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A GENERAL EQUILIBRIUM EVALUATION OF TAX POLICIES IN SPAIN DURING THE GREAT RECESSION

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A general equilibrium evaluation of tax policies in Spain during the Great Recession

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Abstract

The main goal of the paper is to assess the effects of several permanent tax rate hikes implemented by the Spanish Government in 2009 and 2010 to counteract the rapid increase of the public deficit and debt registered in 2009 and 2010. It uses a numerical general equilibrium model calibrated to a social accounting matrix elaborated by the authors for the year 2000. The effects of increases in excise, value added and personal income taxes are simulated separately and jointly. The results indicate that the extra revenues obtained from each tax figure are lower than ex-ante calculations estimated by the Government. Moreover, the reductions in the public deficit accomplished are considerably smaller due to general equilibrium effects, such as lower production levels, greater unemployment rates and higher prices and transfers paid by the Government. The joint results indicate the enormous difficulties the Government faces to close the deficit gap by raising taxes.

***Keywords**:* Computable General Equilibrium Models, Tax Reforms, Public Deficit
JEL Classification: C68, H20, H30

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INTRODUCTION

The main objective of this paper is to evaluate the effectiveness of tax rates changes in oil products and tobacco, VAT and personal income taxes implemented by the Spanish Government in 2009 and 2010 to bring under control a huge public deficit. This is a pressing issue since the Spanish Government has had little success until now in complying with the public deficit objectives accorded with EU authorities. The effects of the tax policies on prices, quantities and main macroeconomic variables are quantified with a disaggregated computable general equilibrium (CGE) model of the Spanish economy.

The start of the global recession in the second semester of 2008 reduced exports, closed financial markets to highly indebted Spanish credit institutions and businesses and put an abrupt end to the capital accumulation process in Spain. The average volume index of exports (excluding tourism) and tourists' services from the third quarter of 2008 until the second quarter of 2009 fell 9.4 and 8.75 %, respectively, relative to their average values in the previous four quarters. In the same time span, the average volume index of gross fixed capital formation fell 13.07 %, GDP dropped 2.16 % and the unemployment rate increased 5.96 percentage points (pp.). The sudden turnabout of the economic situation put highly indebted credit institutions, non-financial businesses and families under serious stress.[3]

The expansionary budget of 2008 (an election year) and the fall of tax revenues turned the 2007 budget surplus (20.057 EUR millions) into a large deficit in 2008 (45.162 EUR millions). The Government, however, approached the situation convinced that to weather the storm it would be enough to back financial institutions' debt emissions and increase temporarily government expenditures and transfers. Numerous initiatives were approved to that end during the last quarter of 2008, including the 2009 budget that contemplated a public deficit of 70,654.4 EUR millions. In June 2009, the Government had to approve a large extraordinary credit (19.821 EUR millions) to face the rapidly growing unemployment benefits bill.

Fearful of the growing public deficit, the Government raised excise taxes on oil and tobacco products in June 2009. Moreover, it included in the General Budget of 2010 two measures to counteract the steady fall in fiscal revenues: it eliminated the 400 EUR personal income tax rebate introduced a year earlier and announced an increase in the

[3] Out of a total external debt of 1,563,730 EUR millions, the general Government was only responsible for 197,835 EUR millions at the end of 2007.

value added tax (VAT) rates that came into effect on July 1st, 2010. The fiscal situation at the end of 2009 was rather critical as the public deficit reached 117.306 EUR millions or 11.1 percent of GDP

The effect of changes in VAT rates has received some attention in recent years.[4] Crossley, Low and Wakefield (2009), Barrell and Weale (2009) and Blundell (2009) discuss the effects of a temporary cut in the central VAT rate from 17.5 to 15 percent implemented by the U.K Government in December 2008. They evaluate the importance of income and intertemporal substitution effects. In the case of Spain, Fernández de Córdoba and Torres (2010) and Conesa *et al*. (2010) have estimated the effects of a permanent increase in VAT rates in Spain employing intertemporal aggregated models of a closed economy. Fernández de Córdoba and Torres estimate that in the long run, output, consumption, investment and employment fall 0.74 %, VAT revenues increase 9.2 % and total government revenues 1.9 %. The figures reported by Conesa *et al*., although slightly different, confirm the fall in production (0.85 %), consumption (1.1 %), investment (1.0 %) and employment (1.0 %), as well as the increase in VAT revenues (10.5 %) and total government revenues (1.7 %) in the long-run.

The CGE model used in this study is more alike the one used by Boeters et al. (2010) to study the distributional effects of eliminating VAT differentiation in Germany. As theirs, it is a static and highly disaggregated model with thirty different commodities and six types of different private and public capital goods. Production and consumption commodities are different and so are production and consumption prices. Demand of products and services is satisfied with a mix of domestic products and equivalent imports. The model includes six different taxes, social security contributions, personal income tax, corporate tax, VAT, other taxes on production, and import taxes that affect producers and consumers decisions. Private investment (except residential construction) and exports are VAT exempted, but public consumption and investment do pay VAT rates. Moreover, the labor market does not clear and the real wage depends on the unemployment rate. The model is calibrated to an accounting matrix (SAMES-00) constructed by the authors for the year 2000.

