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Abstract:

We develop a multiregional general equilibrium model for Greece to simulate the short run impacts of temporary deficit-financed rises in government spending. It has been recognized that the fiscal multiplier is a function of structural features of the economy and policy reaction parameters. Moreover, the debate on the magnitude of the multiplier along the business cycle has also been the subject of disputed debates. On these grounds, we look at the Greek case by calibrating the model using data for distinct states of the Greek economy during the development of the recent crisis. Whether this matters for local and nationwide multipliers depends on qualitative differences of the numerical structures of the model. Our results imply that structural coefficients have a strong effect on government spending impact multipliers. In the case of Greece, lack of information on the changing magnitudes of behavioral parameters over time adds another layer of uncertainty to this debate.

Keywords: Multiregional models; Fiscal multiplier; Sensitivity analysis; Business cycle; Greece.

JEL Codes: D58; E17; E62; R13.

On the Numerical Structure of Local and Nationwide Government Spending Multipliers: What Can We Learn from the Greek Crisis?[1]

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Abstract. We develop a multiregional general equilibrium model for Greece to simulate the short run impacts of temporary deficit-financed rises in government spending. It has been recognized that the fiscal multiplier is a function of structural features of the economy and policy reaction parameters. Moreover, the debate on the magnitude of the multiplier along the business cycle has also been the subject of disputed debates. On these grounds, we look at the Greek case by calibrating the model using data for distinct states of the Greek economy during the development of the recent crisis. Whether this matters for local and nationwide multipliers depends on qualitative differences of the numerical structures of the model. Our results imply that structural coefficients have a strong effect on government spending impact multipliers. In the case of Greece, lack of information on the changing magnitudes of behavioral parameters over time adds another layer of uncertainty to this debate

1. Introduction

The global financial crisis and ensuing recession triggered major fiscal packages throughout the world. Many countries implemented fiscal expansion measures in order to stimulate their economies with the hope of boosting demand and limiting job losses. In this context, the debate regarding the impact of fiscal policy on economic activity regained momentum. Despite the existence of many academic studies about the impacts of government spending, the effectiveness of fiscal packages remains a disputed issue. In fact, among such various studies, there is consensus on neither the sign nor the size of government multipliers (Parker, 2011; Ramey, 2011; Taylor, 2011).

The magnitude of the multiplier may vary for different reasons, including alternative theoretical approaches, methods of calculations and data sources (Chinn, 2013). Contrasting results in the theoretical literature stems mainly from different analytical structures[2] embedded in Neoclassical and New Keynesian classes of models (Ramey, 2011; Nakamura and Steinsson, 2014). The usual empirical approaches to calculate multipliers – Vector Auto-

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[2] "An empirical economic model (…) embodies three types of information: analytical, functional and numerical. The analytical structure is the background theoretical material which identifies the variables of interest and posits their causal relations. The functional structure is the mathematical representation of the analytical material, and consists of the algebraic equations which make up the actual model. The numerical structure consists of the signs and magnitudes of the coefficients in the equations which form the functional structure." (McKitrick, 1998, p. 545)

Regressions (VAR) and Dynamic Stochastic General Equilibrium Models (DSGE) –, together with a plethora of reduced-form econometric estimation, rely on different functional structures, bringing additional uncertainty to their magnitude (Parker, 2011). Moreover, identifying strategies under limited availability of reliable instruments may cast doubts in econometric studies on the required exogeneity assumption on changes in government fiscal policy (Romer and Romer, 2010; Barro and Redlick, 2011).

In addition to distinct analytical and functional structures underlying different theoretical and empirical approaches, the numerical structure embedded in empirical studies is another source of uncertainty for the magnitude of the fiscal multiplier. As Chinn (2013) observes, the multiplier is a function of structural features of the economy and policy reaction parameters. The information contained in the data also reflects the economic context, which is an important element to define the magnitude of fiscal multipliers (Ilzetzki et al., 2013; Arin et al., 2015; Hory, 2016).

