Evaluating the Impact of the Introduction of a Carbon Tax in Portugal Using Input-Output-based Models

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This paper presents the methodology and results for the evaluation of the macroeconomic, fiscal and environmental impact of the introduction of a carbon tax in Portugal, using a multisectoral (input-output based) model (MODEM 7) combined with an input-output (I-O) price model, considering different levels and scopes for this tax as well as alternative ways of recycling the additional corresponding public revenue. MODEM 7 is a multisectoral model (with 85 industries), which includes an input-output based block (determining output, employment and taxes and subsidies on products, as well as imports by products, assuming that supply is determined by final demand, in line with the classic input-output Leontief model). All components of final demand are exogenous, with the exception of private consumption, which is determined by private disposable income. The model includes also macroeconomic equations determining private disposable income and consumption, GDP, total employment, the unemployment rate and fiscal variables which allow the determination of public deficit and debt. In alternative, a fiscal policy rule may be included in model simulations, imposing, for example, no deterioration of public deficit compared to a reference scenario and making the adjustment through a chosen fiscal variable. All variables are defined at current prices, assuming that, for each model simulation, there are no price changes within each year. All equations are static, except for public debt. The model determines also CO_2 emissions through the application of emission coefficients to each product's output and to households' consumption. Model coefficients were estimated on the basis of a system of I-O tables for Portugal, 2008, as well as of other data from Portuguese national accounts and from the environmental satellite accounts. Most of the equations (702) are simultaneously determined.

A carbon tax applied to CO_2 emissions resulting from fossil fuel combustion implies, as a primary effect, the increase in fossil fuel prices. An input-output price model (disaggregated into 85 products and calibrated with the same system of I-O tables used for MODEM 7) was used to estimate the direct and indirect effects of this tax on each product's basic price, as well as on purchaser's price for the various demand components and products, using a cost-push assumption for price determination.

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The price effects simulated with the price model for each carbon tax scenario (tax level and scope) were subsequently used to reestimate MODEM's nominal input-output coefficients, assuming that I-O coefficients (for intermediate consumption) remained unchanged in real terms. Final exogenous demand was assumed to remain constant in nominal terms (equal to the, before-tax, reference scenario), except for Change in Inventories, which was assumed to remain constant in volume for each product. After these adjustments, simulations were performed, with the adjusted MODEM, for various levels and scopes of the carbon tax, with no fiscal policy rule (without recycling additional tax revenue) as well as with a fiscal policy rule imposing an unchanged public deficit (compared to the reference scenario) and making the adjustment through various alternative variables: other tax cuts (households or company income taxes) or the increase in different types of expenditure (Education, R&D, investment in infrastructures and incentives to private investment), i.e., considering alternative ways of recycling the additional net revenue resulting from the carbon tax introduction. The impacts of the carbon tax introduction were obtained, for each alternative simulation, from the comparison between the scenario "with the carbon tax" and the reference scenario (without the carbon tax). These comparisons were made both in nominal and in real terms (after deflating the results from the scenarios "with tax" with the appropriate price deflators, obtained from the I-O price model simulation). The results from this study suggest that, while the introduction of a carbon tax without recycling the additional public revenue has a negative impact on

the economy, recycling this revenue through the reduction of direct taxes may not be enough to totally reverse this negative effect and that better economic global effects may be achieved if this revenue is recycled through certain types of public expenditure such as those having simultaneously a low unit (direct+indirect) import content (and, therefore, a positive short-term impact on GDP), and also contributing to the increase in total factor productivity, such as investment in human capital and in R&D (with a positive long-term effect on potential output).