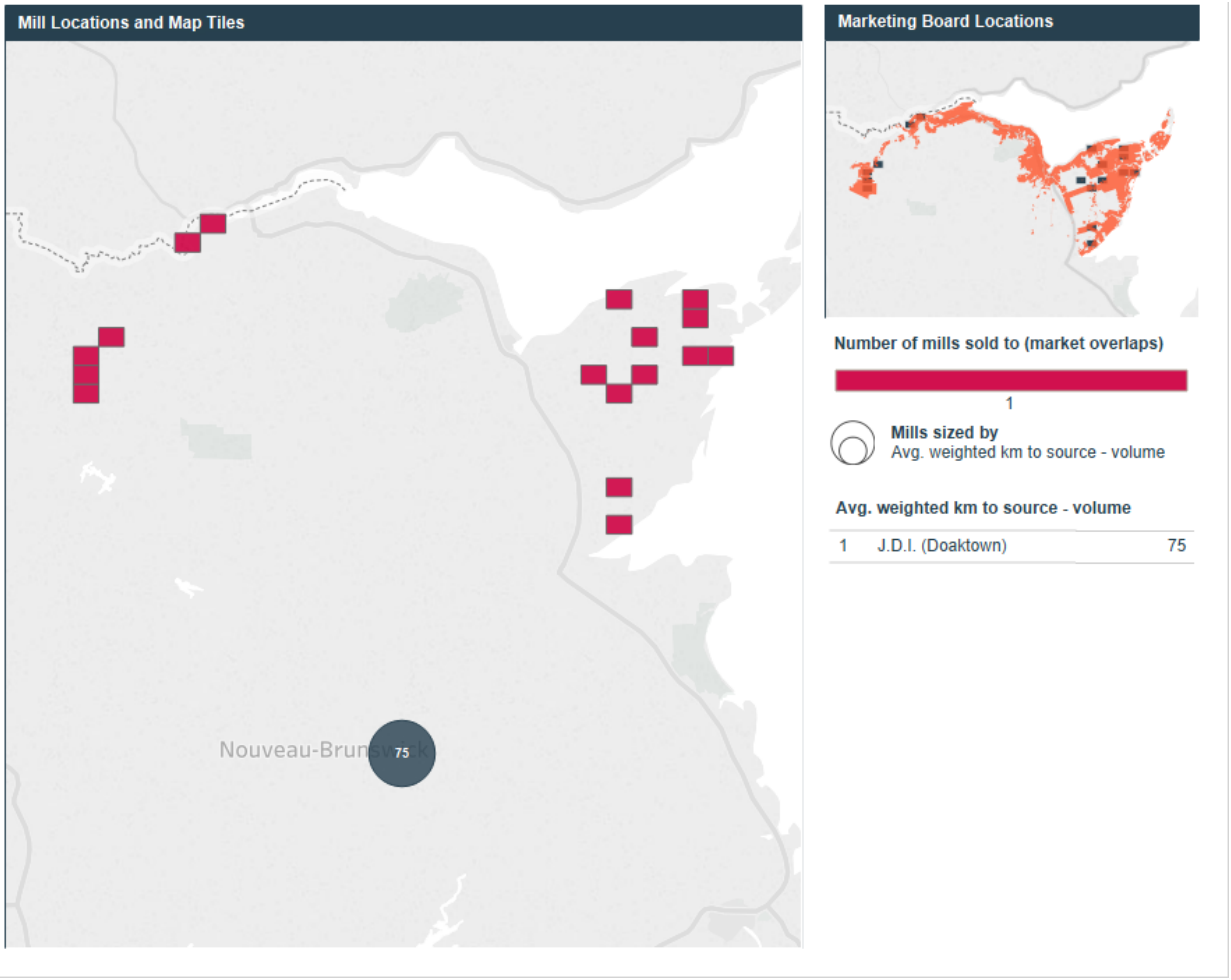
However, the NSH area has relatively homogenous selling opportunities, as illustrated in the map below. There are three mills located immediately in the NHS vicinity, with the only mill located outside being the only purchaser of softwood from the NHS area. All three other mills purchase mainly hardwood. This in itself distinguishes NSH from the rest of the province, where transactions are largely oriented toward softwood species. This distinction in NSH may be due to the composition of its forest, closer to the Boreal forest than to the Acadian forest present on the rest of New Brunswick's territory.

Chart 66: NSH wood market, all species, 2010-2017



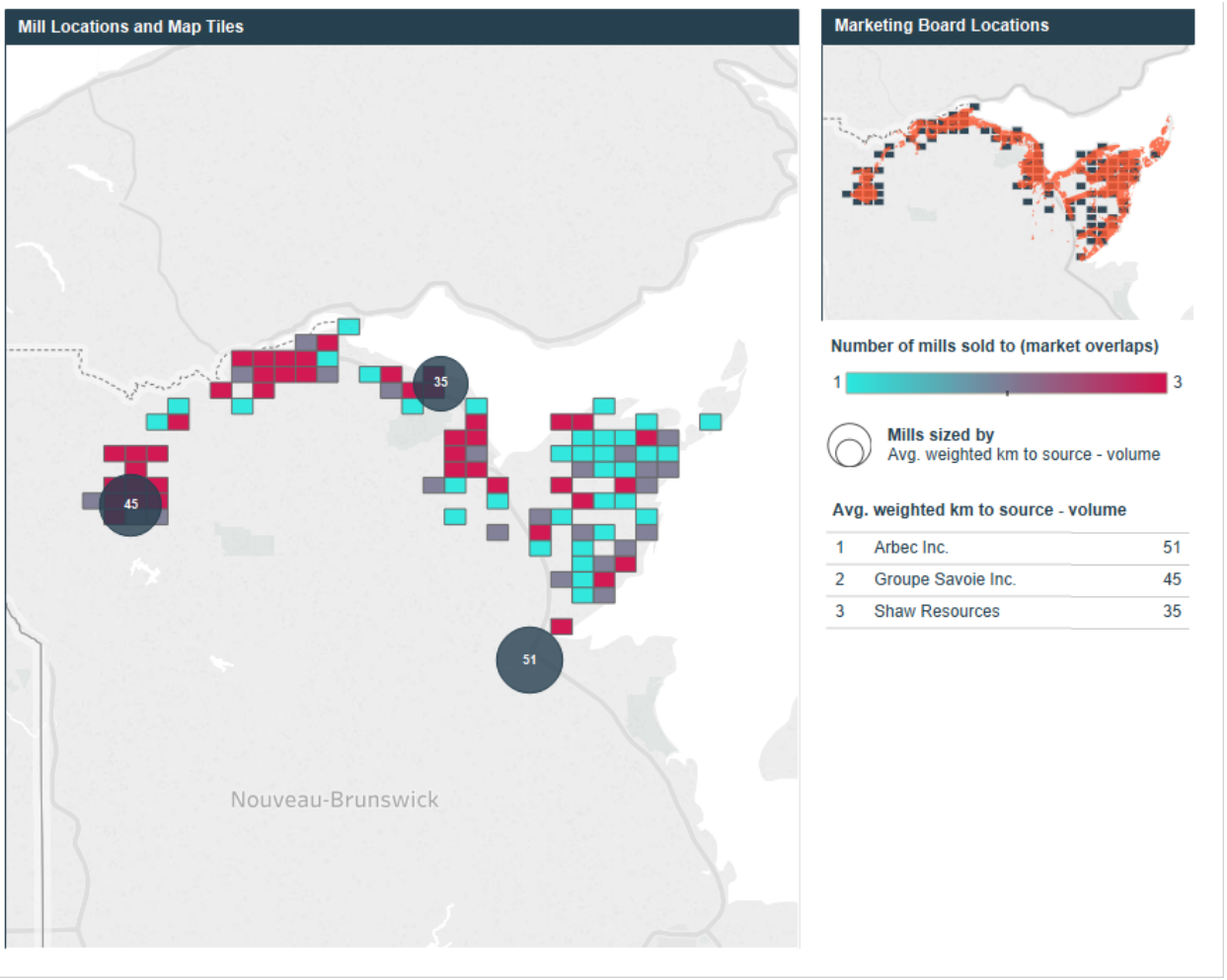
Source: Deloitte analysis.

Chart 67: NSH wood market, softwood, 2010-2017



Source: Deloitte analysis.

Chart 68: NSH wood market, hardwood, 2010-2017



Source: Deloitte analysis.

Hypothesis 3: The Carleton-Victoria marketing board area is a distinct market.