Thus, based upon strictly methodological grounds, it is understandable that, even by adopting the same theoretical model, the evidence extracted from different methods of calculations may be quite different. Even keeping the same theoretical model and method of investigation, it is also possible that different specifications of the method adopted are able to produce different outcomes (Almeida et al., 2010). In an extreme case, holding both the analytical and the functional structures constant, numerical structures based on different states of the economy may also lead to different results. Hence, interpretation of the relationship between government spending and changes in output is unlikely to be independent of the choice of the database (Auerbach and Gorodnichenko, 2012; Charles, 2016; Haddad et al., 2017).

A renewed stream of literature relates to the calculation of local fiscal multipliers (Moretti, 2010; Acconcia et al., 2014; Chodorow-Reich, 2017). Local multipliers, or geographic cross-sectional fiscal spending multipliers, usually relates the change in regional output to a change in government spending in the region.[3] Compared to the debate on nationwide multipliers, there is a caveat in the definition of local multipliers that prevents reconciliation between them. In an integrated interregional system within a country's territory, the focus on intraregional effects excludes interregional spillovers of government spending from the

[3] Hereafter, we narrow down the definition of local multipliers by excluding other fiscal policy instruments.

calculation. Given the more open nature of subnational regions, there are potentially relevant leakages in the spending from a jurisdiction recipient of resources from the central government. Thus, as observed by Fishback and Kachanovskaya (2015), reduced-form econometric estimation of local multipliers cannot be easily translated into a national multiplier because of spillover effects outside each region's boundaries not captured in those models. Nonetheless, as we will show later on, this limitation does not exist in bottom-up multiregional structural models, at least in the short run.

In this paper, we explore the role of numerical structures in the context of local multipliers derived from a multiregional multisectoral structural general equilibrium framework. Given the complexity and amount of feedback involved in this kind of investigation for which data constraints preclude econometric estimation, we rely on the calibration method. The choice of such approach is grounded on its capacity for examining policy shocks across regions in the midst of all complexity and feedback effects involved. Adopting this perspective, the model, the method of investigation, and its specification are chosen and will be kept constant, following a strategy suggested in Almeida et al. (2010). We can thus focus on the role of the numerical structure by calibrating the model with different datasets for Greece. Moreover, we show that the multiregional approach can circumvent the lack of a desirable reconciliation between local and nationwide multipliers.

The Greek case is particularly interesting to be examined. From 2010 to 2013, period of our analysis, real GDP fell almost 23% in Greece, with a decrease in government expenditures by 25% and in investments by roughly 45%, with a small increase in international exports by less than 2%. In the same period, real GRP from the 13 NUTS-2 regions varied from -14.7%, in Western Macedonia to -31.9% in Eastern Macedonia and Thrace. In the case of Greece, geography has played an important role since the spatial pattern of the initial impacts of the austerity measures was influenced by the geographical presence of the public sector. However, when taking into account indirect and induced effects, the regional structure of the Greek economy has also influenced the spatial propagation of the impacts through a complex diffusion of the multiplier effects (Haddad et al., 2017). Though small, the Greek economy is not internally homogenous, presenting variations across both industries and regions. Thus, the anti-crisis, austerity, measures taken in Greece, though horizontal in their nature, may have significantly differentiated implications across space (Psycharis et al., 2014).

The remainder of the paper is structured as follows. In Section 2 we narrow down the issues addressed in the analysis, defining the empirical strategy. Section 3 presents the model used in the simulations, whose results we present and discuss in Section 4. A final section concludes.

2. Modeling Issues and Empirical Strategy

Addressing the abovementioned issues as the main contributions of this paper – role of numerical structure and reconciliation of local and nationwide multipliers – would require an applied modelling approach that took into consideration the structure of interregional linkages within a country driven by trade relations (commodity flows), and factor mobility. Information on structural features of distinct states of such integrated interregional national system should also be available for calibration of different versions of the model.

