



# Depreciation rules and value invariance with extractive firms

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## Abstract

The application of Samuelson's theorem on value invariance to the case of intertemporally optimizing firms is shown to require a judiciously chosen economic depreciation formula which depends on both current stock and current flow variables, in order to prevent the firms from changing their actions in the face of the tax regime. We illustrate by deriving depreciation rules which achieve non-distortingness of actions and value-invariance for resource-extracting firms. © 2002 Elsevier Science B.V. All rights reserved.

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## 1. Introduction

Samuelson (1964) proved the following fundamental theorem of value invariance:<sup>1</sup> 'if, and only if, true loss of economic value is permitted as a tax-deductible depreciation expense will the present discounted value of a cash–receipt stream

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<sup>1</sup> Sinn (1987, p. 119) refers to this result as the Johansson–Samuelson theorem, since the idea also appeared in Johansson (1961) in Swedish. Fane (1987) also refers to Johansson (1961,1969).

be independent of the rate of tax' (p. 604). Value invariance is important because it is *efficiency-enhancing*: it is a sufficient condition for neutral business taxation, under the assumption (which we maintain throughout this paper) that the tax does not cause the rate of interest to change.<sup>2</sup> In particular, in the case of natural resources, ownership of a resource deposit should not be dependent on one's marginal tax rate, but on one's comparative advantage of managing it. In general, however, neutrality with respect to investment does not require value invariance: it only requires that the sign of net present value of all investment projects remain unchanged when the tax is imposed.<sup>3</sup> Value invariance is a strong form of neutrality. Many authors have sought weaker (i.e., less demanding) forms of neutrality.<sup>4</sup>

In this paper, we pursue the issue of value invariance in the context of taxation of natural resource firms because this strong form of neutrality does imply extraction path invariance, which is desirable in the sense that distortions are avoided. Admittedly, we are abstracting from the more important but more difficult question: what is the best set of biases (distortions) to have, given that some sort of distortions is unavoidable? We restrict our attention to the following question: can we be sure that the Samuelsonian economic depreciation will ensure value invariance and extraction path invariance, if firms try to reduce the tax burden by contemplating deviation from the extraction path which would be optimal under the no-tax scenario?

In the analysis of resource extraction firms, each with a given resource stock (we abstract from capital equipment for simplicity), resource economists are often interested in the effects of taxation on the time path of extraction, which may be regarded as disinvestment, since extraction reduces the resource stock. (See, for example, Dasgupta and Heal, 1979; Gaudet and Lasserre, 1986). The purpose of this paper is to explore the invariance issue in the context of extractive firms. As will be seen below, in this context, value invariance goes hand-in-hand with extraction path invariance to the tax rate. If one interprets each feasible extraction path as an investment project (or, rather, disinvestment project), then the invariance of the firm's optimal extraction path to the tax rate

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<sup>2</sup> The rate of interest would not be affected by the tax rate if (a) we are dealing with a small open economy that can borrow or lend at the world rate of interest, which the small country takes as exogenously given, or (b) the marginal product of capital in the economy is constant over the relevant range. The assumption that the nominal discount rate is unchanged by the presence of the tax is a standard one, see, for example, Bond and Devereux (1995, p. 59). In this paper we take this partial equilibrium approach. For a model that takes into account the effect of taxation on the equilibrium interest rate, see Long and Sinn (1984).

<sup>3</sup> The cash flow tax, for example, is neutral but does not imply value invariance; in this paper, we assume that the cash flow tax is not available.

<sup>4</sup> For example, the tax proposal in Bond and Devereux (1995) achieves neutrality by 'imposing no tax on marginal investment projects; revenue is raised by taxing the pure profits or economic rents earned on infra-marginal investment'. (p. 58).

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