[4] The temporary reduction lasted until December 2009. At the beginning of 2011, the U.K Government increased the central VAT rate from 17.5 to 20 %. Portugal also raised VAT rates from 20 to 21% in May 2010 and then to 23 % in September 2010.

The rest of the paper is divided in four sections. First, the main features of the model are presented. In section 3, the policies simulated are explained and the simulation results discussed. The main findings are summarized in the concluding section.

2. THE MODEL

This section presents the main features of the disaggregated general equilibrium model employed to simulate tax policies.

Agents and commodities

There are 30 producers, one representative consumer, the government, the corporate sector and two external sectors and foreign consumers, the European Union (EU) and the rest of the world (ROW). There are 30 produced commodities, 30 consumption goods and services, labor and capital and six types of private and public capital goods.

Producers

Products are obtained with domestic production and equivalent imports. Domestic products are aggregates of products and value added; and value added is, in turn, produced with labor and capital services. The production technology is represented by a nested production function with constant returns to scale. At the top level, total output, Y_i, is a CES aggregate of domestic products, Y_{di}, and imports from the EU, Y_{eui}, and the ROW, Y_{rowi}.

$$Y_i = \phi_i \left(\delta_{di} Y_{di}^{\rho_i} + \delta_{eui} Y_{eui}^{\rho_i} + \delta_{rowi} Y_{rowi}^{\rho_i} \right)^{1/\rho_i}, \quad -\infty < \rho_i < 1 \tag{1}$$

where δ_{di}, δ_{eui} and δ_{rowi} are, respectively, the domestic and foreign distributive parameters and ρ_i the parameter that determines the constant elasticity of substitution between domestic production and equivalent imports. At the second level, domestic production is obtained combining intermediate inputs and value added in fixed proportions

$$Y_{di} = \min\left(\frac{X_{1i}}{a_{1i}}, \frac{X_{2i}}{a_{2i}}, \ldots, \frac{X_{30i}}{a_{30i}}, \frac{V_i}{v_i} \right) \tag{2}$$

being X_{ji} and V_i are the amounts of product *j* and value added used to produce domestic output, Y_{di}, and a_{ji} and v_i the corresponding technical coefficients. Finally, valued added is a Cobb-Douglas aggregate of labor, L_i, and capital services, K_i

$$V_i = \gamma_i L_i^{\beta_{li}} K_i^{(1-\beta_{li})} \tag{3}$$

where γ_i, is a scale parameter and β_{li} and $(1-\beta_{li})$ the distribution parameters.

Firms maximize profits. At the lowest level of the nest, they minimize labor and capital cost subject to the value added function

$$\min w\left(1+\tau_i^{ssc}\right)L_i + rK_i \qquad s.t. \quad V_i = \gamma_i L_i^{\beta_{li}} K_i^{(1-\beta_{li})} \tag{4}$$

where w and r are the prices of labor and capital and τ_i^{ssc} are the social security contribution rate paid by employers and employees. The solution provides the labor, L_i^*, and capital, K_i^*, demands. The price of value added is set equal to the minimum average production cost

$$pv_i^* = w\left(1+\tau_i^{ssc}\right)\frac{L_i^*}{V_i} + r\frac{K_i^*}{V_i} \tag{5}$$

to insure profits are zero. Similar problems are set at the intermediate and upper levels of the nest. Taxes (net of subsidies) on products enter in the equations of domestic prices and import taxes in the equations of prices of products.

The consumption commodities are produced by a Leontief technology

$$C_c = \min\left(\frac{Z_{1c}}{z_{1c}}, \frac{Z_{2c}}{z_{2c}}, \ldots, \frac{Z_{30c}}{z_{30c}}\right) \tag{6}$$

where Z_{ic} is the amount of product i employed to produce commodity c, and z_{ic} is the unitary requirement. VAT rates enter in the price equations of products

$$p_c = \sum_{i=1}^{30} p_i z_{ic}\left(1+t_c^{vat}\right) \tag{7}$$

and consumer price index can be defined as a weighted average of consumer prices

$$p^{cpi} = \sum_{c=1}^{30} \theta_c p_c \tag{8}$$

Household

The representative household derives utility from consumption commodities, C_c and savings. Preferences are represented by a Cobb-Douglas utility function

$$U(C_1, C_2, ..., C_{30}, S) = \prod_{c=1}^{30} C_c^{\alpha_c} S^{1-\sum_{c=1}^{30}\alpha_c} \qquad 0 < \alpha_c < 1, \sum_{c=1}^{30}\alpha_c < 1. \tag{9}$$

The household sells its labor, $\overline{L}$, and capital, $\overline{K}$, services to firms. It also receives unemployment and welfare benefits, property income and other current transfers

$$GI_h = w(1-u)\overline{L} + r\overline{K} + \mu \cdot w \cdot u \cdot \overline{L} + EISSC + p_c(ADJ + TRR + PIR + WFR) \tag{10}$$

where w and r are the prices of labor and capital services, respectively; $\overline{L}$, and $\overline{K}$ the endowments of labor and capital; u the unemployment rate; μ the proportion of the wage rate paid to unemployed; $EISSC$ employers' imputed social security contributions; ADJ transfers to households due to changes in net equity in pension funds' reserves; TRR current transfers; PIR property income receipts; and, WFR welfare benefits other than social transfers in kind. Disposable income, DI_h, is obtained by subtracting personal income tax, self-employees social security contributions, current transfers, property income payments and residents' consumption in the EU and the ROW.

