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Pereira, Alfredo and Pereira, Rui

College of William and Mary, College of William and Mary

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OF AN INCREASE IN THE VAT ON ELECTRICITY IN PORTUGAL

Alfredo Marvão Pereira,[1*] Rui Marvão Pereira [1]
Department of Economics, The College of William and Mary

* Corresponding author: ampere@wm.edu, College of William and Mary, Williamsburg, VA 23187, USA

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ABSTRACT

In this paper we analyze the budgetary, economic, distributional and environmental effects of a permanent increase in Portugal of the value added tax on electricity spending. The analysis in conducted in the context of a new multi-sector and multi-household dynamic general equilibrium model of the Portuguese economy. Simulation results suggest that a permanent increase in the VAT on electricity from 6% to 23% has positive budgetary and environmental effects but both come at the cost of detrimental economic and distributional effects. As economic performance in Portugal improves and the public budgetary situation becomes less constraining, it is inevitable that pressure will mount for this increase in the VAT rate on electricity to be reversed. This mixed bag of results provides an important element in this debate. Reverting to a VAT tax rate of 6% on electricity, would improve economic performance and have positive distributional effects. From this perspective such reversion would be desirable. The question is then whether or not the public budget can somehow compensate for the loss of revenues in a way that would not eliminate the positive economic and distributional effects of such reversion.

INTRODUCTION

An increase in the Value Added Tax [VAT, hereafter] rate on electricity purchases from 6% to 23% was introduced in late 2011. This increase – designed essentially as a revenue generating measure – was part of a rather extensive austerity plan implemented by the Portuguese authorities in the context of the international bailout under the auspices of the European Commission, the European Central Bank, and the International Monetary Fund.

Naturally, this austerity measure was greeted with widespread concern for its potential economic, equity and environmental effects. On the economic front, the main concerns have centered on its potentially detrimental effects on economic performance. On the equity front, the regressive distributional effects were a matter of great concern. Finally, in the environmental front, the worry was that this measure would lead to a shift away from the use of electricity and to the alternative use of less environmental friendly forms of energy. Almost six years after this measure was introduced, and although there has been a significant improvement in both the economic and budgetary conditions in the country, there is no sign that this measure will be reversed. Accordingly, there is a very pertinent policy question of evaluating the effects of this measure on the public account – by any reckoning the rationale for its introduction – and to attempt to measure the possible detrimental effects on economic performance, social equity and the environment. Ultimately, our objective is to inform the question of whether or not the possible revenue benefits of this measure might outweigh any potential adverse economic, distributional, or environmental costs.

The economic, budgetary, distributional, and environmental effects of this increase in the VAT on electricity in Portugal are analyzed in the context of a multi-sector, multi-household, dynamic general equilibrium model of the Portuguese economy. From a methodological perspective, this work is based on a newly developed disaggregated dynamic general equilibrium model of the Portuguese economy. This new model builds upon the aggregate dynamic general equilibrium model of the Portuguese economy DGEP. Previous versions of this model are documented in Pereira and Pereira (2012) and have been used to evaluate the impact of tax policy [see Pereira and Rodrigues (2002, 2004)], of public pension reform [see Pereira and Rodrigues (2007)], and more recently of energy and climate policy issues [see Pereira and Pereira (2014a, 2014b, 2016a, 2016b)]. An important shortcoming of the previous version of the model was its aggregated nature – it was based on a representative consumer and a representative producer. The new version of the model, while keeping the richness of the dynamic framework and the detailed modelling of the public sector, disaggregates the economy into five household income groups and thirteen production sectors. Furthermore, it greatly develops the energy module of the model to accommodate the use of different primary energy sources, different forms of final energy production, namely of electricity from conventional sources and from renewables, and different final uses by households and productions sectors. Emissions of CO_2 are calculated based on the use of primary energy sources – coal, oil, natural gas, according to fixed technical proportions.

Equally important, from a methodological perspective, this work is part of a joint project on the role of electricity in the process of de-carbonization of the Portuguese economy with a team working with the TIMES-PT model [see for example, Simões, Cleto et al (2008) and Fortes, Pereira, et al. (2014)]. This means that the reference scenarios considered are either jointly determined – as for example, the evolution of international fossil fuel prices or the extent of carbon pricing, or based on the technological projections of the TIMES-PT model – as for example, the evolution of energy efficiency. While the results presented here are outside the immediate scope of our joint project they were generated as part of the economic model building and calibration efforts in that context. Furthermore, these results are the first generation of policy results generated by our new model in this joint research context and should, therefore, be understood as somewhat tentative.

THE DYNAMIC GENERAL EQUILIBRIUM MODEL

We present here a very brief and general description of the design and implementation of the new multisector, multi-household dynamic general equilibrium model. For full documentation see Pereira and Pereira (2017).

The General Features

The dynamic multi-sector general equilibrium model of the Portuguese economy incorporates fully dynamic optimization behavior, detailed household accounts by quintile of income, detailed industry accounts for thirteen sectors of economic activity, a detailed modeling of the public sector activities, and a detailed description of the energy sectors. We consider a decentralized economy in a dynamic general equilibrium framework. All agents are price-takers and have perfect foresight. With money absent, the model is framed in real terms.