Our choice of the modelling approach highlights the specification of an interdependent system of regions within a country in which national-regional feedbacks may occur in both directions. In this so-called bottom-up approach, analysis of policies originating at the regional level is also possible. The adding-up property is fully recognized, since national results are obtained from the aggregation of regional results (Giesecke and Madden, 2013).

We depart from a static multiregional and multisectoral general equilibrium model, whose specification we describe in details in Section 3. Despite some caveats, discussed below, the framework embeds some of the distinct features raised in the literature as deemed important for understanding regional adjustment mechanisms to government spending shocks. It includes some of the quantifiable forces that make local multipliers differ from national multipliers, namely expenditure switching due to domestic terms of trade effects; income effects affecting consumption of both locally-produced and external goods; and labor mobility (Chodorow-Reich, 2017).

Another reason for differences between local and national multipliers is the absence of the possibility of a reaction, at the regional level, by monetary policy. Nonetheless, given the neoclassical nature of our model, with flexible relative prices, money is neutral, implying that the specification of monetary policy is irrelevant (Nakamura and Steinsson, 2014). In this case, assumptions on the sources and period of financing, as well as the persistence of government stimuli, gain greater relevance.

Our results will focus on the short run impacts of a temporary deficit-financed increase in government spending in the fitted-model Greek economy. We will compute the impact multiplier as the change in output that results when government spending is increased by 1 percent of GDP. Due to the static nature of the modelling framework adopted in this paper, we switch off some of the usual mechanisms that are present in dynamic settings. First, it is important to distinguish between impact multipliers and the cumulative multiplier (Chinn, 2013). In our context, we provide a first-order approximation of the impact multiplier of government spending on goods and services. Since there is no dynamics in the model, the simulations will capture the effects associated with what-if questions in a comparative-static framework. Considerations on short run and long run differ in the way the equilibrating mechanisms are set through the closures of the model, discussed in Section 3.

The definition of the closure also deals with identification issues. Although some critics may argue for the charge of incredible identifying assumptions (Sims, 1980), structural models with explicit behavioral assumptions for the relevant agents do not face identification problems commonly found in econometric models. Thus, our exogeneity assumption on government spending shocks will be structurally explicit.

Second, we exempt our analysis from any intertemporal considerations in agents' behavior. The implications for the discussion on fiscal multipliers are at least twofold. On one hand, we can have a narrative approach to justify the short run financing of additional transitory government demand shocks by deficit increases. Moreover, if agents ignore the intertemporal aspect of their spending problem, then outside-financed and locally deficit-financed multipliers may coincide, as suggested in Chodorow-Reich (2017). On the other hand, we do not need to worry about long run reversal of short run changes in relative prices in the context of transitory demand shocks in single-currency interregional systems.

Finally, we will calibrate the model using two different datasets. Our strategy is to use the same set of behavioral parameters for both models, and use data from interregional input-output systems for two years, 2010 and 2013, to calibrate the structural coefficients. The choice of the years is based on both data availability and, mainly, the ability to represent distinct states of the Greek economy during the development of the crisis. As we can see in Figure 1, we have selected two snapshots of the Greek economy related to two points in time that reveal structural features just before the recession took off and in its peak, when the unemployment rate reached its highest point.

Figure 1. Unemployment Rates in Greece and the EU, 2002-2016

Source: EUROSTAT

3. Specification of the Model

In this section, we present the analytical, functional and numerical structures of the multiregional general equilibrium model for Greece. The specification of the linearized form of the model is provided, based on different groups of equations. The notational convention uses uppercase letters to represent the levels of the variables and lowercase for their percentage-change representation. Superscripts *(u)*, *u = 0, 1j, 2j, 3, 4, 5*, refer, respectively, to output *(0)* and to the five different regional-specific users of the products identified in the model[4]: producers in sector *j (1j)*, investors in sector *j (2j)*, households *(3)*, purchasers of exports *(4)*, and government *(5)*; the second superscript *(r)* identifies the domestic region where the user is located. Inputs are identified by two subscripts: the first *(i)* takes the values *1, ..., g*, for commodities, *g + 1*, for primary factors; the second subscript identifies the source of the input, being it from domestic region *b (1b)* or imported *(2)*, or coming from labor *(1)* or capital *(2)*, the two primary factors in the model. The symbol (•) is employed to indicate a sum over an index.