Consumption and savings demands are the solution to

$$\max \prod_{c=1}^{30} C_c^{\alpha_c} S^{1-\sum_{c=1}^{30}\alpha_c} \quad \text{s. t.} \quad DI_h = \sum_{c=1}^{30} p_c C_c + p_I S \tag{11}$$

where p_I is a weighted price index of investment goods. It is assumed that a fixed proportion of savings ι_r is devoted to purchase residential investment RI

$$p_r RI = \iota_r p_s S \tag{12}$$

where p_r is the production price of construction (sector 17). Since residential investment is subject to the VAT, its price is

$$p_r = p_{17}\left(1 + \tau_{17}^{vat}\right). \tag{13}$$

Government

The Government collects taxes from labor, income, production and consumption, which together with capital income and transfers are used to finance public consumption and investment, unemployment benefits and transfers. Public consumption and investment are exogenous but since prices, revenues and some expenditures are endogenous, the budget surplus, GS, is also endogenous. It is important to keep in mind that public purchases are subject to the VAT.

Foreign sectors

There are two foreign sectors, the EU and the ROW. Revenues stem from labor and capital endowments, imports of commodities, residents' consumption out of the territory and taxes and transfers received from domestic agents. These revenues are used to pay exports, income payments to residents and transfers. Exports and transfers are exogenously fixed, but since imports and prices are endogenous, the current account balance CAB is also endogenous.

Factors' markets

For the capital services market, the demand of services by all producers equals the endowment. In the case of labor, however, the model includes a real wage-unemployment rate equation

$$\frac{w\left(1-\tau_h^{cs}-\tau^i\right)}{p_c}=k\left(1-u\right)^{\frac{1}{\eta}}\ ,\ \ \eta>0 \tag{14}$$

where w is the wage rate; p_c the consumption price index, τ_h^{cs} the social contributions tax rate on households, τ^i the personal income tax rate; k a calibration constant; η the parameter that determines the response of the real wage to the unemployment rate and u the endogenous unemployment rate. In this case, the demand of labor services by producers equals the labor endowment multiplied by one minus the unemployment rate. Notice that the smaller the value of η, the larger the elasticity of the real wage to the unemployment rate:[5]

$$\varepsilon_u^{\frac{w}{p_c}}=-\frac{1}{\eta}\frac{u}{1-u}\,. \tag{15}$$

[5] The unemployment rate is 13.87 % in 2000, the base year.

Private non-residential investment

The level of non-residential private investment determined by households and corporate savings, the public deficit and the current account surplus of the foreign sectors:

$$p_I I_{nr} = p_I S_h (1 - \iota_r) + S_{cs} + GS + CAS_{EU} + CAS_{ROW} \ . \tag{16}$$

Equilibrium

The equilibrium can be defined as a set of prices, production plans for producers, a consumption-savings plan for the representative household, an unemployment rate, a public deficit and a current account deficit such that producers maximize profits, the household maximize utility, all commodity markets and the capital market clear, effective labor supply equals labor demand and the difference between revenues and expenditures for the government and the two foreign sectors equal government surplus and the current account surpluses.

Calibration of the model

The 2000 SAM for the Spanish economy (SAMES-00) elaborated by the authors is the database used to specify the parameters and the exogenous variables of the model. It is a 128x128 square matrix with accounts for 30 domestic production goods and services, 30 final production goods and consumption commodities, 6 private and 6 public capital goods, stocks variation, labor and capital, a representative household, a corporate sector, the Government, two foreign consumers and two foreign sectors. There is a savings account, eight taxes, five transfers and two subsidies accounts. The elasticities of substitution between domestic products and equivalent imports have been taken from Blake (2000). Finally, the central value chosen for η in the real wage-unemployment equation (1.2) was derived from Andrés *et al*. (1988). More recent estimates of wage curves by Montuenga *et al*. (2003) and García-Mainar and Montuenga (2005) confirm 1.2 as a central estimate.[6]

[6] The wage curves estimated by Montuenga *et al*. (2003) and García-Mainar and Montuenga(2005) imply values for η in the range (0.8-1.5). Sanz-de-Galdeano and Turunen (2006) results for a panel of 11 EU countries point to a value of 0.9.

3. SIMULATIONS AND RESULTS

Tables 2-6 present the results of simulating three tax policies implemented by the Spanish Government in 2009 and 2010 to cut down the public deficit[7]. Simulation S1 quantifies the effects of tobacco and oil products tax hikes enacted in June 2009. The new effective tax rates, 13.08 and 10.5 percent, of the two sectors in the model affected by the reform, 'Food, beverages and tobacco' and 'Extraction of energetic products, coke and refined petroleum', respectively, were calculated using the weights of tobacco and oil products in the supply input-output table. Simulation S2 quantifies the consequences of VAT rate increases implemented on July 1st, 2010. The increase in the VAT rates of each commodity was calculated using the BADESPE database constructed by the Spanish Institute of Fiscal Studies. Table 1 presents the pre and post VAT rates for all commodities in the model and the estimated average change. Simulation S3 estimates the effects of eliminating the 400 EUR tax rebate in the 2010 personal income tax that amounts to a 7.2 percent increase in the model's effective tax rate. Finally, the joint effects of the three tax reforms are reported in column S4 in Tables 2-6.