There are four types of agents in the economy: households, firms, the public sector and a foreign sector. All agents and the economy in general face financial constraints that frame their economic choices. Households and firms implement optimal choices as appropriate to maximize their objectives. Households maximize their intertemporal utilities subject to an equation of motion for financial wealth, thereby generating optimal consumption, labor supply, and savings behaviors. Firms maximize the net present value of their cash flow subject to the equation of motion for their capital stock to yield optimal output, labor demand, and investment demand behavior. The public sector and the foreign sector, in turn, evolve in a way determined by the economic conditions and their respective financial constraints. The different agents interact through demand and supply mechanisms in different markets: commodity markets, factor markets, and financial markets. All markets are assumed to clear.

The evolution of the economy is described by the optimal and endogenous change in the stock variables – five household-specific financial wealth variables and thirteen sector-specific private capital stock variables, and their respective shadow prices/co-state variables. In addition, the evolution of the public debt and of the foreign debt act as resource constraints in the overall economy. The endogenous and optimal changes in these stock variables – investment, saving, public deficit, and current account deficit - provide the endogenous and optimal link between subsequent time periods. Accordingly, the model can be conceptualized as a large set of non-linear difference equations where critical flow variables are optimally determined through optimal control rules.

The intertemporal path for the economy is described by the behavioral equations, by the equations of motion of the stock and shadow price variables, and by the market equilibrium conditions. We define the steady-state growth path as an intertemporal equilibrium trajectory in which all the flow and stock variables grow at the same rate while market prices and shadow prices are constant.

Calibration

The model is calibrated with data for the period 2005-2014 and stock values for 2015. The calibration of the model is ultimately designed to allow the model to replicate as its most fundamental base case, a stylized steady state of the economy as defined by the trends and information contained in the data set. In the absence of any policy changes or any other exogenous changes the model implementation will just replicate forward such stylized economic trends. Counterfactual simulations allow for identifying the marginal effects of any policy or exogenous change as deviations from the base case.

There are three types of calibration restrictions imposed by the existence of a steady-state. First, it determines the value of critical production parameters, like adjustment costs and depreciation rates given the initial capital stocks. These stocks, in turn, are determined by assuming that the observed levels of investment of the respective type are such that the ratios of capital to GDP do not change in the steady state. Second, the need for constant public debt and foreign debt to GDP ratios implies that the steady-state public account deficit and the current account deficit are a fraction of the respective stocks of debt equal to the steady-state growth rate. Finally, the exogenous variables, such as public transfers or international transfers, have to grow at the steady-state growth rate.

Numerical Implementation

The dynamic general equilibrium model is fully described by the behavioral equations and accounting definitions and thus constitutes a system of nonlinear equations and nonlinear first order difference equations. No objective function is explicitly specified due to the fact that each of the individual problems (the household, firm and public sector) are set as first order and Hamiltonian conditions. These are implemented and solved using the GAMS (General Algebraic Modeling System) software and the MINOS nonlinear programming solver.

MINOS uses a reduced gradient algorithm generalized by means of a projected Lagrangian approach to solve mathematical programs with nonlinear constraints. The projected Lagrangian approach employs linear approximations for the nonlinear constraints and adds a Lagrangian and penalty term to the objective to compensate for approximation error. This series of sub-problems are then solved using a quasi-Newton algorithm to select a search direction and step length.

SIMULATION RESULTS

We now turn to the evaluation of the effects of a permanent increase in the VAT on electricity. We focus on the budgetary, economic, distributional and environmental impacts. More detailed results at the disaggregated level for the households, the different production sectors, the public account, the foreign account, and the energy sectors are available from the authors upon request. All results are reported vis-à-vis a steady state trajectory for the economy reflecting the trends for the

On the Budgetary Effects

The increase in the VAT rate on electricity translates – as desired - into a net increase of tax revenues. This is because of a large increase in the VAT revenues of 1.541% in the long-term. This increase more than compensates for small declines in the personal income tax and social security tax collections, of 0.010 and 0.015 respectively, associated with a reduction in economic activity and employment induced by the VAT increase [more on this below]. Overall, this increase in tax revenues leads to a reduction in public deficits over time, to up to 11.991% in the long term. Because of the debt dynamics, a reduced debt translates into a decreasing commitment on interest payments which, in turn, reinforces the positive revenue effects of the VAT tax increase. In the long term, the progressive decline of the public debt would reach 4.317%.