[4] We have specified a sixth residual user, *(6)*, to deal with statistical discrepancies in the balancing of the model's absorption matrix based on the Greek interregional input-output system (IIOS). This procedure deals with the information provided in the IIOS on re-exports, and direct purchases abroad by residents and purchases on the domestic territory by non-residents, not explicitly introduced in the specification of the CGE model.

We define the following sets: $G = \{1, \dots, g\}$, where g is the number of composite goods; $G^* = \{1, \dots, g, g+1\}$, where *g+1* is the number of composite goods and primary factors, with $G^* \supset G$; $H = \{1, \dots, h\}$, where h is the number of industries; $U = \{(3), (4b), (5), (kj)\}$ for $k = (1), (2)$ and $j \in H$, is the set of all users in the model; $U^* = \{(3), (5), (kj)\}$ for $k = (1), (2)$ and $j \in H$, with $U \supset U^*$, is the subset of domestic users; $S = \{1, \dots, r, r+1\}$, where *r+1* is the number of all regions (including foreign); $S^* = \{1, \dots, r\}$, with $S \supset S^*$, is the subset with the r domestic regions; and $F = \{1, \dots, f\}$ is the set of primary factors. In the ICGE model for Greece, $g = h = 44$, and $r = 13$, $f = 2$.

We model the sourcing of composite goods based on multilevel structures, which enable a great number of substitution possibilities. We employ nested sourcing functions for the creation of composite goods, available for consumption in the regions of the model. We assume that domestic users, i.e. firms, investors, households, and government, use combinations of composite goods specified within two-level CES nests. At the bottom level, bundles of domestically produced goods are formed as combinations of goods from different regional sources. At the top level, substitution is possible between domestically produced and imported goods. Equations (1) and (2) describe, respectively, the regional sourcing of domestic goods, and the substitution between domestic and imported products.

$$x_{(i(1b))}^{(u)r} = x_{(i(1\bullet))}^{(u)r} - \sigma 1_{(i)}^{(u)r} \left(p_{(i(1b))}^{(u)r} - \sum_{l \in S^*} \left(\frac{V(i,1l,(u),r)}{V(i,1\bullet,(u),r)} \right) \left(p_{(i(1l))}^{(u)r} \right) \right)$$

$$i \in G;\ b \in S^*; (u) \in U^*;\ r \in S^* \qquad (1)$$

where $x_{(i(1b))}^{(u)r}$ is the demand by user *(u)* in region r for good i in the domestic region *(1b)*; $p_{(i(1b))}^{(u)r}$ is the price paid by user *(u)* in region r for good i in the domestic region *(1b)*; $\sigma 1_{(i)}^{(u)r}$ is a parameter measuring the user-specific elasticity of substitution between alternative domestic sources of commodity i, known as the regional trade Armington elasticity; and $V(i, 1l, (u), r)$ is an input-output flow coefficient that measures purchasers' value of good i from domestic source l used by user *(u)* in region r.