[7] Given the commitment of the Government to bring down the deficit to 3% of GDP in 2013, those changes can be assumed to be permanent.

Table 1. Pre and post reform VAT rates (In percentage)

		Pre tax reform	Post tax reform	Average change
1	Agriculture, fishing and aquaculture	4 - 7 - 16	4 - 8 - 18	11.11
2	Extraction of other mining and quarrying	7 - 16	8 - 18	13.04
3	Extraction of energetic products, coke and refined petroleum	16	18	12.50
4	Electricity, gas and water	7 - 16	8 - 18	13.04
5	Food, beverages and tobacco	4 - 7 - 16	4 - 8 - 18	11.11
6	Textile and dressing	16	18	12.50
7	Leather products	16	18	12.50
8	Wood	16	18	12.50
9	Paper, publishing and printing	4 - 16	4 - 18	10.00
10	Chemical industry	4 - 7 - 16	4 - 8 - 18	11.11
11	Non-metallic mineral products	16	18	12.50
12	Metallurgy and metal products	16	18	12.50
13	Mechanical machinery and equipment	16	18	12.50
14	Manufacture of electrical machinery and precision instruments	7 - 16	7 - 18	13.04
15	Manufacture of vehicles and other transport material	16	18	12.50
16	Other manufacturing industries	16	18	12.50
17	Construction	7 - 16	8 - 18	13.04
18	Wholesale trade and retail trade	4 - 7 - 16	4 - 8 - 18	11.11
19	Accommodation and catering	7	8	14.29
20	Transport and communications	7 - 16	8 - 18	13.04
21	Financial intermediation	16	18	12.50
22	Real estate activities	7 - 16	7 - 18	13.04
23	Market Education	NS.Ex. 7 - 23	NS.Ex. 8 - 23	3.33
24	Market Healthcare and Social services	NS.Ex.7	NS.Ex.8	14.29
25	Other activities and associative market services	7 - 16	8- 18	13.04
26	Households which employ household personnel	NS	NS	NS
27	Public Administration	NS	NS	NS
28	Non market Education	NS	NS	NS
29	Non market healthcare and Social services	NS	NS	NS
30	Other activities and associative non market services	NS	NS	NS

Source: BADESPE and own elaboration

Effects of increases in oil and tobacco tax rates

The increase of tax rates on tobacco and oil has a noticeable impact on the domestic prices of a few production commodities. Domestic prices of the two sectors directly affected by the tax rates hikes go up: the price of 'Extraction of energetic products, coke and refined petroleum' increases by 4.75 % and that of 'Food, beverages and tobacco' 0.94 %. Prices of other energy intensive sectors (Electricity, Gas and water, Chemical

industry, Extraction of other mining and quarrying, Transportation and Accommodation and catering, etc.) also go up. There are, however, other sectors whose prices are smaller due to the fall of the price of capital services. Changes in domestic prices are passed through and the consumer price index (CPI) increases by 0.26 %. Domestic production levels fall in those sectors most affected by the tax hike but go up in investment oriented sectors because the tax increase reduces the public deficit.

The effects on public revenues are noticeable but small. The percentage of taxes on products over GDP goes up from 4.41 to 4.60 percent. Employing the 2010 GDP figure, 1,062,591 million, the estimated increase is 2,018.92 million, a figure lower than the Government estimate, 2,317 million, presumably obtained by applying the new tax rates to the old bases. However, the results in Table 2-6 indicate that neither prices nor quantities remain constant after the tax reform. It is worth noticing that the public deficit falls less than the increase in taxes on products' revenues, because the ratios of several current expenditures items (unemployment benefits, other social benefits and current transfers, etc.) over GDP go up.

The increase in taxes on products raises a bit the unemployment rate (0.27 pp) and lowers employment (0.31 %) and real GDP (0.30 %). In sum, raising taxes on oil and tobacco has a noticeable effect on production and consumer prices of a few commodities and negligible effects on the rest. Production of sectors directly affected by the increase in tax rates fall while other sectors' output register either negligible changes or even some advances in the case of investment oriented sectors. The public deficit far falls less than the increase in revenues from taxes on products, and there is a negative although limited impact on unemployment, employment and GDP.