Table 1: On the Budgetary Effects of an increase in the VAT on Electricity

(% change relative to status quo)

	2025	2030	2035	2040	2045	2050
Value Added Tax	1.542	1.539	1.538	1.538	1.539	1.541
Personal Income Tax	-0.013	-0.011	-0.010	-0.010	-0.010	-0.010
Social Security Contributions	-0.018	-0.016	-0.015	-0.015	-0.015	-0.015
Interest Payments	-1.067	-1.646	-2.259	-2.906	-3.592	-4.317
Public Deficit	-7.615	-8.570	-9.583	-10.655	-11.789	-12.991
Public Debt	-1.067	-1.646	-2.259	-2.906	-3.592	-4.317

On the Economic Effects

In terms of its economic impact, the VAT rate increase on electricity has a negative effect in overall economic performance. GDP and employment decline in the long term by 0.054% and 0.014% respectively, a reduction led by a decline in private consumption of 0.024%. The foreign balance, however, improves somewhat in the long term as the VAT tax rate hike increases exports by 0.273% and decreases imports by 0.010%. In the long-term, helped by the interest rate dynamics, the current account balance would improve by 9.026%. Overall, the foreign debt would progressively decline over time to reach in the long-term a reduction of 2.521%.

Table 2: On the Economic Effects of an increase in the VAT on Electricity

(% change relative to status quo)

	2025	2030	2035	2040	2045	2050
Gross Domestic Product	-0.045	-0.045	-0.046	-0.049	-0.051	-0.054
Private Consumption	-0.259	-0.255	-0.252	-0.250	-0.249	-0.248
Public Consumption	0.043	0.053	0.058	0.061	0.062	0.061
Private Investment	0.266	0.181	0.117	0.069	0.034	0.008
Exports	0.170	0.212	0.240	0.258	0.268	0.273
Imports	-0.007	-0.005	-0.005	-0.006	-0.008	-0.010
Current Account Deficit	-3.598	-4.823	-5.946	-7.001	-8.020	-9.026
Foreign Debt	-0.340	-0.654	-1.041	-1.487	-1.983	-2.521
Employment	-0.016	-0.015	-0.014	-0.014	-0.014	-0.014

On the Distributional Effects

The increase in the VAT rate on electricity represents for the households a loss in purchasing power and reduced consumption. The associated welfare loss is measured by the equivalent variation or the amount of compensation as percentage of income that the household would require to be able to reach its original level of utility given the new price conditions. In all cases we observe a welfare loss. This welfare loss, however, is clearly regressive with the compensation required by the lowest income group is about four times the compensation required by the highest income group – a long-term compensation of 0.210% for the lowest income group and 0.064% for the highest income group. This is due to the fact that electricity spending is a declining share of income and therefore the effects for lower income groups are amplified.

Table 3: On the Distributional Effects of an increase in the VAT on Electricity

(% change relative to status quo)

	2025	2030	2035	2040	2045	2050
			Equivalent Variations			
First Quintile (Lowest Income)	-0.216	-0.212	-0.210	-0.209	-0.209	-0.210
Second Quintile	-0.167	-0.164	-0.162	-0.161	-0.161	-0.162
Third Quintile	-0.137	-0.133	-0.132	-0.131	-0.131	-0.132
Fourth Quintile	-0.114	-0.111	-0.109	-0.109	-0.109	-0.109
Fifth Quintile	-0.066	-0.064	-0.062	-0.062	-0.062	-0.062

On the Environmental Effects

Finally, the effects of the VAT rate increase on electricity on CO2 emissions are favorable. We estimate a long-term reduction in emission of 0.514%, with reduction in emissions by both households and production activities of 0.167% and 0.534%, respectively. Clearly, although this is a favorable outcome from a strict environmental perspective, it is clouded by the fact that it essentially due to the reduction in economic activity induced by the VAT tax hike and as such not necessarily a desirable way of reducing emissions.

Table 4: On the Environmental Effects of an increase in the VAT on Electricity

(% change relative to status quo)

	2025	2030	2035	2040	2045	2050
Economy-wide	-0.520	-0.514	-0.512	-0.511	-0.512	-0.514
Households	-0.173	-0.173	-0.171	-0.170	-0.169	-0.167
Production	-0.541	-0.535	-0.532	-0.531	-0.532	-0.534

CONCLUSIONS AND FURTHER RESEARCH

In this paper we analyze the budgetary, economic, distributional and environmental effects of a permanent increase in Portugal of the value added tax on electricity spending. The analysis in conducted in the context of a new multi-sector and multi-household dynamic general equilibrium model of the Portuguese economy. Simulation results suggest that a permanent increase in the VAT on electricity from 6% to 23% has positive budgetary and environmental effects but both come at the cost of detrimental economic and distributional effects.

As economic performance in Portugal improves and the public budgetary situation becomes less constraining, it is inevitable that pressure will mount for this increase in the VAT rate on electricity to be reversed. This mixed bag of results provides an important element in this debate. Reverting to a VAT tax rate of 6% on electricity, would improve economic performance and have positive distributional effects. From this perspective such reversion would be desirable. The question is then whether or not the public budget can somehow compensate for the loss of revenues in a way that would not eliminate the positive economic and distributional effects of such reversion.

Overall, it would seem that this is yet another issue in which a comprehensive approach to budget policy as opposed to a piece-meal approach is necessary. As tempting as it would be to endorse a reversal of the VAT rate increase based on the negative economic and distributional effects we have identified, the key is to realize that only a comprehensive reform of the public sector policies – both taxes and expenditures – will provide a picture of the effects of such a reversal with enough definition.

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