

Deforestation and Development in a Small Open Economy¹

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Our economy faces world prices and starts with a large endowment of land in forest and a small endowment of land in agriculture. Clearing of forested land yields marketable timber and a unit of land for agriculture. Early, the high price of agricultural land drives the clearing process. Later, the profit from marketing timber from the cleared land drives the process. Dates of “phase transitions” are endogenous. We also set out a submodel of perpetual cyclic clearing and reforestation, and show that it when cyclical harvesting–regrowing is optimal, the extent of clearing can be relatively large. © 2000 Academic Press

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1. INTRODUCTION

We investigate the argument that deforestation is a market mediated stock adjustment for a hypothetical small open economy that “opens” with “too much” land in forestry relative to agriculture. Deforestation or stock adjustment is formulated as gradual in our model, with three phases: clearing timber at a loss per tree cut, clearing timber at a surplus per tree and at a surplus per unit of agricultural land opened up, and clearing forested land at a loss per unit of agricultural land open up. The latter phase raises the question of whether, once the trees are cleared, it might not be most profitable to return the land recently converted to agriculture, back to marketable timber. We investigate the possibility of such a cycle as being the equilibrium outcome of our process of land conversion. We find support for a terminal phase of cyclical clear cutting for part of the originally forested land.

We come at this topic with the history of Canada and the United States in mind. There were small open economies, starting with an underendowment of agricultural land and deforestation was a natural process, taking place within a system of

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markets. These are our stylized small open economies. A small, open economy generating revenue for consumption and investment from natural capital is known in the literature as a “staples economy” [8, 14], and our analysis can be viewed as an instance of the staples theory of development.²

In contrast with Faustmann [4], our cycling model has the *area* left for the re-growth of trees as the control variable, rather than the size or age of the trees. The cycle involves then a fixed interval of re-growth and an endogenous interval of re-clearing. If an end phase of cyclical timbering is optimal, we observe examples in which the start of “replanting” occurs with more land cleared than would have been cleared in the solution with cycling ruled out, a priori. The possibility of a terminal mode of cyclical timbering “pushes” the margin of cleared land relatively far. We find that it may be optimal to push this margin beyond the level that would be the optimal steady state in the “benchmark case” (examined in Section 2) where cycling is not permitted. We refer to this result as the possibility of overshooting the steady state level of forest land area. That is, the economy may first clear more land than the steady state of the benchmark case as the initial state of cycling is started. There are some indications that this is happening in certain areas, particularly in North America. There is, of course, an alternative explanation: one could argue that the economic and technological conditions have changed so that the steady-state amount of cleared land has changed.

A complete model of development of virgin territory would have immigration a central component, and would consider the allocation of labor among three activities, sustainable agriculture, sustainable activity on forested land, and land clearing. This was done in a fuller version of this paper. To economize space, in this paper we abstract from these issues and take up a specialized version, with the labor allocation at each date left implicit. In this simpler model, there is a single control, the amount of land to clear, and a single state variable, the amount of land in forest at each date. Using this model we can address the possibility of a perpetual cycle of clearing–regrowing.

2. THE BASIC MODEL

The economy’s endowment of land is normalized to one unit. $f(L)$ is current output from land in sustainable forestry and $g(1 - L)$ is current output from land in sustainable agriculture. For simplicity, we assume that the country is a small open economy, so that the prices of its products are given in the world market. The price of the agricultural product is normalized at unity, and the price for forestry product (a composite good, including nut and sap, etc.) is ψ . Harvested timber, obtained from land clearing activity, is sold at the price p . Land rents in forestry and agriculture are $\psi f'(L)$ and $g'(1 - L)$, respectively. The functions $f(\cdot)$ and $g(\cdot)$ are taken to be strictly concave. $C(R)$ is the total cost of clearing R hectares and

²Staples theory is associated with the name Harold Innis but was set out first in MacKintosh [14]. The two ideas in the theory are natural resource exports leading the growth process and the particular exported product having backward linkages into the economy doing the exporting, linkages which contribute to the development process. Marvin McInnis (Queen’s Economics) argues that timber and lumber exports from Canada constituted a staple in the sense of MacKintosh and Innis for the period 1820–80.

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