Table 2. Variation in domestic production prices (In percentage)

	Sector	S1	S2	S3	S4
II1	Agriculture, fishing and aquaculture	-0.05	-0.59	-0.41	-1.05
II2	Extraction of other mining and quarrying	0.15	-0.45	-0.31	-0.61
II3	Extraction of energetic products, coke and refined petroleum	4.75	-0.47	-0.32	3.92
II4	Electricity, gas and water	0.78	-0.54	-0.37	-0.13
II5	Food, beverages and tobacco	0.94	-0.46	-0.32	0.15
II6	Textile and dressing	-0.04	-0.41	-0.28	-0.73
II7	Leather products	0.01	-0.41	-0.28	-0.68
II8	Wood	0.03	-0.41	-0.29	-0.67
II9	Paper, publishing and printing	-0.05	-0.42	-0.29	-0.76
II10	Chemical industry	0.20	-0.42	-0.29	-0.52
II11	Non-metallic mineral products	0.03	-0.43	-0.30	-0.70
II12	Metallurgy and metal products	0.03	-0.41	-0.28	-0.66
II13	Mechanical machinery and equipment	-0.02	-0.39	-0.27	-0.68
II14	Manufacture of electrical machinery and precision instruments	0.00	-0.40	-0.28	-0.68
II15	Manufacture of vehicles and other transport material	0.03	-0.40	-0.28	-0.65
II16	Other manufacturing industries	-0.03	-0.39	-0.27	-0.69
II17	Construction	-0.03	-0.36	-0.25	-0.64
II18	Wholesale trade and retail trade	-0.11	-0.44	-0.30	-0.85
II19	Accommodation and catering	0.07	-0.43	-0.30	-0.66
II20	Transport and communications	0.12	-0.48	-0.33	-0.69
II21	Financial intermediation	-0.14	-0.39	-0.27	-0.79
II22	Real estate activities	-0.18	-0.51	-0.35	-1.04
II23	Market Education	-0.07	-0.31	-0.22	-0.59
II24	Market Healthcare and Social services	-0.08	-0.39	-0.27	-0.73
II25	Other activities and associative market services	-0.13	-0.45	-0.31	-0.89
II26	Households which employ household personnel	0.00	0.00	0.00	0.00
II27	Public Administration	-0.03	-0.24	-0.16	-0.43
II28	Non market Education	0.02	-0.09	-0.06	-0.13
II29	Non market healthcare and Social services	0.05	-0.17	-0.12	-0.23
II30	Other activities and associative non market services	0.01	-0.33	-0.23	-0.55

S1: Taxes on products: Extraction of energetic products, etc.: 10.5 %; Food, beverages and tobacco: 13.08 %.

S2: VAT.

S3: Income tax on households: 7.2 %.

S4: S1+S2+S3.

Table 3. Variation in consumer prices (In percentage)

	Sector	S1	S2	S3	S4
II1	Agriculture, fishing and aquaculture	-0.02	-0.10	-0.40	-0.51
II2	Extraction of other mining and quarrying	0.17	0.81	-0.31	0.67
II3	Extraction of energetic products, coke and refined petroleum	3.00	1.32	-0.32	4.03
II4	Electricity, gas and water	0.78	1.52	-0.37	1.93
II5	Food, beverages and tobacco	0.86	0.37	-0.32	0.91
II6	Textile and dressing	0.02	1.18	-0.29	0.91
II7	Leather products	0.05	1.07	-0.29	0.83
II8	Wood	0.06	1.10	-0.29	0.87
II9	Paper, publishing and printing	-0.01	0.43	-0.29	0.12
II10	Chemical industry, rubber and plastic products	0.20	0.55	-0.30	0.45
II11	Non-metallic mineral products	0.04	1.42	-0.30	1.16
II12	Metallurgy and metal products	0.07	1.78	-0.29	1.55
II13	Mechanical machinery and equipment	0.07	1.54	-0.28	1.32
II14	Manufacture of electrical machinery and precision instruments	0.10	1.81	-0.29	1.61
II15	Manufacture of vehicles and other transport material	0.09	1.25	-0.29	1.06
II16	Other manufacturing industries	0.01	1.29	-0.28	1.01
II17	Construction	-0.03	1.38	-0.25	1.10
II18	Wholesale trade and retail trade	-0.11	1.11	-0.30	0.69
II19	Accommodation and catering	0.07	0.47	-0.30	0.24
II20	Transport and communications	0.13	1.09	-0.33	0.89
II21	Financial intermediation	-0.12	-0.35	-0.27	-0.74
II22	Real estate activities	-0.15	0.22	-0.35	-0.28
II23	Market Education	-0.07	-0.31	-0.22	-0.59
II24	Market Healthcare and Social services	-0.08	-0.38	-0.27	-0.72
II25	Other activities and associative market services	-0.10	0.35	-0.31	-0.07
II26	Households which employ household personnel	0.00	0.00	0.00	0.00
II27	Public Administration	-0.03	-0.24	-0.16	-0.43
II28	Non market Education	0.02	-0.09	-0.06	-0.13
II29	Non market healthcare and Social services	0.05	-0.17	-0.12	-0.23
II30	Other activities and associative non market services	0.01	-0.33	-0.23	-0.55
	Consumption Prices Index (CPI)	0.26	0.56	-0.30	0.52

S1: Taxes on products: Extraction of energetic products, etc.: 10.5 %; Food, beverages and tobacco: 13.08 %.

S2: VAT.

S3: Income tax on households: 7.2 %.

S4: S1+S2+S3.