$$x_{(is)}^{(u)r} = x_{(i\bullet)}^{(u)r} - \sigma 2_{(i)}^{(u)r} \left(p_{(is)}^{(u)r} - \sum_{l=1\bullet,2} \left(\frac{V(i,l,(u),r)}{V(i,\bullet,(u),r)} \right) \left(p_{(il)}^{(u)r} \right) \right)$$

$$i \in G;\ s = 1\bullet, 2; (u) \in U^*;\ r \in S^* \qquad (2)$$

where $x_{(is)}^{(u)r}$ is the demand by user *(u)* in region *r* for either the domestic composite or the foreign good *i*; $p_{(is)}^{(u)r}$ is the price paid by user *(u)* in region *r* for either the domestic composite or the foreign good *i*; $\sigma 2_{(i)}^{(u)r}$ is a parameter measuring the user-specific elasticity of substitution between the domestic bundle and imports of good *i*, known as the international trade Armington elasticity; and $V(i, l, (u), r)$ is an input-output flow coefficient that measures purchasers' value of good *i* from either the aggregate domestic source or the foreign source *l* used by user *(u)* in region *r*.

In addition to goods used as intermediate inputs, firms in the model also demand primary factors of production. The equations that describe the industry *j*'s demands inputs are derived under the assumption of Leontief technology with Armington nests (imperfect substitution between inputs of the same type from different sources). In our specification of the nested production functions, we assume firms to use combinations of composite intermediate inputs, formed according to Equations (1) and (2), and primary factor composites. In the case of the primary factor bundle, substitution is possible among different types of primary factors. Equation (3) specifies the substitution between labor and capital in the model, and is derived under the assumption that industries choose their primary factor inputs to minimize costs subject to obtaining sufficient primary factor inputs to satisfy their technical requirements (nested Leontief/CES specification). We have included technical change variables to allow for factor-specific productivity shocks. We model the combination of intermediate inputs and the value added (primary factors) aggregate in fixed proportions, at the very top of the nested production function, assuming there is no substitution between primary factors and other inputs. The Leontief specification is presented in Equation (4). More flexible functional forms have been rarely introduced in multi-regional models, mainly due to data availability constraints. In addition to a technical coefficient in the relation between the sectoral demand for the primary factor composite and the total output, we have also included a scale parameter. This modeling procedure has been based on previous work made by Haddad and Hewings (2005) which allows for the introduction of Marshallian agglomeration (external) economies, by exploring local properties of the CES function.

$$x^{(1j)r}_{(g+1,s)} - a^{(1j)r}_{(g+1,s)} = \alpha^{(1j)r}_{(g+1,s)} x^{(1j)r}_{(g+1,\bullet)} - \sigma 3^{(1j)r}_{(g+1)} \left(p^{(1j)r}_{(g+1,s)} + a^{(1j)r}_{(g+1,s)} - \sum_{l \in F} \left(\frac{V(g+1,l,(1j),r)}{V(g+1,\bullet,(1j),r)} \right) \left(p^{(1j)r}_{(g+1,l)} + a^{(1j)r}_{(g+1,l)} \right) \right)$$

$$j \in H;\ s \in F;\ r \in S^{*} \qquad (3)$$

where $x^{(1j)r}_{(g+1,s)}$ is the demand by sector *j* in region *r* for each primary factor; $a^{(1j)r}_{(g+1,s)}$ is the exogenous sector-specific variable of (saving) technical change for primary factor *s* in region *r*; $p^{(1j)r}_{(g+1,s)}$ is the price paid by sector *j* in region *r* for primary factor *s*; $\sigma 3^{(1j)r}_{(g+1)}$ is a parameter measuring the sector-specific elasticity of substitution among different primary factors; and $V(g+1,l,(1j),r)$ is an input-output flow coefficient that measures purchasers' value of factor *l* used by sector *j* in region *r*.

$$x^{(1j)r}_{(i\bullet)} = \mu^{(1j)r}_{(g+1,\bullet)} z^{(1j)r} + a^{(1j)r}_{(i)}$$

$$j \in H;\ i \in G^{*};\ r \in S^{*} \qquad (4)$$

where $x^{(1j)r}_{(i\bullet)}$ is the demand by sector *j* in region *r* for the bundles of composite intermediate inputs and primary factors *i*; $z^{(1j)r}$ is total output of sector *j* in region *r*; $a^{(1j)r}_{(i)}$ is the exogenous sector-specific variable of technical change for composite intermediate inputs and primary factors in region *r*; and $\mu^{(1j)r}_{(i\bullet)}$ is a scale parameter measuring the sector-specific returns to the composite of primary factors in each region.

