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Effects of tax incentives on long-run capital formation and total factor productivity growth in the Canadian sawmilling industry

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ABSTRACT

The goal of this study was to analyze effects of tax incentives on long-run dynamics of total factor productivity (TFP) growth and capital formation in the Canadian sawmilling industry over a 40-year period (1961–2000). Simulated tax incentives involved *increasing* capital cost allowance and investment tax credit and *reducing* corporate income tax. The production technology was specified as a function of capital, labor, energy, sawlogs, and a time dependent technological progress variable. A translog multilateral index number model was applied to measure and analyze TFP.

Two analytical phases were followed. In the first phase, *without* the tax incentives, we analyzed annual levels and growth rates of TFP1; and parametrically examined effects of output growth and time dependent technology on the growth of TFP1. Over the study period, the average annual growth rate of TFP1 was 2%; and the parametric results revealed that the marginal effects of each of output growth and technological progress on TFP1 growth were highly significant. The second phase involved recalculation of the rental price of capital to estimate effects of the simulated tax incentives on capital formation and growth of TFP (=TFP2). As expected, the average annual share of capital in total cost *with* the tax incentives rose to 12% from 9% *without* the tax incentives. The average annual capital intensity also rose to real $15,263.70 *with* the incentives from real $10,402.91 *without* the incentives. Most importantly, higher capital formation, motivated by the tax incentives, raised aggregate quantity of the inputs significantly, leading to a slightly lower TFP2 than TFP1, because output was unchanged. In short, the data validated the hypothesis that tax incentives do indeed spur capital formation and TFP growth.

1. Introduction

1.1. The Canadian forest products sector: an overview of its importance

In 2005 the forest products sector accounted for 3% of Canada's GDP; contributed $31.9 billion to Canada's trade balance; employed a total of 864,000 persons (a total of direct, indirect, and induced); and more than 300 rural and remote communities were identified as dependent on the sector's operations (Canadian Forest Service, 2006b). The sawmilling industry dominates the Canadian forest products sector in many ways. The dramatic increase in the amount of timber harvested for lumber, the industry's principal product, shows prominence of the sawmilling industry. Utilization of sawlogs for lumber jumped from 32.60 million m^3 in 1940 to 164.4 million m^3 in 2002, while harvest for the other three end-uses, namely: pulpwood, fuelwood, and special uses, declined steadily (Fig. 1).

1.2. Challenges

Frequent industrial restructuring measures that involved industrial relocation and consolidation through mergers, acquisitions, plant closures, and workforce layoffs indicated that market and non-market forces challenged productivity performance of the Canadian sawmilling industry over the years. National organizations, such as the Canadian Chamber of Commerce (CCC) (2004) and the Forest Products Association of Canada (2006), attribute the industry's challenges to the national taxation policy prescriptions that raised capital cost. High marginal tax rates on individual income and savings; high effective tax rates on capital for corporate investments; withholding taxes on income paid to non-resident investors; low capital cost allowance that does not take into account the economic life- of a capital asset; and lack of investment in research and development (R&D) were identified as the main causes of total factor productivity (TFP) decline in Canada (CCC, 2004). Other sources of challenge that are mentioned in public policy papers and the press include: new sources of timber supply from low cost, fast growing plantations in the Southern Hemisphere; higher productivity levels achieved by Canada's traditional competitors in the marketplace; and technological advances in producing

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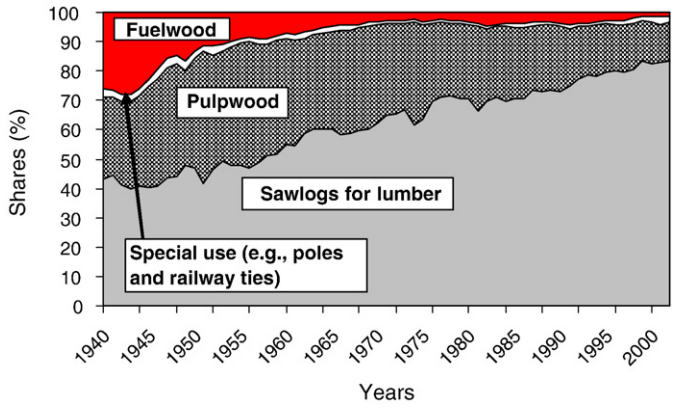

Fig. 1. Shares in total Canadian timber harvested by end-use: 1940-2002.

specialized, engineered products, such as aluminum, composite material, and plastic products that are substitutes for solid wood products.

Under these challenging circumstances, therefore, TFP growth is a vital driving force of the industry's competitiveness. In addition, society gains multiple benefits from TFP growth. Several of the societal gains are identified in the conclusions and policy implications section (Section 6).