Table 4. Variation in domestic production (In percentage)

	Sector	S1	S2	S3	S4
II1	Agriculture, fishing and aquaculture	-0.38	-0.33	-0.50	-1.20
II2	Extraction of other mining and quarrying	0.07	-0.33	-0.02	-0.29
II3	Extraction of energetic products, coke and refined petroleum	-6.97	-0.72	-0.37	-7.97
II4	Electricity, gas and water	-0.49	-0.80	-0.38	-1.65
II5	Food, beverages and tobacco	-0.95	-0.56	-0.65	-2.14
II6	Textile and dressing	0.11	-1.04	-0.60	-1.52
II7	Leather products	0.07	-0.86	-0.53	-1.32
II8	Wood	-0.04	-0.52	-0.19	-0.76
II9	Paper, publishing and printing	-0.02	-0.42	-0.35	-0.78
II10	Chemical industry, rubber and plastic products	-0.08	-0.35	-0.22	-0.65
II11	Non-metallic mineral products	-0.04	-0.35	-0.04	-0.45
II12	Metallurgy and metal products	0.16	-0.36	0.04	-0.17
II13	Mechanical machinery and equipment	0.23	-0.32	0.22	0.13
II14	Manufacture of electrical machinery and precision instruments	0.29	-0.36	0.22	0.13
II15	Manufacture of vehicles and other transport material	0.36	-0.46	-0.02	-0.13
II16	Other manufacturing industries	0.03	-0.79	-0.22	-0.98
II17	Construction	-0.07	-0.37	0.04	-0.41
II18	Wholesale trade and retail trade	-0.37	-0.57	-0.33	-1.26
II19	Accommodation and catering	-0.21	-0.68	-0.70	-1.58
II20	Transport and communications	-0.21	-0.33	-0.18	-0.72
II21	Financial intermediation	-0.09	-0.20	-0.48	-0.77
II22	Real estate activities	-0.04	-0.31	-0.13	-0.49
II23	Market Education	-0.11	-0.08	-0.55	-0.74
II24	Market Healthcare and Social services	-0.10	-0.03	-0.58	-0.71
II25	Other activities and associative market services	-0.03	-0.49	-0.52	-1.03
II26	Households which employ household personnel	-0.18	-0.34	-1.14	-1.64
II27	Public Administration	0.00	0.00	0.00	0.00
II28	Non market Education	-0.01	-0.01	-0.06	-0.08
II29	Non market healthcare and Social services	0.00	0.00	-0.01	-0.01
II30	Other activities and associative non market services	-0.01	0.00	-0.03	-0.04
S1: Taxes on products: Extraction of energetic products, etc.: 10.5 %; Food, beverages and tobacco: 13.08 %.					
S2: VAT.					
S3: Income tax on households: 7.2 %.					
S4: S1+S2+S3.					

Table 5. Public revenues and expenditures (In percentage of GDP)

	Base year	S1	S2	S3	S4
Total revenues	**52.92**	**53,16**	**53.50**	**53.47**	**54.28**
Property income	1.17	1.17	1.18	1.17	1.18
Total income tax	10.15	10.16	10.13	10.67	10.65
Income tax (households)	6.95	6.96	6.94	7.47	7.45
Income tax (corporate)	3.20	3.20	3.20	3.20	3.20
SSCE	9.51	9.50	9.46	9.52	9.45
SSCH	1.92	1.92	1.91	1.93	1.91
SSCS	1.11	1.11	1.10	1.11	1.10
Current transfers	16.08	16.15	16.18	16.12	16.29
Taxes on production	1.25	1.25	1.24	1.25	1.24
Taxes on imports	0.02	0.02	0.02	0.02	0.02
VAT	5.68	5.68	6.31	5.65	6.28
Taxes on products	4.41	4.60	4.37	4.41	4.55
Capital	1.62	1.61	1.60	1.62	1.60
Total current expenditure	**49.84**	**50.03**	**50.07**	**50.05**	**50.48**
Public consumption	18.05	18.09	18.04	18.13	18.14
Property income	3.27	3.28	3.29	3.27	3.31
Unemployment benefits	1.97	2.01	2.05	2.04	2.16
Other social benefits	9.68	9.72	9.73	9.70	9.80
Current transfers	15.75	15.81	15.84	15.79	15.95
Subsidies on production	0.63	0.63	0.63	0.63	0.62
Subsidies on products	0.50	0.50	0.50	0.50	0.49
Public investment	**3.22**	**3.23**	**3.26**	**3.23**	**3.28**
Non residential public investment	3.10	3.10	3.14	3.10	3.15
Agriculture products	0.00	0.00	0.00	0.00	0.00
Machinery and mechanical products	0.48	0.48	0.49	0.48	0.49
Transport equipment	0.07	0.07	0.07	0.07	0.07
Other constructions	2.32	2.32	2.35	2.33	2.36
Other products	0.23	0.23	0.23	0.23	0.23
Residential public investment	0.13	0.13	0.13	0.13	0.13
Public surplus	**-0.14**	**-0.09**	**0.16**	**0.18**	**0.53**
S1: Taxes on products: Extraction of energetic products, etc.: 10.5 %; Food, beverages and tobacco: 13.08 %.					
S2: VAT.					
S3: Income tax on households: 7.2 %.					
S4: S1+S2+S3.					