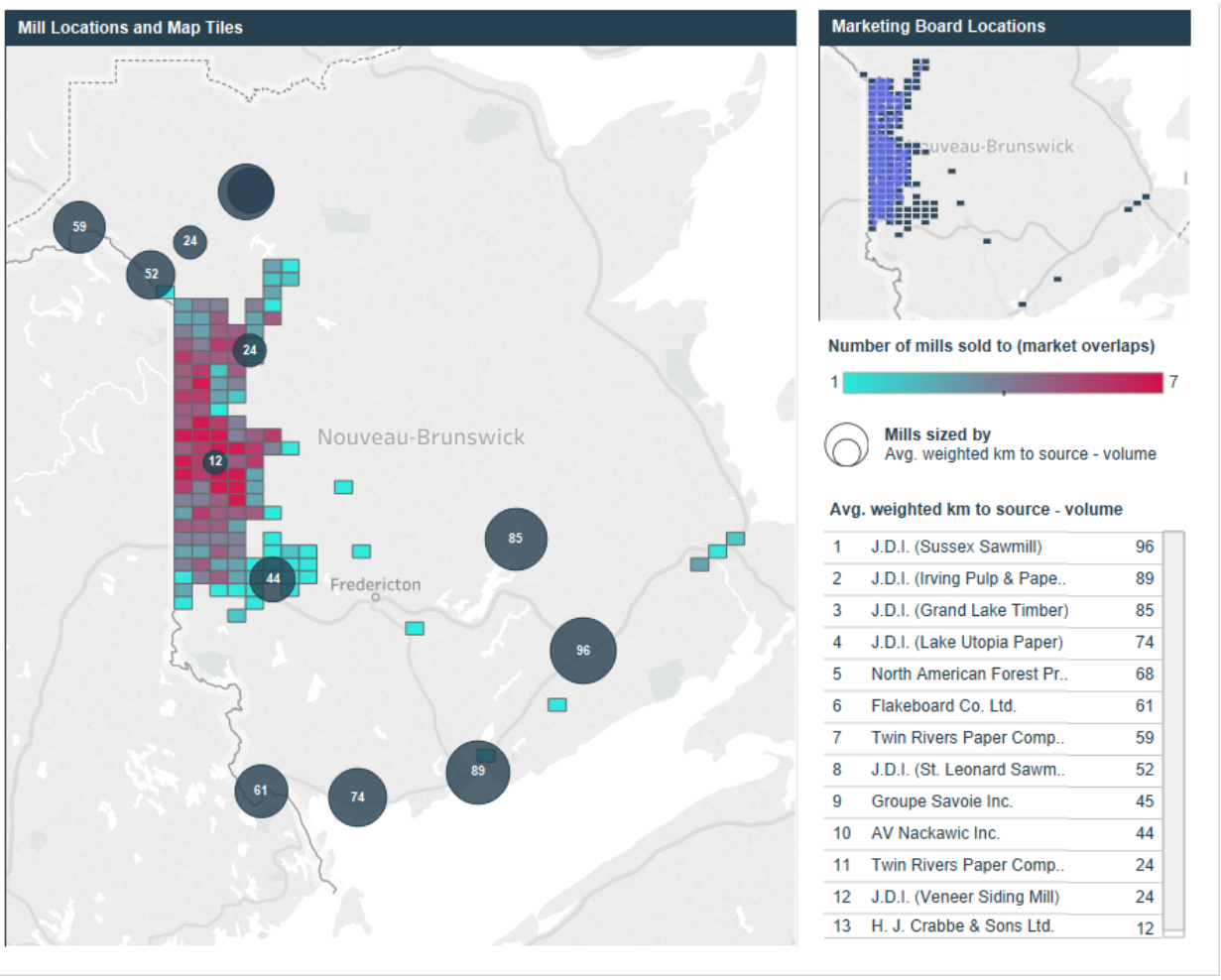
We cannot reject this hypothesis based on Carleton-Victoria's woodlot owners' access to multiple selling opportunities and to the Maine market. As such, our working hypothesis is to treat the CV market as a single regional market.

The Carleton-Victoria Marketing Board area is located at the extreme West of New Brunswick and shares a border with the state of Maine, where some mills are owned by Canadian forest product companies also present in New Brunswick. As shown in the map below, Carleton-Victoria has one of the highest number of selling opportunities across New Brunswick, with some map tiles selling to up to seven different mills, a number surpassed only by the two other central New Brunswick marketing boards, YSC and SNB. The access to selling opportunities is also more evenly distributed across CV than for other marketing board areas.

What also makes Carleton-Victoria distinct is the relative captivity of some mills to the marketing board's supply of wood, especially those located at the North of CV's area. Out of those five North Western mills, four source their wood almost exclusively from CV. The fifth one, owned by Groupe Savoie, also sources wood from NSH. It is also worth noting that CV woodlots have access to selling opportunities across the Southern New Brunswick and YSC marketing board areas, as evidenced in the map below, which shows that YSC woodlots sell to three JDI mills to the southeast and to the Flakeboard mill.

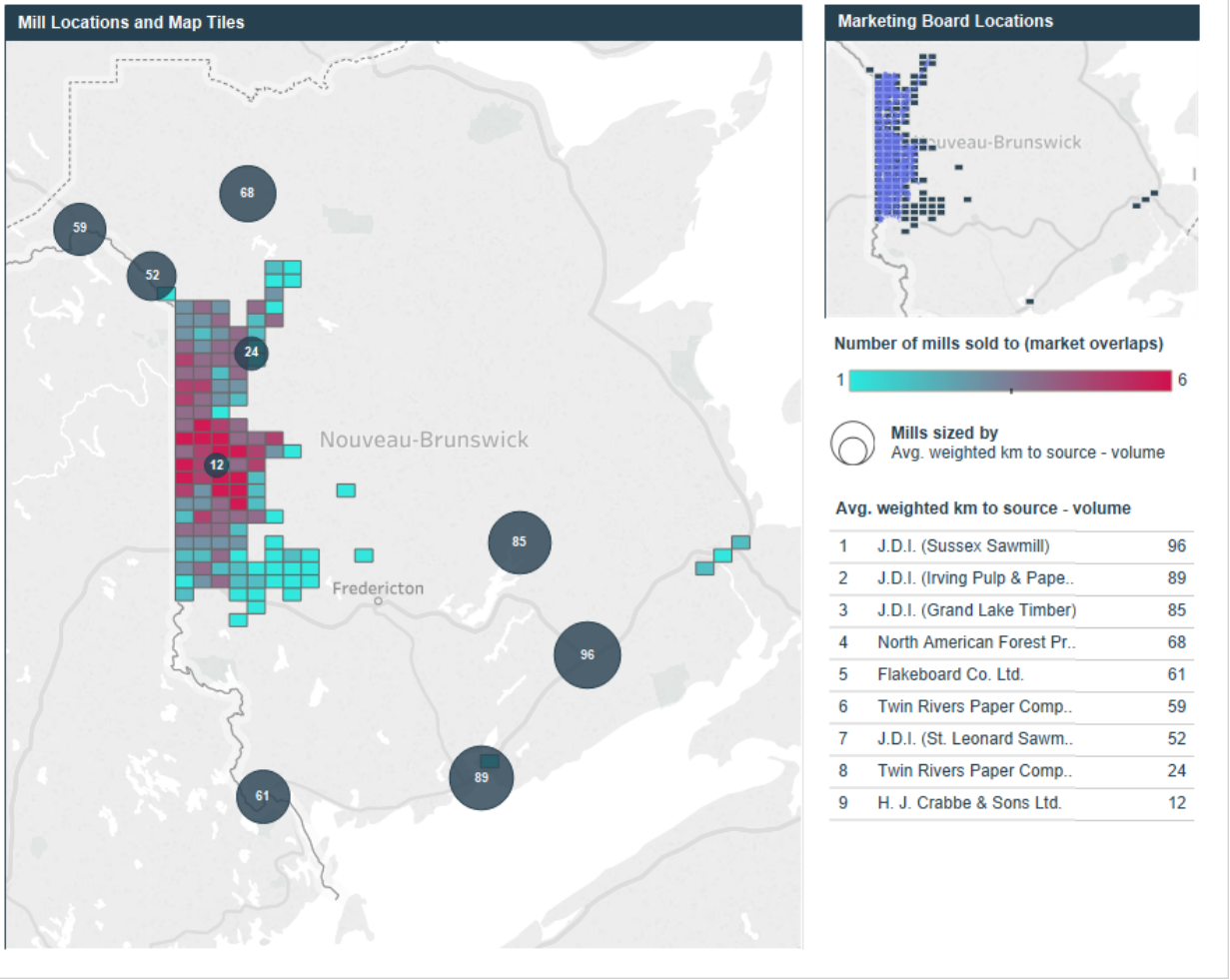
As for most of the province, the CV hardwood market shows less selling opportunities than the softwood market segment. As such, distances observed for mills doing business with CV are more dispersed, which is also a distinctive feature of the area.

Chart 69: CV wood market, all species, 2010-2017



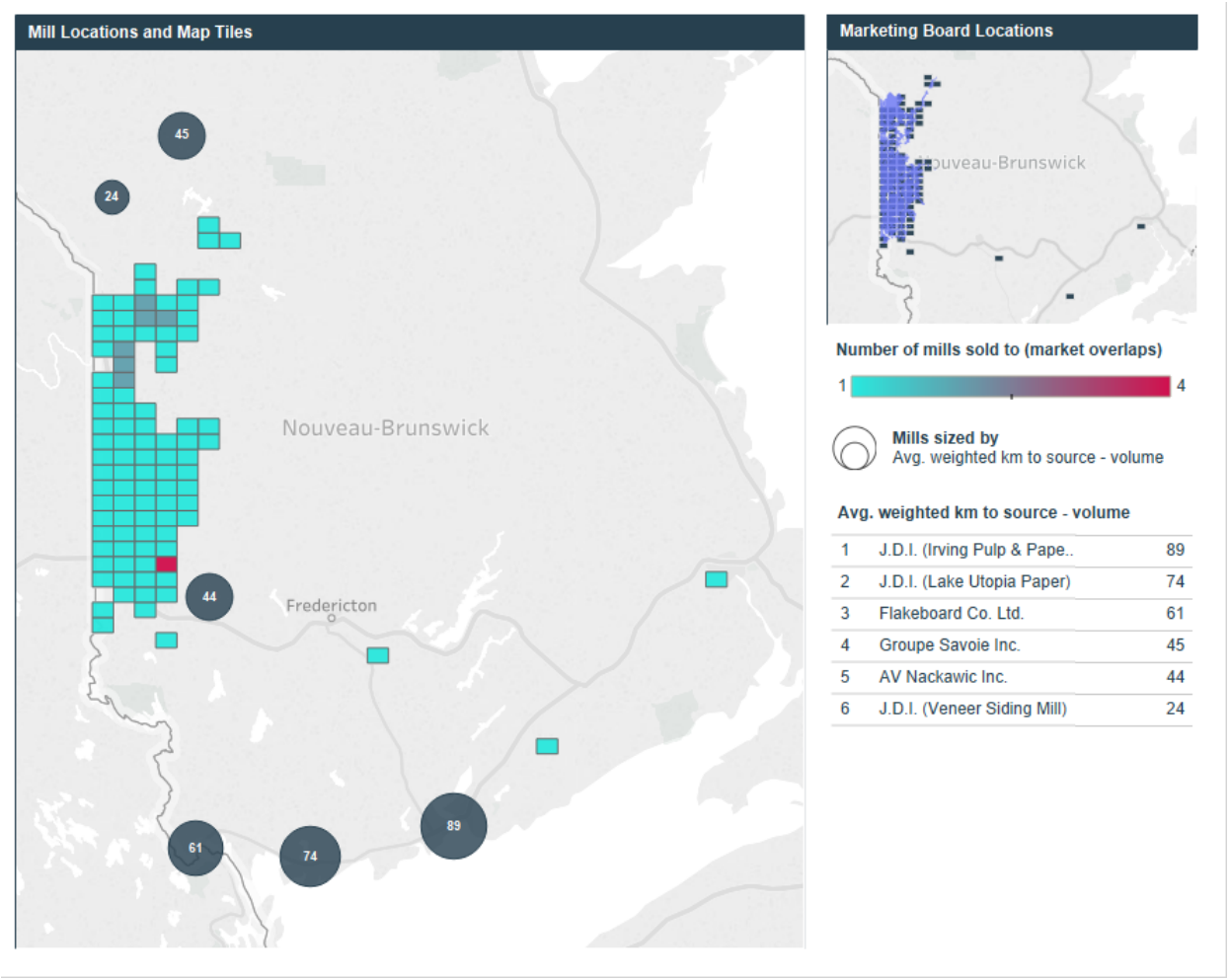
Source: Deloitte analysis.