Units of capital stock are created for industry *j*, at minimum cost. Commodities are combined via a Leontief function, as specified in Equation (5). As described in Equations (1) and (2), regional, and domestic and imported commodities are combined, respectively, via a CES specification (Armington assumption). No primary factors are used in capital creation. The use of these inputs is recognized through the capital goods producing sectors in the model, mainly machinery and equipment industries, construction, and support services.

$$x^{(2j)r}_{(i\bullet)} = z^{(2j)r} + a^{(2j)r}_{(i)}$$

$$j \in H;\ i \in G;\ r \in S^{*} \qquad (5)$$

where $x_{(i\bullet)}^{(2j)r}$ is the demand by sector *j* in region *r* for the bundles of composite capital goods *i*; $z^{(2j)r}$ is total investment of sector *j* in region *r*; $a_{(i)}^{(2j)r}$ is the exogenous sector-specific variable of technical change for changing the composition of the sectoral unit of capital in region *r*.

In deriving the household demands for composite commodities, we assume that households in each region behave as a single, budget-constrained, utility-maximizing entity. The utility function is of the Stone-Geary or Klein-Rubin form. Equation (6) determines the optimal composition of household demand in each region. Total regional household consumption is determined as a function of real household income. The demands for the commodity bundles in the nesting structure of household demand follow the CES pattern established in Equations (1) and (2), in which an activity variable and a price-substitution term play the major roles. In Equation (6), consumption of each commodity *i* depends on two components: first, for the subsistence component, which is defined as the minimum expenditure requirement for each commodity, changes in demand are generated by changes in the number of households and tastes; second, for the luxury or supernumerary part of the expenditures in each good, demand moves with changes in the regional supernumerary expenditures, changes in tastes, and changes in the price of the composite commodity. The two components of household expenditures on the composite commodities are weighted by their respective shares in the total consumption of the composite commodity.

$$V(i,\bullet,(3),\mathrm{r})\left(p_{(i\bullet)}^{(3)r}+x_{(i\bullet)}^{(3)r}-a_{(i\bullet)}^{(3)r}\right)$$
$$=\gamma_{(i)}^{r}P_{(i\bullet)}^{(3)r}Q^{r}\left(p_{(i\bullet)}^{(3)r}+x_{(i\bullet)}^{(3)r}-a_{(i\bullet)}^{(3)r}\right)$$
$$+\beta_{(i)}^{r}\left(C^{r}-\sum\nolimits_{j\in G}\gamma_{(j)}^{r}P_{(j\bullet)}^{(3)r}Q^{r}\left(p_{(j\bullet)}^{(3)r}+x_{(j\bullet)}^{(3)r}-a_{(i\bullet)}^{(3)r}\right)\right)$$
$$i\in G;\ r\in S^{*} \tag{6}$$

where $p_{(i\bullet)}^{(3)r}$ is the price paid by household in region *r* for the composite good *i*; $x_{(i\bullet)}^{(3)r}$ is the household demand in region *r* for the composite good *i*; $a_{(i\bullet)}^{(3)r}$ is the commodity-specific variable of regional taste change; Q^{r} is the number of households in region *r*; $C^{r}$is the total expenditure by household in region *r*, which is proportional to regional labor income; $\gamma_{(i)}^{r}$ is the subsistence parameter in the linear expenditure system for commodity *i* in region *r*; $\beta^{r}_{(i)}$ is the parameter defined for commodity *i* in region *r* measuring the marginal budget shares in the linear expenditure system; and $V(i,\bullet,(3),\mathrm{r})$ is an input-output flow coefficient that measures purchasers' value of good *i* consumed by households in region *r*.