Table 6. Aggregate variables

Main aggregates and welfare index					
	Base year	**S1**	**S2**	**S3**	**S4**
Unemployment rate (%)	13.87	14.14	14.45	14.28	15.12
Employment growth rate	-	-0.31	-0.67	-0.48	-1.45
Variation of households' net disposable income	411,757.00	-0.18	-0.34	-1.14	-1.65
Variation Consumer price index	-	0.26	0.56	-0.30	0.52
Households' welfare	-	-0.40	-0.79	-0.84	-2.02
Nominal GDP	630,263.00	-0.16	-0.04	-0.55	-0.76
Real GDP	630,263.00	-0.30	-0.30	-0.28	-0.88

Demand side aggregate variables (In percentage of GDP)					
	Base year	**S1**	**S2**	**S3**	**S4**
Private consumption	**57.91**	**57.91**	**57.74**	**57.57**	**57.39**
Total private investment	**22.61**	**22.64**	**22.56**	**22.84**	**22.82**
Non-residential private investment	16.62	16.65	16.59	16.89	16.88
Agriculture products	0.08	0.08	0.08	0.08	0.08
Machinery and mechanical products	5.20	5.21	5.19	5.28	5.28
Transport equipment	2.38	2.39	2.38	2.42	2.42
Other constructions	4.87	4.88	4.86	4.95	4.95
Other products	4.08	4.09	4.07	4.15	4.15
Residential private investment	5.99	5.99	5.97	5.96	5.94
Public consumption	**18.05**	**18.09**	**18.04**	**18.13**	**18.14**
Public investment	**3.22**	**3.23**	**3.26**	**3.23**	**3.28**
EU current balance	**1.06**	**1.03**	**1.00**	**1.05**	**0.96**
ROW current balance	**2.96**	**3.07**	**2.88**	**2.94**	**2.97**
S1: Taxes on products: Extraction of energetic products, etc.: 10.5 %; Food, beverages and tobacco: 13.08 %.					
S2: VAT.					
S3: Income tax on households: 7.2 %.					
S4: S1+S2+S3.					

Effects of an increase in VAT rates

The effect of the increase in the effective VAT rates reduces domestic prices in Table 2, due again to the fall (0.9 %) of the price of capital services. However, consumer prices in Table 3 increase in all but a few exempted sectors (Market education and Health care, and the three public service sectors) and Agriculture. In a few cases, the increase in consumption prices exceeds 1 %, although the overall impact measured by the CPI is 0.56 %. Changes in production levels depend on three factors: the increase in consumer prices, the change in households' income and the effect of the reduction in the public

deficit on private investment. The increase in consumer prices and the fall in employment and household income reduce domestic production levels, while the reduction of the public deficit softens those impacts in investment oriented sectors. As Table 4 makes clear the reduction in domestic production levels is larger in industrial consumption oriented sectors ('Textiles and dressing', 'Leather products', 'Other Manufacturing', 'Electricity, gas and water', etc.) and in private non exempted services (Wholesale trade, Accommodation and catering, etc.) than in investment oriented sectors ('Non-metallic mineral products', 'Metallurgy and metal products', 'Mechanical machinery and equipment', etc.).

Under the new VAT rates, the ratio of VAT revenues over GDP raises 0.63 pp, VAT revenue goes up 11 % and total revenues increase 1.10 %. Multiplying 0.63 by the 2010 GDP, VAT revenues go up by 6,607.96 million, a figure that is considerably larger than the 5.150 million announced by the Government.[8] Notice that the reduction of the public deficit, 0.30 pp., is less than half the increase in VAT revenues due to general equilibrium effects. The VAT reform raises the unemployment rate 0.58 pp and reduces employment and GDP by 0.67 and 0.30 percent, respectively. The fall in production levels and employment and the increase in consumer prices reduces the GDP shares of other taxes (income, social security contributions and taxes on products other than VAT) and increases those of public expenditures (unemployment and other social benefits, current transfers and public investment in other constructions).

Effects of an increase in households' income tax rate

The increase in the personal income tax reduces production prices a bit less than in the VAT simulation. That is no surprise since the equilibrium price of capital services falls 0.6 % now. In contrast with the VAT case, however, the reductions in production prices are translated into consumer prices and the CPI falls 0.30 %.

The reduction of disposable income reduces consumption and savings. However, this effect is to some extent counteracted by the reduction in consumer prices and the reduction in the public deficit. This explains the differences observed in production levels with the VAT previous simulation: the fall is considerably smaller in consumption oriented sectors and even there is an increase in production in some

[8] The overshooting may be caused by assuming there is no tax evasion. Although ruling out tax evasion may be an acceptable assumption in the case of excise taxes, given the strict control exercised by the Government over the production and distribution of oil and tobacco products, it is unrealistic to adopt the same assumption in the case of the VAT.

investment oriented sectors. Personal income revenues over GDP increase 0.52 pp. as a result of the elimination of the tax rebate. Multiplying 0.52 by the 2010 GDP, the estimated increase in revenues is 5,525.47 millions, a figure not too far from the 5.700 million advanced by Government officials

General equilibrium effects are again responsible for other things not being equal. Notice that the reduction in the public deficit (0.32 pp) is also in this case well below the increase in the personal income tax share. The fall in production level and the increase in the real wage raises 0.41 percentage points the unemployment rate and reduces 0.48 % employment and 0.28 % GDP. On the revenue side, there is a small fall in the share of VAT revenues and on the expenditure side the share of public consumption, unemployment and other social transfers and current transfers go up.