Chart 70: CV wood market, softwood, 2010-2017



Source: Deloitte analysis.

Chart 71: CV wood market, hardwood, 2010-2017



Source: Deloitte analysis.

Hypothesis 4: The Northumberland Marketing Board area is a distinct regional wood market

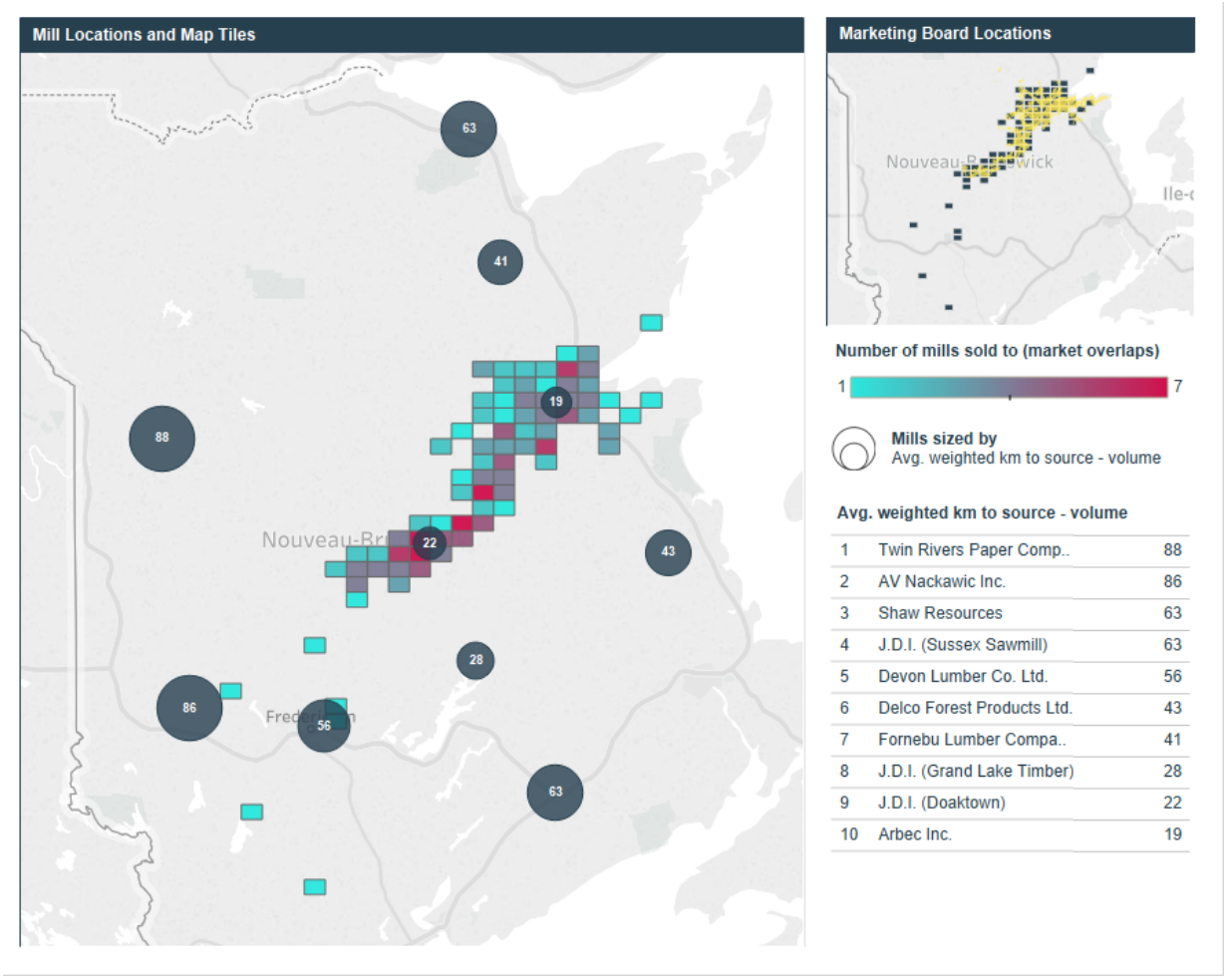
We cannot reject this hypothesis based on the geographical location of the Northumberland Marketing Board. However, there may be linkages between NTH and SENB that are not apparent, due to the lack of data on the SENB market. Nevertheless, our working hypothesis is to treat the NTH market as a distinct regional market.

The Northumberland Marketing Board area is located in between the East end of NSH and the central part of YSC. It is connected to those two other areas by Highway-8, which goes through its territory from its North Eastern end to its Central Western end. NTH is also an area showing a relatively high number of selling opportunities, with some map tiles selling up to seven mills.

Geographically, NTH has no connection to SNB, but is a direct neighbour to SENB to which it is connected through Highway-11. However, the lack of data for SENB prevented any analysis of this interconnection.

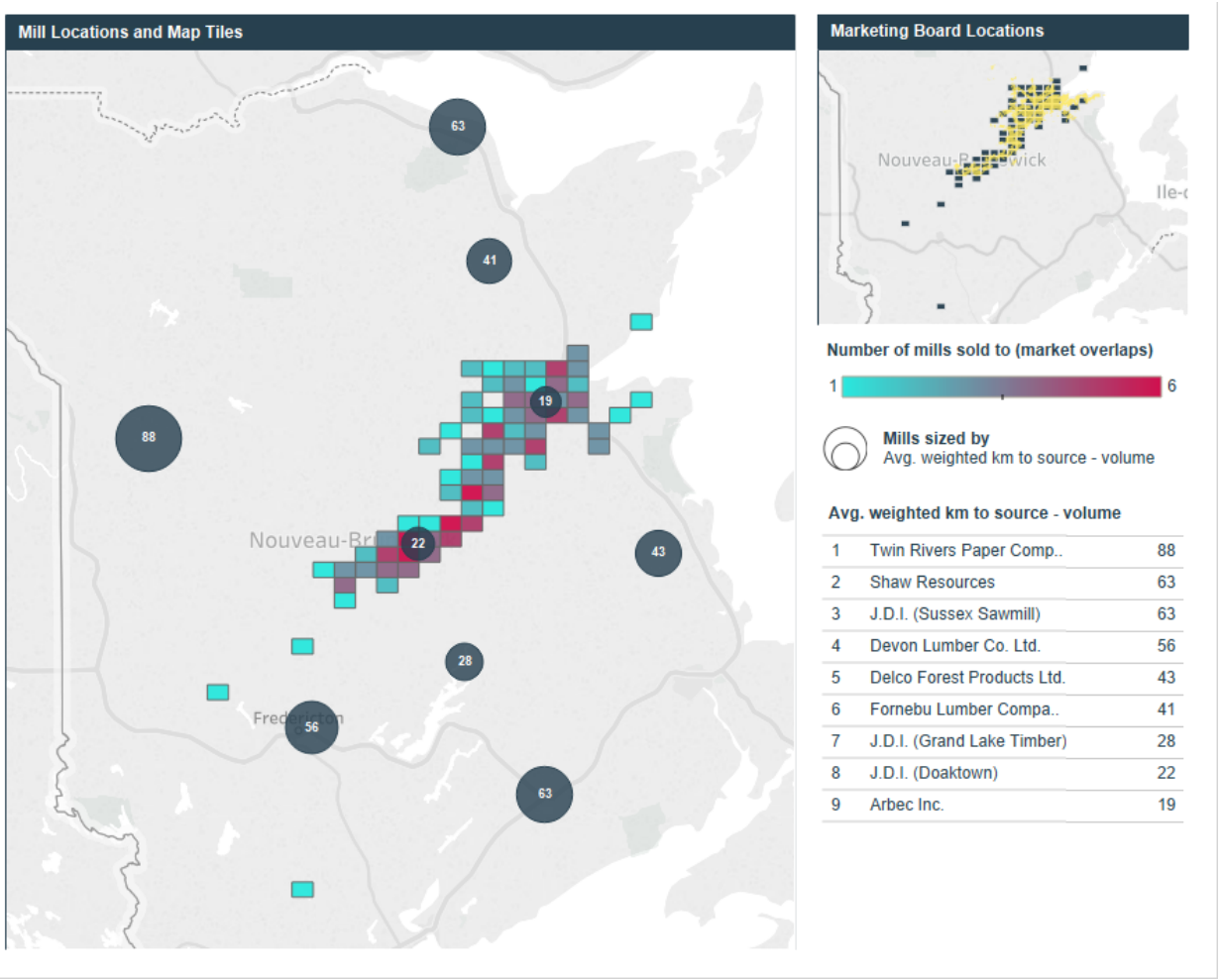
The NTH location, at the junction of Highway-11 and Highway-8, also allows its woodlot owners to transact with a broader array of mills than for other more isolated areas. However, the average distances from woodlot to mill remain roughly within the provincial norm. NTH is predominantly a softwood market, also reflecting the provincial norm.