1.3. Goal, hypothesis, specific procedural steps, and organization of the paper

The goal of this study is to analyze effects of tax incentives on the long-run capital formation and on TFP growth in the Canadian sawmilling industry over a 40-year period (1961–2000). It is hypothesized that tax incentives would raise the demand for capital stock by reducing its rental price, leading to enhanced capital formation and TFP growth. To test the hypothesis, we follow the following four steps:

First, calculate gross TFP *without* the tax incentives. Second, assess the effects of output growth and time dependent technological progress on the growth rate of TFP *without* tax incentives. Third, analyze the combined effect of *raising* capital cost allowance (CCA) and investment tax credit (ITC) and *reducing* corporate income tax (CIT) on capital formation and TFP growth by *recalculating* the rental price of capital and then by *re-running* the model described in Section 3.3. Forth, compute the difference between the two measures: TFP1, the *without* tax incentive, and TFP2, the *with* tax incentive to analyze the gap between these two measures. It is expected that TFP1 would be greater than TFP2, because capital stock increases, while output and the variable inputs of labor, energy, and materials remained unchanged. This leads to a larger aggregate input quantity that absorbs TFP down.

Including this introductory section, the paper is organized into six sections. Sections 2–4 present highlights of the literature, the theoretical framework, and the data, respectively. The empirical results are reported in Section 5, while Section 6 closes the paper with conclusions and policy implications of the findings.

2. Literature review

The available literature shows a wide gap of knowledge in terms of time, methods, analytical depth, and statistical adequacy of data used. Several studies, almost all of which were conducted in the 1980s, used annual data, covering less than or equal to 20-year data-points; and estimated transcendental logarithmic forms of cost functions to examine various aspects of the Canadian sawmilling industry's production technology (Nautiyal and Singh, 1985; Martinello, 1985; Banskota et al., 1985; Singh and Nautiyal, 1986). Only one of them was conducted in the early 1990s (Puttock and Prescott, 1992). Using a multilateral index number procedure, Ghebremichael et al. (1990) conducted an inter-regional comparative analysis of productivity in the Canadian sawmilling industry. These authors were unable to carry out TFP analysis, for lack of capital data at regional level. Instead, they estimated "variable factor productivity (VFP)", which is an aggregate quantity of output per unit of aggregate quantity of the variable inputs: labor, energy, and material.

This study differs from previous studies in the following five perspectives: Firstly, the study covers a longer time frame than any other previous study. Secondly, the Perpetual Inventory Method (PIM), which is detailed in Appendix A.2, is used in this study for calculating the rental price of capital. Ability to take into account the *opportunity cost* of various capital assets establishes credibility of the PIM procedure (Christensen and Jorgenson, 1969). Thirdly, this study treats the Canadian sawmilling industry as a multi-output and multi-input industry. Fourthly, no study has explored the effects of taxation policy incentives on capital formation and TFP growth in this industry. Fifthly, the translog multilateral index number (TMIN) model (Section 3.3), which has the following six important merits is applied in this study: (i) allows regional and international comparison; (ii) enables measurement of levels and growth rates of productivity; (iii) is easily understood by policy makers, business executives, and other non-specialists; (iv) avoids the problems often associated with specification and estimation of econometric models; (v) displays the results as index numbers, which draw attention to data anomalies, allowing the researcher to take remedial measures, unlike econometric models that tend to conceal data irregularities; and (vi) enables the researcher to examine productivity performance in terms of a wide range of measures, such as historical trends in the data and productivity indexes.

The main drawback of the TMIN model is that it does not provide the several parametric measures of technological change that an econometric model does. But, it is well known to the reader that an econometric method also has several pitfalls that we cannot detail here for lack of space.

3. Theoretical framework

This section establishes the foundation for the empirical work. To shed some light into the role of taxation in economic growth, the concept of capital formation and the neoclassical exogenous economic growth accounting framework are described first.

Capital formation means net addition to existing real capital stock, after the removal of depreciation cost allowance. Both capital formation and technological progress are the key determinants of a long-run productivity growth.

3.1. The role of tax incentives in the neoclassical exogenous growth model

Assessing the effects of taxation policy instruments on annual flow of investment and technological progress is necessary for explaining the role of taxation in economic growth (Boskin, 1988).[1] To that effect, looking into the workings of the Keynesian macroeconomic model of aggregate demand management provides helpful insights. Keynes' model suggests that tax incentives spur saving and thereby capital formation and business liquidity, leading to enhanced aggregate demand and reduced unemployment. Based on these conceptions, Solow (1957), winner of the 1987 Nobel Prize in economic science, developed the neoclassical economic growth accounting framework.

[1] Jorgenson and Yun (1990), Quadrini (1999), Kneller et al. (1999), and Myles (2000) are excellent additional references.