Effects of an increase in taxes on products, VAT rates and the personal income tax

Column S4 in Tables 2-6 includes the results obtained jointly simulating the three tax reforms just discussed. Production prices fall in all sectors except in 'Extraction of energetic products, coke and refined petroleum' and 'Food, beverages and tobacco', the two sectors directly affected by the increase in oil and tobacco tax rates. Notwithstanding the fall in production prices, consumption prices of manufactures and not exempted service products go up driven by the increase in VAT rates. The CPI increases 0.52 %. Domestic production levels fall in all sectors, except 'Mechanical machinery and equipment' and 'Manufacture of electrical machinery and precision equipment', being noticeable the reduction in 'Extraction of energetic products, coke and refined petroleum', 7.9 %, and 'Food, beverages and tobacco', 2.14%.

The increase in the joint share over GDP of the personal income tax, VAT and taxes on products, 1.24 pp, is a bit lower than the sum of the increases obtained for each of them in the individual simulations, 1.33 pp. Multiplying 1.24 by the 2010 GDP, the estimated increase in revenues caused by the simultaneous increase in all rates is 13,176.13 million, a figure very similar to the figure obtained by adding up the increases estimated ex-ante by the Government in the three instances (13,167.0). Notice again that, the reduction in the public deficit estimated in the joint simulation, 0.67 pp, is almost half the foreseen increase in revenues. As indicated in other simulations, changes in prices and production levels explain the fall of other revenue shares and the increase of public consumption and expenditure shares in Table 5. The changes of the main

macroeconomic variables in Table 6 sum up the situation: The unemployment rate increases 1.25 pp and employment and real GDP fall 1.45 and 0.88 percent, respectively The sensitivity of the results has been tested simulating the tax policies for η=0.9 and η=1.5. The lower the value of η, smaller are the fall in domestic production, the increase in consumption prices and the fall production levels. Public revenues increase a bit more and public expenditures a bit less. However, the change in the public surplus is just 0.07 pp, or 743.8 million using the 2010 GDP. Changes in the unemployment rate, employment and GDP growth rate are also small.

4. CONCLUSIONS

This article has presented the effects of simulating three permanent tax rate increases implemented by the Spanish Government in the second semester of 2009 and 2010 to reduce a public deficit that reached an all times record (11.1 % of GDP) in 2009. Taxes on oil products and tobacco were increased in June 2009; the normal and reduced VAT rates were increased in July 2010 and a 400 EUR deduction was eliminated in 2010 raising the effective personal income tax rate. The results obtained in each simulation indicate that the three measures increase revenues in amounts not far from those foreseen by the Government, but their effects on the public deficit are considerably smaller than one might have advanced in view of the increase in revenues. The reason is that the policies implemented change prices and quantities, modify the tax bases and revenues, and increase Government expenditures and transfers. In the three scenarios, the unemployment rate goes up and employment and GDP fall.

Those changes are quite significant when the three policies are jointly simulated. As expected, the GDP shares of taxes on products other than VAT, VAT and the personal income tax go up, although a bit less than in the individual simulations. The total increase in revenues (1.4 pp) is also in line with the figures expected by the Government, but the reduction achieved in the public deficit (0.7 pp) is only half of that figure. Considering that the observed ratio of the public deficit to GDP fell just 1.8 pp in 2010 (from 11.1 to 9.3 percent), the result of the joint simulation suggest that the task rate hikes implemented in 2009-2010 account for only 38.9 % of the reduction in the public deficit in 2010.

The main policy implication that can be extracted from the tax simulations discussed is that further substantial spending cuts will be required in the next few years to bring

down the ratio of the public deficit over GDP to 5.2 % in 2012 and 3 % in 2013, as accorded with EU authorities. On the expenditure side, the Spanish government may continue cutting down education and health programs. They may face the need to reform the unemployment benefit system that has channeled more than 120.000 million to the unemployed in 2009-11, a generous system that may be behind the anomalous increase of the official unemployment rate in Spain that rose from 8.01 % in the third quarter of 2007 to 24.4 % in the first quarter of 2012.

On the revenue side, the Government needs to increase the efficiency of the fiscal system highly dependent on labor income taxes and VAT revenues from real estate transactions and automobile sales in the boom years (1996-2007). Automatic stabilizers may explain that fiscal revenues fall more than nominal GDP in recession times, but not to the extent observed in Spain. Notice that although the Government raised substantially taxes on products, VAT and personal income taxes in 2009-2010, the revenues of all public administrations in 2010 were still 53,311 million inferior to those in 2007. Since nominal GDP was almost the same (1,062,591 million in 2010 and 1,053,057 million in 2007), and the labor income share fell 2 pp. in the interim, it is hard to escape to the conclusion that non-labor income is not adequately taxed and there is widespread VAT fraud in many sectors. A profound reform is needed to increase the revenue efficiency of the Spanish fiscal system whose limitations have been exposed by the Great Recession.

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