Chart 72: NTH wood market, all species, 2010-2017



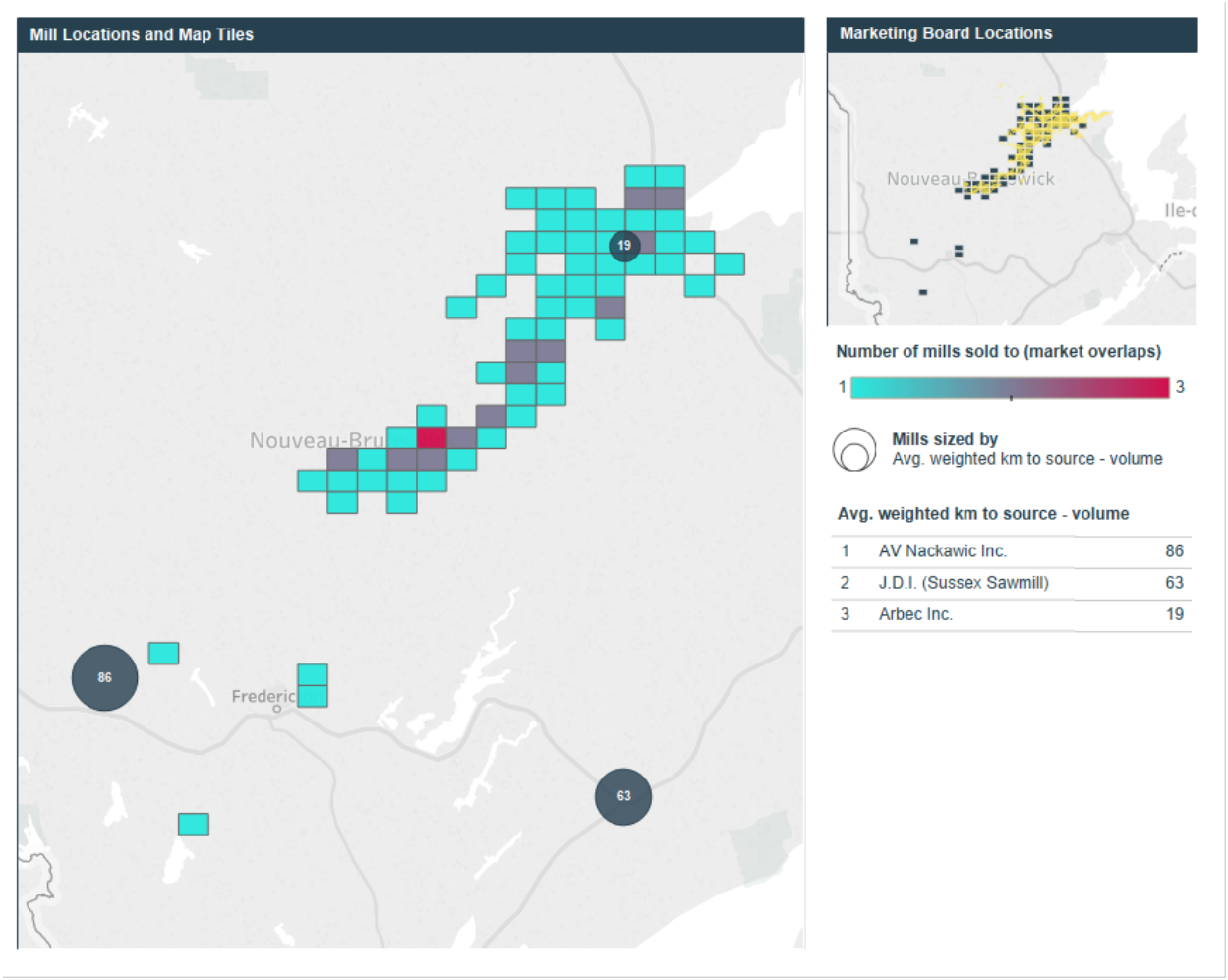
Source: Deloitte analysis.

Chart 73: NTH wood market, softwood, 2010-2017



Source: Deloitte analysis.

Chart 74: NTH wood market, hardwood, 2010-2017



Source: Deloitte analysis.

Hypothesis 5: The Southern New Brunswick and YSC Marketing Boards areas are one distinct market.

We cannot reject this hypothesis for the hardwood segment of the market, but we can reject the hypothesis for the softwood segment, because there is evidence that SNB and YSC are a single market for hardwood (but distinct regional markets for softwood).

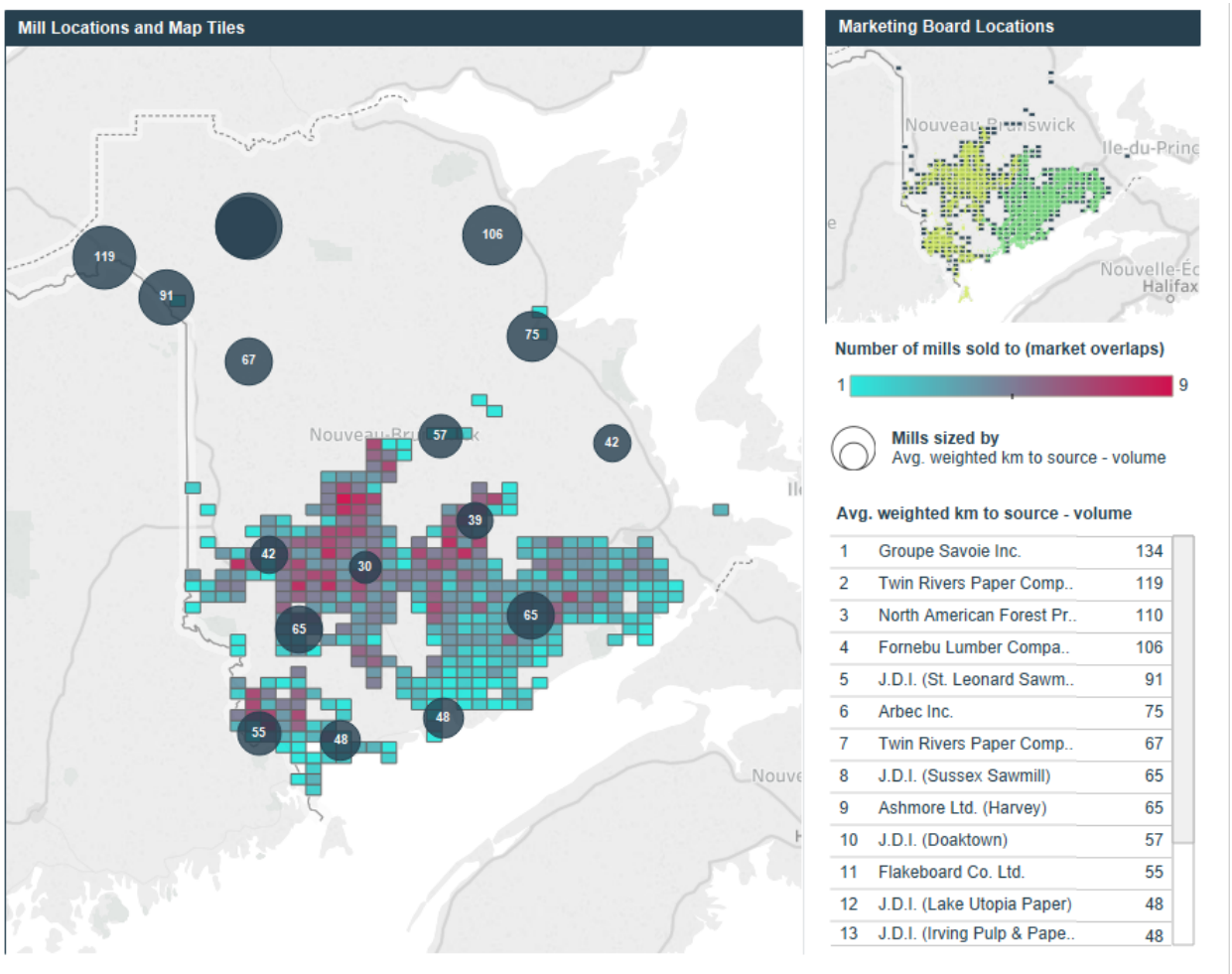
Together, YSC and SNB cover all the southern area of New Brunswick, and account for close to a third of the province's area. YSC is located at the western end of this area, while SNB is at the central and eastern end. Despite its location, SNB does not have direct land connection to Nova Scotia. Of the two, YSC is the area showing some alternating trade patterns, as it has been a net exporter of wood for some years and a net importer for other years. SNB consistently imports wood from outside the province.

At first glance, the two areas appear relatively integrated. Highway-2 goes across both areas in the east-west axis, which would support some integration. However, YSC is also connected to CV through Highway-2 and to NTH through Highway-8. YSC is also more central, with a relatively larger number of mills that are closer. As such, distances between woodlot owner and mill are shorter in YSC than in SNB.

Overall, they also show similar selling opportunities, with mills in YSC selling to up to nine mills while this number is eight in SNB. When looking further into it, however, the weighted average selling opportunity per tile differs significantly between the two areas. For the period under review, YSC map tiles sell to 6.8 mills on average, while SNB map tiles sell to only 4.5 map tiles on average. Selling opportunities also vary based on species. There are relatively more selling opportunities for softwood in YSC than in SNB, seven compared to six respectively. The reverse is true for hardwood, with four and five respectively.

