Chapter 6

A COMPARISON BETWEEN MULTINOMIAL LOGIT AND PROBIT MODELS

Analyzing the Determinants of Environmental Innovations

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Abstract
Although the estimation of flexible multinomial discrete choice models generally needs the incorporation of simulation methods, their application is recently common in environmental and resource economics such as in many other economic disciplines (e.g. transportation economics). Based on a firm level data set of the German manufacturing sector, this paper examines determinants of environmental innovations by comparing the estimation results in flexible multinomial probit models and restrictive multinomial logit and independent probit models. The analysis of the two latter models implies that some specific environmental organizational measures, technological opportunities, and market pull factors have a significantly positive effect on both environmental product and process innovations. Taking this into consideration, the flexible multinomial probit model analysis provides few new insights since the simulated maximum likelihood estimations are rather unreliable as a consequence of the sole inclusion of firm-specific characteristics as explanatory variables. In this respect, the incorporation of simulation methods into the maximum likelihood estimations is not crucial since the problems do not decrease if the number of random draws in the considered Geweke-Hajivassiliou-Keane simulator rises. Furthermore, the difficulties grow if the number of choice alternatives increases. It can therefore be concluded that the applicability of these flexible multinomial discrete choice models without the incorporation of choice-specific attributes as explanatory variables is rather limited in practice.

Keywords: Environmental innovations, double dividend, multinomial probit.
1. Introduction

Although the estimation of flexible multinomial discrete choice models generally needs the incorporation of simulation methods due to the underlying multiple integrals, their application has only recently become common in environmental and resource economics (see e.g. Björner et al., 2004, Rennings et al., 2004) as well as in many other economic disciplines (e.g. transportation economics, see Bolduc, 1999, Brownstone and Train, 1999, Greene and Hensher, 2003). Based on a firm level data set of the German manufacturing sector, this paper examines determinants of different types of environmental innovations as a measure of environmental performance by comparing the estimation results in multinomial probit models (MPM) and multinomial logit models (MLM). The background is that such environmental innovations receive increasing attention from policy makers and scholars since they are expected to produce a double dividend, i.e. limit environmental burden and contribute to the technological modernization of the economy (see Rennings, 2000, Jaffé et al., 2002).

It is well-known that the popular MLM (see McFadden, 1974) have restrictive properties due to the underlying assumptions regarding the stochastic model components. Whereas the independent MPM are still rather restrictive (see Hausman and Wise, 1978) due to the independence assumption in these components, the flexible variants of the MPM (see e.g. Börsch-Supan and Hajivassiliou, 1993) are a general framework since they allow correlations between the choice alternatives of the dependent variable. Indeed, the application of flexible MPM requires the inclusion of simulators into an estimation method due to the underlying multiple integrals in the choice probabilities. In this paper, the maximum simulated likelihood method (MSL), i.e. the simulated counterpart of the maximum likelihood method (ML), incorporating the so-called Geweke-Hajivassiliou-Keane (GHK) simulator (see Börsch-Supan and Hajivassiliou, 1993, Geweke et al., 1994, Keane, 1994) is considered, since its use seems to be advantageous compared with the use of other combinations of classical estimation methods and simulators.1

This paper is organized as follows: In the second section, the methodological approach as well as the dependent and explanatory variables for the empirical analysis are explained. The third section provides some details concerning the firm level data set. In the fourth section, the estimation results in the differ-

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1A general practical advantage is that the MSL estimation of MPM has been implemented directly in some software packages (e.g. GAUSSX and LIMDEP) in contrast to other simulated classical estimations of MPM and also (to my knowledge) in contrast to the MSL estimation of mixed logit models as alternative flexible multinomial discrete choice models (see e.g. Revelt and Train, 1998, Brownstone and Train, 1999, McFadden and Train, 2000, Greene and Hensher, 2003, Björner et al., 2004).