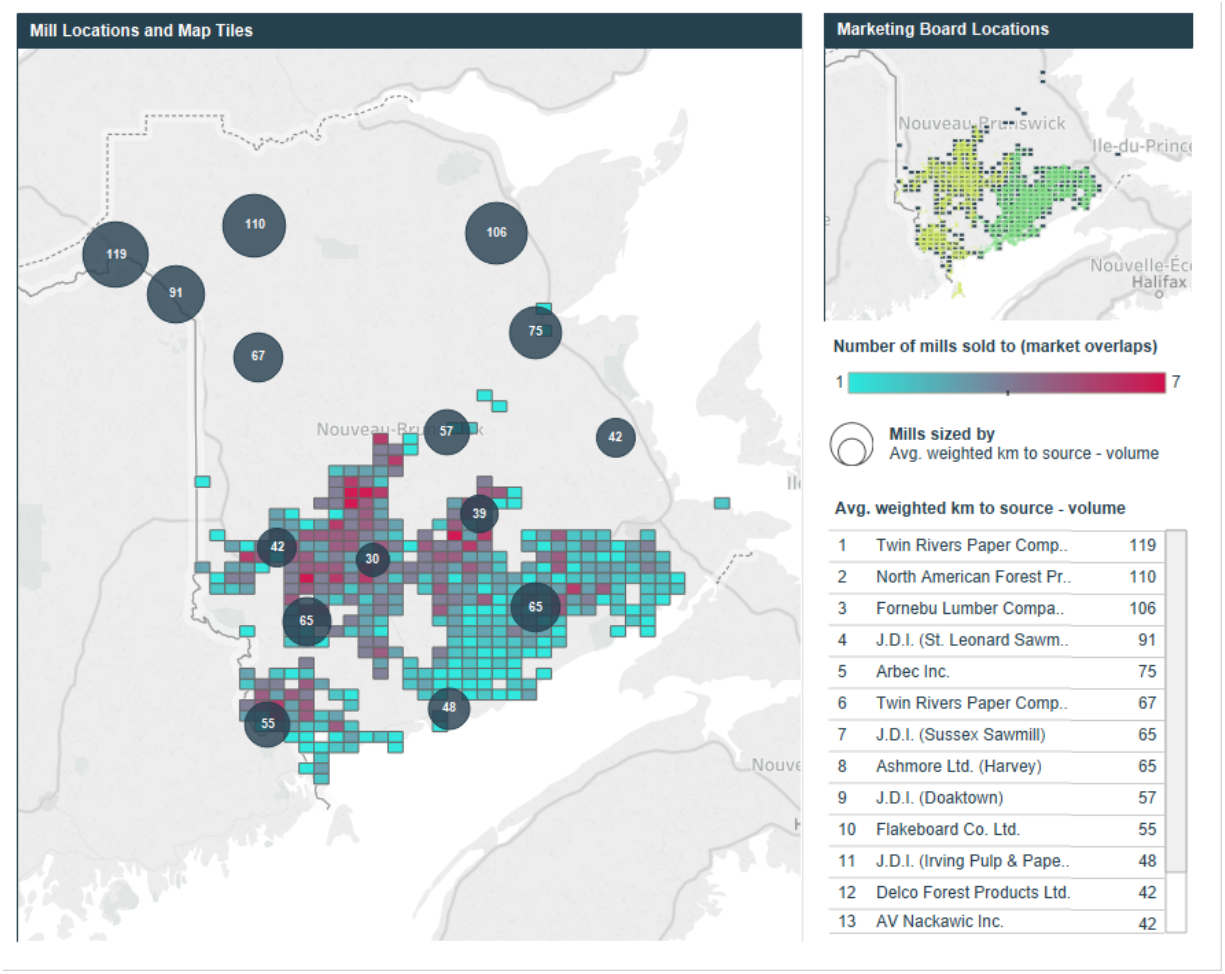
When an analysis is conducted based on species, it becomes apparent that SNB and YSC are two different markets for softwood but are more integrated for hardwood. For the softwood market segment, YSC has higher selling opportunities and draws from a broader array of mills province-wide than SNB, as evidenced in the map below. However, for hardwood, the market is much more homogenous and limited, in terms of selling opportunities. Selling opportunities for hardwood are also more local to the area than for softwood. As such, we consider the market for hardwood to be integrated between YSC and SNB, but not for softwood. This working hypothesis is subject to change as we analyze other data which may have implications for market definition.

Chart 75: YSC and SNB wood market, all species, 2010-2017



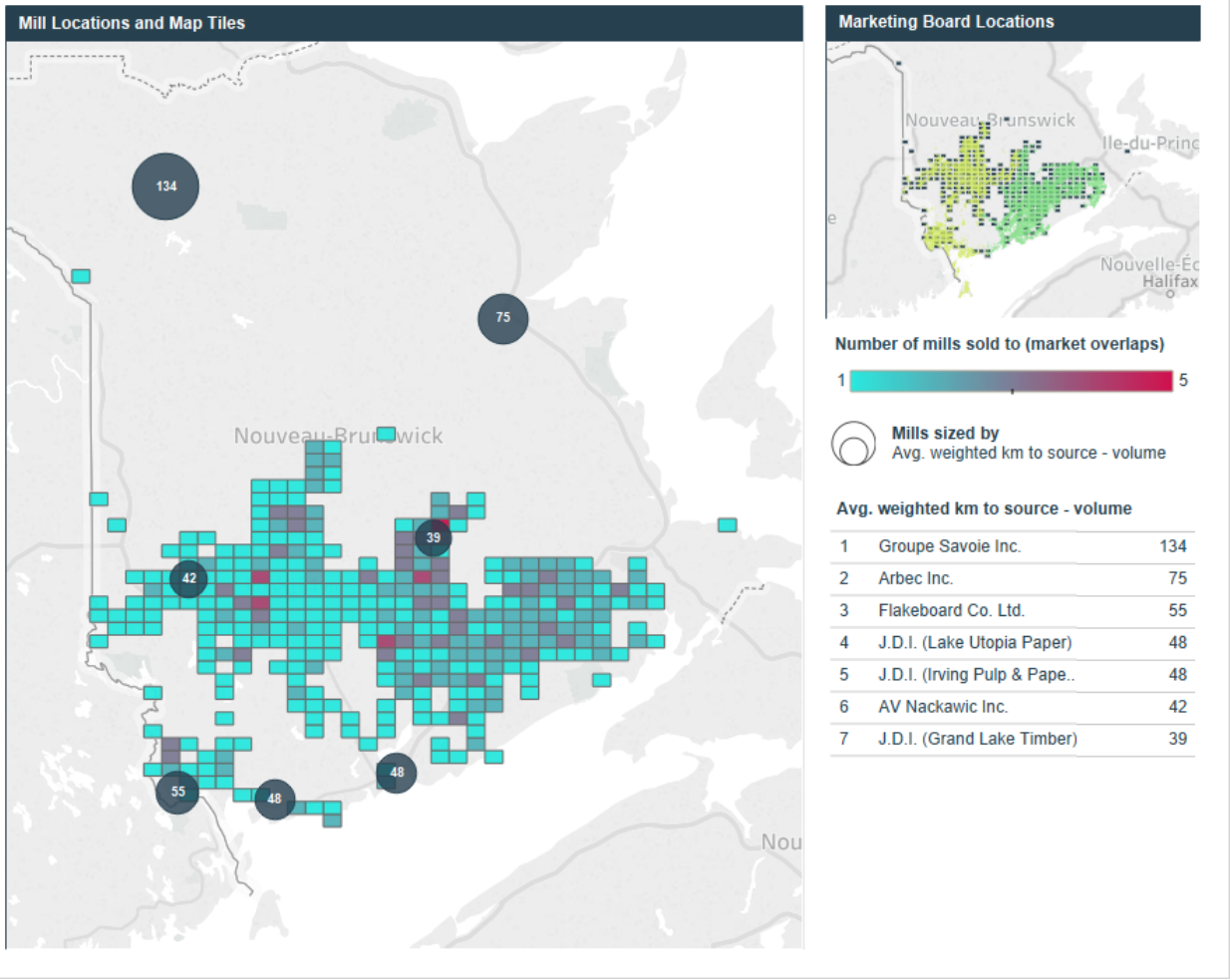
Source: Deloitte analysis.

Chart 76: YSC and SNB wood market, softwood, 2010-2017



Source: Deloitte analysis.

Chart 77: YSC and SNB wood market, hardwood, 2010-2017



Source: Deloitte analysis.

In summary, our preliminary analysis suggests that there are six distinct regional markets:

- A North Shore market, which is primarily a hardwood market;
- A Carlton-Victoria market, a combined hardwood and softwood market;
- A Northumberland market, a combined hardwood and softwood market;
- A single softwood market for the York-Sunbury-Charlotte market area;
- A single softwood market for the Southern New Brunswick market area; and
- A single YSC/SNB market for hardwood.

We have not come to a view regarding Madawaska and SENB, given the lack of stumpage price data from these marketing boards. These initial working hypotheses are subject to change as we fully assimilate other data sources.

Descriptive statistics of the Marketing Board Data

This section aims at providing an overview of stumpage prices and other transaction-level variables recorded in our Marketing Board Transaction Database. The summary statistics reported are calculated based on aggregated data, which are used in our econometric analysis reported in the report. The intent of this section is to provide sufficient transparency on the impact of our data preparation methodologies, so the reader can assess the inputs we used in our quantitative analysis. For comparison purposes, hardwood and softwood stumpage prices for sawlog from the Private Woodlot Stumpage Survey (PWSS) are also reported in separate tables.

Our econometric analysis is restricted to 2000/01-2017/18 sample due to the availability of the TUS HHI data (except for the regressions that makes of the Crown share metrics or marketing board exports which are further restricted due to availability of those data). Therefore summary statistics is also presented for those years.

The table shows the number of observations available for each marketing board and transaction level variable following data preparation steps described in previous section, including filtering, removal of outliers and aggregation. It illustrates the large number of aggregated observations, and highlights the lack of two transaction level variables in CV: contractor and trucking rates. Those were not provided as part of the raw data obtained from the marketing board. It is also worth noting that the econometric analysis will be conducted on the 24,413 observations reporting stumpage only, given stumpage price is the selected dependent variable.

Table 26: Number of aggregated observations in the Marketing Board database, by variable and marketing board

	Contractor rate ($/m^3)	Stumpage price ($/m^3)	Trucking rate ($/m^3)	Mill gate price ($/m^3)	Volume (m^3)	Distance (Km)
CV	N/A	3,048	N/A	14,256	14,256	5,808
NTH	843	1,902	6,504	12,211	12,212	3,704
SNB	34,110	12,166	24,260	34,129	34,129	26,858
YSC	27,159	7,297	17,232	27,160	27,160	17,556
Total	**62,112**	**24,413**	**47,996**	**87,756**	**87,757**	**53,926**

Source: Deloitte calculations using transaction-level data provided by Marketing Boards.

The next table shows the breakdown of observations by marketing board and operating year. It highlights the significance of SNB and YSC in our sample, at about twice the share of NTH or CV across the full time period. The sample also catches the reduction in activity during the 2008-2009 recession, with a through in transaction observed in 2009, which represents 3.2% of the observations of the full sample. Data in NTH for the 2010-2011 also shows some anomalies, which are nevertheless expected to have limited impacts on the overall results.

Table 27: Number of aggregated observations in the Marketing Board database, by marketing board and year of observation

	CV	NTH	SNB	YSC	Total
2000	N/A	1,265	N/A	348	1,613
2001	N/A	1,253	N/A	199	1,452
2002	359	1,317	3,671	3,076	8,423
2003	829	1,705	4,271	3,194	9,999
2004	441	1,652	4,439	3,273	9,805
2005	173	523	3,307	2,803	6,806
2006	94	543	2,213	2,290	5,140
2007	43	291	1,648	1,597	3,579
2008	538	186	1,266	1,102	3,092
2009	765	101	995	953	2,814
2010	1,181	4	1,192	1,114	3,491
2011	1,223	3	1,694	1,296	4,216
2012	1,117	335	1,510	1,109	4,071
2013	1,402	432	1,957	1,196	4,987
2014	1,373	577	1,677	1,106	4,733
2015	1,789	641	1,564	912	4,906
2016	1,859	739	1,496	891	4,985
2017	1,070	645	1,229	701	3,645
Total	**14,256**	**12,212**	**34,129**	**27,160**	**87,757**

Source: Deloitte calculations using transaction-level data provided by marketing boards.

Table 28: Number of aggregated observations with available stumpage price in the Marketing Board database, by marketing board and year of observation

	CV	NTH	SNB	YSC	Total
2000	N/A	212	N/A	35	247
2001	N/A	191	N/A	23	214
2002	48	192	1,198	774	2,212
2003	92	196	1,410	724	2,422
2004	51	199	1,527	820	2,597
2005	35	55	1,234	818	2,142
2006	26	70	682	579	1,357
2007	13	39	489	439	980
2008	96	27	398	325	846
2009	119	6	244	241	610
2010	295	0	423	268	986
2011	281	0	598	304	1,183

	CV	NTH	SNB	YSC	Total
2012	307	52	513	290	1,162
2013	372	80	675	408	1,535
2014	282	79	649	389	1,399
2015	361	122	774	314	1,571
2016	411	182	750	281	1,624
2017	259	200	602	265	1,326
Total	**3,048**	**1,902**	**12,166**	**7,297**	**24,413**

Source: Deloitte calculations using transaction-level data provided by marketing boards.
Note: the years are operating years.

As illustrated in the next series of tables, the stumpage price for softwood sawlog in the marketing board database and in the PWSS are mostly similar. While the average stumpage price for this specie and product in the Marketing Boards database is $19.2 per cubic metre, it averages between $15.5 and $16.9 per cubic metre in the PWSS, from 2014 to 2018. Softwood compose about 60% of wood harvested in New Brunswick any given year and, as such, those results provide sense of confidence on the inputs in our quantitative analysis.

Results for the comparison for hardwood sawlog stumpage prices between the PWSS and our Marketing Board database are not as compelling. In our database, across the whole time series, stumpage prices for hardwood sawlogs average $19.1 per cubic metre, compared to a range between $15.8 and $28 for the PWSS. A number of explanations may provide confidence in the marketing board dataset despite those apparent divergent results. First, the summary statistics for hardwood sawlog using the PWSS were calculated over a very limited number of observations. For example, only one mill record was used for this specie/product mix in 2014. This obviously limits the explanatory power of these statistics and increases volatility of statistics calculated from a year to another.

Table 29: Summary statistics of weighted and aggregated observations in the Marketing Board database

Variable	Product	Species	Number of Observations	Mean	Median	Max	Min	Standard deviation
Stumpage price ($/m3)	All	All	24,413	15.3	14.0	68.9	2.0	7.7
	Pulpwood	Hardwood	5,059	10.3	9.5	23.6	3.0	3.9
		Softwood	4,761	8.5	8.4	21.4	2.0	3.5
	Sawlog and Studwood	Hardwood	2,166	19.1	15.2	68.9	4.3	11.4
		Softwood	12,427	19.2	18.6	40.4	4.6	6.2
Volume (m3)	All	All	87,757	87.0	36.5	1,206.6	0.1	132.7
	Pulpwood	Hardwood	19,379	112.9	51.7	1,206.6	0.3	164.3
		Softwood	20,783	84.3	35.3	992.9	0.1	131.8
	Sawlog and Studwood	Hardwood	6,596	48.3	14.7	721.5	0.1	91.4
		Softwood	40,999	82.3	37.2	887.1	0.1	119.2

Variable	Product	Species	Number of Observations	Mean	Median	Max	Min	Standard deviation
Contractor rate ($/m3)	All	All	62,112	40.4	37.9	136.2	5.5	17.2
	Pulpwood	Hardwood	10,394	30.2	29.6	57.5	6.9	10.4
		Softwood	13,559	28.5	28.4	56.1	5.5	9.9
	Sawlog and Studwood	Hardwood	6,054	47.8	40.8	136.2	10.8	25.4
		Softwood	32,105	47.3	48.2	80.9	9.3	15.0
Trucking rate ($/m3)	All	All	47,996	13.2	12.3	60.0	3.7	5.8
	Pulpwood	Hardwood	9,013	14.1	13.5	28.0	4.4	4.8
		Softwood	11,915	11.5	10.9	27.0	3.7	4.7
	Sawlog and Studwood	Hardwood	3,378	13.1	12.8	29.0	5.8	3.6
		Softwood	23,69	13.8	12.6	60.0	4.6	6.7
Distance (Km)	All	All	53,926	54.1	41.3	283.0	0.9	46.0
	Pulpwood	Hardwood	7,209	65.2	51.5	203.4	0.9	44.3
		Softwood	9,631	52.7	38.6	262.9	2.6	42.6
	Sawlog and Studwood	Hardwood	4,154	45.5	42.4	232.9	0.9	28.8
		Softwood	32,932	53.2	39.6	283.0	1.0	48.6
Mill gate price ($/m3)	All	All	87,756	55.3	54.1	153.8	25.0	14.5
	Pulpwood	Hardwood	19,379	46.4	46.2	64.1	30.2	6.4
		Softwood	20,782	42.3	42.3	63.1	25.0	7.2
	Sawlog and Studwood	Hardwood	6,596	61.9	51.6	153.8	34.5	25.0
		Softwood	40,999	65.1	65.0	88.1	41.0	8.9

Source: Deloitte calculations using transaction-level data provided by marketing boards.
Note: Calculations were performed on aggregated and normalized data following methodologies described in sections above.

Table 30: Private Woodlot Stumpage Survey, Stumpage for softwood – sawlogs and studwood products, 2014-2018, dollar per cubic metre

Year	Mean	Number of observations	Min	Max	Standard deviation
2015 (Oct. 2014 – March 2015)	16.6	2,704	2	36	4
2016	16.9	7,145	1	63	5
2017	16.5	9,106	0	207	5
2016	15.5	6,393	0	156	5
2019 (March 2018 – Nov. 2018)	16.2	3,018	0	49	5

Source: Deloitte calculations using transaction-level data of New Brunswick Private Woodlot Stumpage Survey.

Table 31: Private Woodlot Stumpage Survey, Stumpage for hardwood – sawlogs and studwood products, 2014-2018, dollar per cubic metre

Year	Mean	Number of observations	Min	Max	Standard deviation
2015 (Oct. 2014 – March 2015)	28.0	32	9	73	12
2016	23.0	203	9	114	14
2017	22.5	110	9	45	7
2016	24.1	135	4	513	44
2019 (March 2018 – Nov. 2018)	15.8	62	1	85	14

Source: Deloitte calculations using transaction-level data of New Brunswick Private Woodlot Stumpage Survey.

Table 32: Private Woodlot Stumpage Survey, Stumpage for hardwood – pulpwood and roundwood chips, 2015-2019, dollar per cubic metre

Year	Mean	Number of observations	Min	Max	Standard deviation
2015 (Oct. 2014 – March 2015)	10.8	1,151	0	28	5
2016	12.8	2,080	1	36	7
2017	11.2	4,030	0	34	6
2016	9.4	2,926	0	41	5
2019 (March 2018 – Nov. 2018)	9.6	1,396	0	42	5

Source: Deloitte calculations using transaction-level data of New Brunswick Private Woodlot Stumpage Survey.
Note: The results shown in the table differ from those published in the document "New Brunswick Private Woodlot Stumpage Values" for two reasons: a) outliers are not excluded in this analysis b) product and species groups are different.

The next two tables show the values of HHI by products, years and market. The HHI is calculated by taking the market share of each firm in the industry, squaring them, and summing the result. By definition HHI values range between 0 and 10,000, with a smaller value indicating more intense competition. In this report, HHI is calculated for private wood supply only.

Table 33: HHI for sawlog and studwood, harvesting view, by market and year

Market area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CV	7,762	7,302	4,381	4,320	6,109	6,770	4,899	2,640	5,264	3,077	4,866	4,198	5,005	4,185	5,146	4,796	3,820	4,379
NTH	2,284	1,475	1,559	1,400	2,137	2,652	2,233	1,662	4,121	2,865	4,817	3,104	3,551	2,242	2,466	2,109	2,673	2,991
YSC-SW	4,244	2,775	2,507	3,271	3,624	2,803	2,649	2,565	5,167	5,902	3,910	4,277	3,902	3,131	3,049	3,489	7,481	5,588
SNB-SW	3,376	3,181	2,554	2,898	2,574	2,111	1,937	3,169	9,586	9,111	7,468	9,333	9,312	9,749	8,800	8,865	9,308	5,681
YSC-SNB-HW	3,832	2,253	4,089	4,354	3,015	3,280	3,455	3,713	4,414	4,957	8,558	7,393	3,019	4,412	3,582	3,806	4,944	2,573

Source: Deloitte calculations using TUS.
Note: Calculations are based on the sourcing location of the wood.

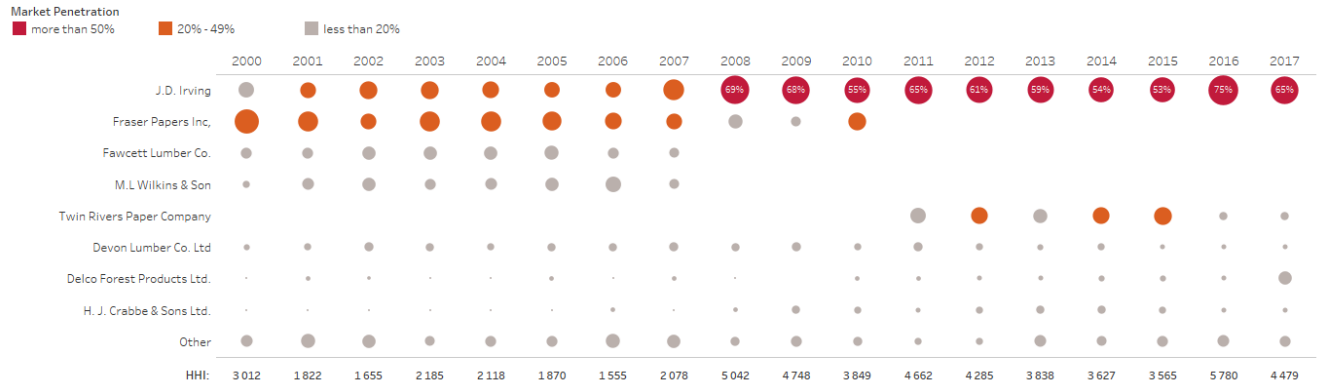
Table 34: HHI for pulpwood and roundwood chips, harvesting view, by market and year

Market area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CV	7,039	7,840	7,639	7,797	3,914	9,230	6,965	5,203	5,302	6,573	4,303	4,165	9,017	3,726	8,851	9,193	9,493	7,305
NTH	6,762	5,439	5,252	5,881	5,250	5,722	3,268	2,602	5,767	4,811	3,778	4,221	6,257	8,655	6,998	7,879	6,535	7,109
YSC-SW	4,052	6,238	6,244	5,641	5,370	8,484	6,402	3,404	5,708	8,669	8,177	9,137	9,721	9,419	5,986	9,088	9,574	8,901
SNB-SW	5,998	4,791	5,073	5,207	5,397	9,200	5,931	7,735	10,000	10,000	9,992	9,920	9,652	9,509	8,563	9,191	9,311	8,840
YSC-SNB-HW	6,071	7,962	4,948	4,433	3,684	6,465	5,207	6,573	5,030	3,782	3,856	4,814	4,097	4,144	3,648	4,007	3,323	4,464

Source: Deloitte calculations using TUS.
Note: Calculations are based on the sourcing location of the wood.

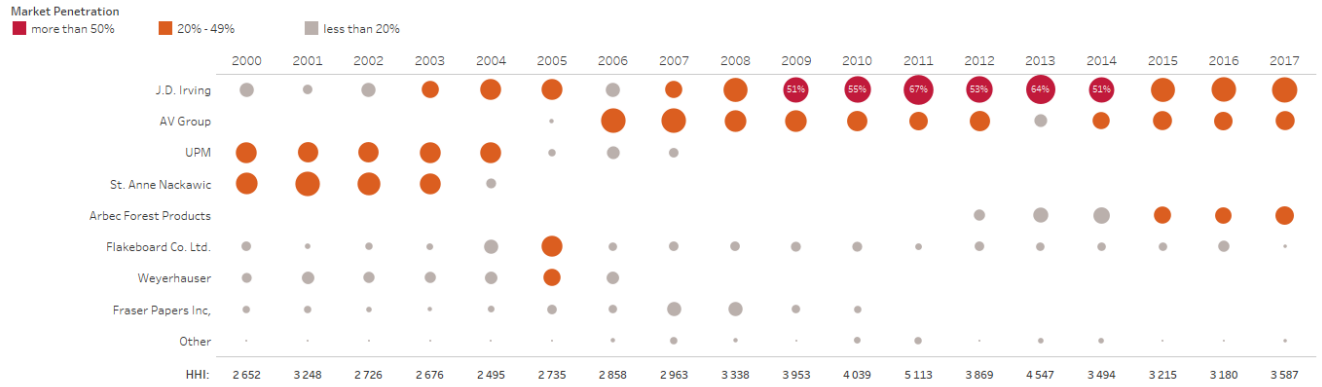
The charts below show the evolution of the market share by forest products company, which is a key component in the calculation of HHI.

Chart 78: Market concentration for sawlog and studwood for markets under review, by forest products company and year



Source: Deloitte calculations using TUS.

Chart 79: Market concentration for pulpwood and roundwood chips for markets under review, by forest products company and year



Source: Deloitte calculations using TUS.

To ensure validity of the HHI calculations, as a key input to our econometric modelling, we performed a deep-dive analysis of the causes for HHI changes over time, in each market area. As illustrated below, the HHI calculations perform as expected, with the index increasing when wood consumption becomes more concentrated and decreasing when wood consumptions is less concentrated.

Table 35: Sources of HHI changes over time and market areas, sawlog and studwood

CV	1.	2003/04 decrease in HHI due to St. Anne Nackawic decreasing consumption.
	2.	2004/05 increase in HHI due to AV Group acquiring St. Anne Nackawic and having 0 consumption in 2005.
	3.	2005/06 decrease in HHI due to AV Nackawic resuming operations.
	4.	2011/12 increase in HHI due to MLM Chipping closure and Twin Rivers Paper Co. – Edmundston decreasing consumption.
	5.	2012/13 decrease in HHI due to JDI – IP&P and Groupe Savoie increasing consumption.
	6.	2013/14 increase HHI due to Groupe Savoie decreasing consumption, JDI – IP&P no consumption.
NTH	1.	2007/08 increase in HHI due to closure of UPM Kymmene and 0 consumption for Groupe Savoie.
YSC	1.	2004/05 increase in HHI due to drop in consumption in UPM Kymmene and JDI IP&P.
	2.	2006/07 decrease in HHI due to increase in consumption in Flakeboard – St. Stephen and Fraser Papers – Edmundston.
	3.	2008/09 increase in HHI due to big increase in consumption in JDI – IP&P and JDI – Sawmill Sussex
	4.	2013/14 decrease in HHI due to AV Nackawic increase consumption and decrease in consumption in JDI – IP&P and JDI – Chip Plant Sussex.
	5.	2014/15 increase in HHI due to 0 consumption in AV Nackawic.
SNB	1.	2004/05 increase in HHI due to decrease in consumption in UPM Kymmene
	2.	2005/06 decrease in HHI due to UPM Kymmene increasing consumption and decrease consumption in JDI- Sussex
	3.	2007/08 increase in HHI due to closure of UPM Kymmene and JDI was the only market player.
YSC/SNB HW	1.	2001/02 decrease in HHI due to increase in consumption for St. Anne Nackawic and decrease in consumption for Flakeboard Company Ltd.
	2.	2004/05 increase in HHI due to AV Group acquiring St. Anne Nackawic and having 0 consumption in 2005. And JDI IP&P decreasing consumption.

Source: Deloitte calculations.

Table 36: Sources of HHI changes over time and market areas, pulpwood and roundwood chips

CV	1.	2005/2006 – Decrease in volume sourced to Fraser Paper – Juniper mill, partially offset by increase in volume sourced to Plaster Rock (owned also by Fraser Paper), but overall volume sourced to Frasers Paper decreased by almost 30k cubic metres.
	2.	2006/2007 – Decrease in volume – Fraser Paper (the mills decreased their consumption gradually until 2009), then Plaster Rock changed the owner.
	3.	2010 – Twin River acquired Plaster Rock mill from Fraser Paper and upgraded the mill and increased its capacity which resulted in increase of the production between 2009/2010.
	4.	2011/2012 – JDI closed Deersdale sawmill
	5.	JDI – Grand Lake Timber – this mill sourced its wood mainly from SNB and YSC, however between 2007 and 2011 it sourced partially from CV – that impacted the total volume sourced by JDI Group – fluctuated over the time.

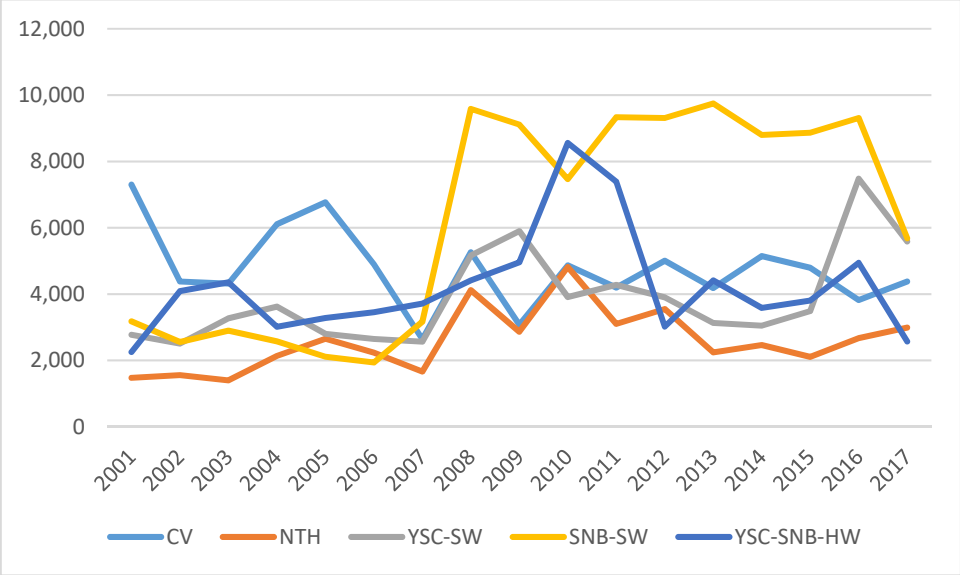
NTH	1.	2003/2004 – the overall consumption from this market increased by more than 50% and the major consumers consumed bigger proportion – Fawcett Lumber (in 2003 – they sourced 15k m3 and in 2014 40k), similar to UPM and Fraser Papers
	2.	2006/2007/2008 – overall decrease of the consumption by 40% in 2007 and 50% in 2008. Closure one of the major consumer – Fawcett Lumber in 2008. UPM Bathurst acquired by Fornebu Lumber –
	3.	2010 – Fornebu acquired Bathurst Lumber from UPM and in 20109 and increased its capacity which resulted in the mill becoming the major consumer in 2010.
	4.	Twin Rivers – Plaster Rock mill sourced partially from this MB in 2013, 2014 and 2015 – another consumer on the market – decrease of HHI
YSC	1.	2007/2008 – Overall decrease of the volume by 50%, closure of the M.L. Wilkins & Sons mill, also increase of the volume by JDI (they consumed 70% of the overall consumption in 2008 – resulting in higher HHI
SNB	1.	2008 – Overall decrease of the consumption by 50%, but JDI consumption decreased only slightly which resulted in JDI being the major consumer (taking up almost 100% of the overall consumption)
	2.	2008 – closure of the Fawcett mil
	3.	2017 – Delco Forest Product sourced a large portion in 2017 (90k) even though in all previous years the mill sourced only from SENB and NTH – resulting in decrease of HHI
YSC/SNB HW	1.	The overall consumption decreased from 9k m3 in 2000 to 400m3 in 2010. Not representative amount to be analyzed.
	2.	2010 – very small production – only by two mills – JDI and Garant, Div. of Hanson Kidde Canada
	3.	2012 – another two mills consumed something (total of four), but together – only 470m3

Source: Deloitte calculations.

Additional descriptive statistics charts are presented in Appendix B.

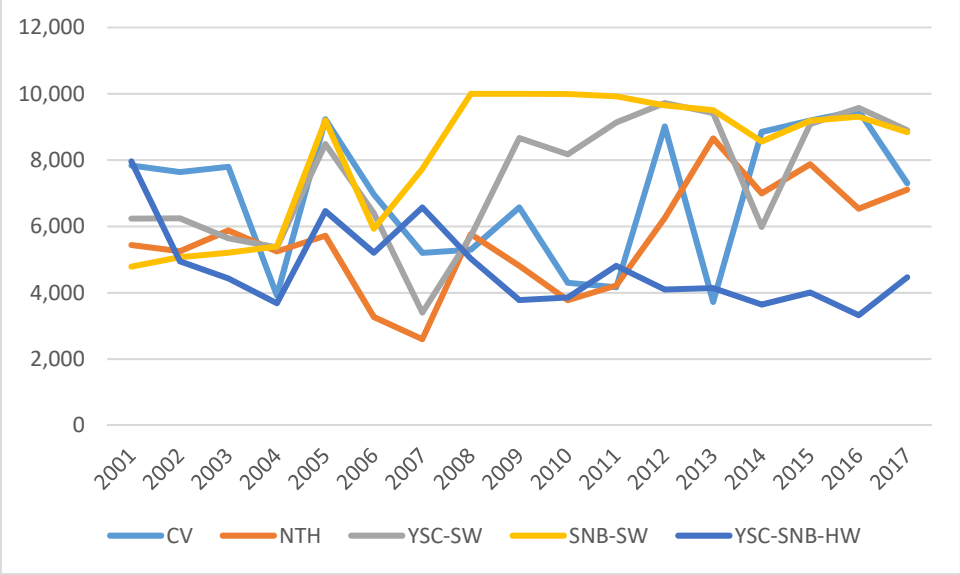
Appendix B: Additional summary statistics charts

Chart 80: HHI dynamics: Saw and Studwood



Source: Deloitte calculations, based on TUS data

Chart 81: HHI dynamics: Pulpwood and Roundwood Chips



Source: Deloitte calculations, based on TUS data

Appendix C: Additional regression tables

Table 37: Regression adding an interaction term between HHI and wood type, sawlog and studwood

	(1)	(2)	(3)	(4)
ln (US Housing Starts)	0.06**	0.11***	0.11***	0.15***
	(0.03)	(0.02)	(0.02)	(0.02)
ln (total mill consum)	0.14***	0.07***	0.07***	0.03**
	(0.02)	(0.02)	(0.02)	(0.01)
HHI	-0.27***	-0.26***	-0.81***	
	(0.02)	(0.02)	(0.28)	
HHI_SW			0.55**	-0.25***
			(0.28)	(0.02)
HHI_HW				-0.04
				(0.16)
ln (Frequency)	0.02***	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
ln (Trucking Rate)	-0.06***	-0.06***	-0.06***	-0.06***
	(0.01)	(0.01)	(0.01)	(0.01)
ln (Contractor Rate)	0.15***	0.15***	0.15***	0.14***
	(0.02)	(0.02)	(0.02)	(0.02)
YSC SW market	-0.01			
	(0.03)			
YSC-SNB HW market	0.49***			
	(0.12)			
NTH market	0.15**			
	(0.07)			
YSC MB		-0.11***	-0.11***	-0.15***
		(0.02)	(0.02)	(0.02)
NTH MB		0.04	0.04	-0.01
		(0.07)	(0.07)	(0.07)
Softwood		-0.22***	-0.44***	
		(0.08)	(0.13)	
Constant	0.35	1.18***	1.38***	1.21***

	(1)	(2)	(3)	(4)
	(0.22)	(0.14)	(0.18)	(0.17)
Observations	9,215	9,215	9,215	9,215
Adjusted R-squared	0.17	0.17	0.17	0.17
BIC	6361.91	6323.17	6325.95	6334.81
AIC	6290.62	6251.88	6247.54	6263.53
F-pval	0.00	0.00	0.00	0.00
Average VIF	21.04	8.38	73.92	5.26
Condition number	19.50	12.31	46.10	9.66

Source: Deloitte calculations.

Table 38: Regression adding an interaction term between HHI and wood type, pulpwood and roundwood chips

	(1)	(2)	(3)	(4)
ln(OSB CAD price)	0.07***	0.11***	0.13***	0.10***
	(0.02)	(0.01)	(0.01)	(0.01)
ln (Exchange Rate)	-0.22***	-0.24***	-0.15***	-0.26***
	(0.04)	(0.04)	(0.04)	(0.04)
ln (total mill consum)	-0.03***	0.02***	0.02***	0.00
	(0.01)	(0.00)	(0.00)	(0.00)
HHI	-0.56***	-0.54***	-0.02	
	(0.04)	(0.04)	(0.07)	
HHI_SW			-0.67***	-0.44***
			(0.07)	(0.03)
HHI_HW				-0.56***
				(0.06)
ln (Frequency)	-0.01**	-0.00	-0.00	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)
ln (Trucking Rate)	-0.07***	-0.01	-0.01	-0.04**
	(0.02)	(0.02)	(0.02)	(0.02)
ln (Contractor Rate)	0.03	-0.03	-0.02	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
YSC SW market	-0.05			
	(0.06)			
YSC-SNB HW market	-0.04**			
	(0.02)			
NTH market	0.08			
	(0.05)			

	(1)	(2)	(3)	(4)
YSC MB		0.21***	0.21***	0.18***
		(0.01)	(0.01)	(0.01)
NTH MB		0.21***	0.10*	0.20***
		(0.06)	(0.06)	(0.06)
Softwood		0.15***	0.51***	
		(0.02)	(0.04)	
Constant	2.55***	1.50***	1.06***	1.80***
	(0.23)	(0.14)	(0.14)	(0.13)
Observations	5,842	5,842	5,842	5,842
Adjusted R-squared	0.13	0.16	0.18	0.16
BIC	4259.10	4031.05	3955.75	4086.75
AIC	4185.70	3957.65	3875.67	4013.35
F-pval	0.01	0.00	0.00	0.00
Average VIF	5.75	1.91	8.74	2.61
Condition number	11.00	4.32	15.86	5.61

Source: Deloitte calculations.

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