As noted by Peter et al. (1996), a feature of the Stone-Geary utility function is that only the above-subsistence, or luxury, component of real household consumption, $utility^{(r)}$, affects the per-household utility, as described in Equation (7).

$$utility^{(r)} = \left(C^{r} - \sum_{j\in G} \gamma^{r}_{(j)} P^{(3)r}_{(j\bullet)} Q^{r} \left(p^{(3)r}_{(j\bullet)} + x^{(3)r}_{(j\bullet)} - a^{(3)r}_{(i\bullet)}\right)\right) - q^{r} - \sum_{i\in G} \beta^{r}_{(i)} p^{(3)r}_{(i\bullet)}$$

$$r \in S^{*} \qquad (7)$$

where q^{r} is the percentage change in the number of households in each region.

In Equation (8), foreign demands (exports) for domestic good *i* depend on the percentage changes in a price, and three shift variables which allow for vertical and horizontal movements in the demand curves. The price variable which influences export demands is the purchaser's price in foreign countries, which includes the relevant taxes and margins. The parameter $\eta^{r}_{(is)}$ controls the sensitivity of export demand to price changes.

$$\left(x^{(4)r}_{(is)} - fq^{(4)r}_{(is)}\right) = \eta^{r}_{(is)} \left(p^{(4)r}_{(is)} - phi - fp^{(4)r}_{(is)}\right)$$

$$i \in G;\ r,s \in S^{*} \qquad (8)$$

where $x^{(4)r}_{(is)}$ is foreign demand for domestic good *i* produced in region *s* and sold from region *r* (in the model there is no re-exports, so that *r* = *s*); $p^{(4)r}_{(is)}$ is the purchasers' price in domestic currency of exported good *i* demand in region *r*; phi is the nominal exchange rate; and $fq^{(4)r}_{(is)}$ and $fp^{(4)r}_{(is)}$ are, respectively, quantity and price shift variables in foreign demand curves for regional exports.

Governments consume mainly public goods provided by the public administration sectors. Equation (9) shows the movement of government consumption in relation to movements in real tax revenue.

$$x_{(is)}^{(5)r} = taxrev + f_{(is)}^{(5)r} + f^{(5)r} + f^{(5)}$$
$$i \in G;\ s = 1\text{b}, 2;\ r, b \in S^* \qquad (9)$$

where $x_{(is)}^{(5)r}$ is the government demand in region *r* for good *i* from region *s*; $f_{(is)}^{(5)r}$, $f^{(5)r}$ and $f^{(5)}$ are, respectively, commodity and source-specific shift term for government expenditures in region *r*, shift term for government expenditures in region *r*, and an overall shift term for government expenditures; and $taxrev$ is the percentage change in real revenue from indirect taxes.

Equation (10) specifies the sales tax rates for different users. They allow for variations in tax rates across commodities, and their sources and destinations. Tax changes are expressed as percentage-point changes in the *ad valorem* tax rates.

$$t_{(is)}^{(u)r} = f_i + f_i^{(u)} + f_i^{(u)r}$$
$$i \in G;\ s = 1\text{b}, 2;\ b, r \in S^*;\ u \in U \qquad (10)$$

where $t_{(is)}^{(u)r}$ is the power of the tax on sales of commodity (is) to user (u) in region r; and f_i, $f_i^{(u)}$, and $f_i^{(u)r}$ are different shift terms allowing percentage changes in the power of tax.

Equations (11) and (12) impose the equilibrium conditions in the markets domestic and imported commodities. Notice that there is no margin commodity in the model. Moreover, there is no secondary production in the model. In Equation (11), demand equals supply for regional domestic commodities.

$$\sum_{j \in H} Y(l, j, r) x_{(l1)}^{(0j)r} = \sum_{(u) \in U} B(l, 1b, (u), r) x_{(l1)}^{(u)r}$$
$$l \in G, b, r \in S^* \qquad (11)$$

where $x_{(l1)}^{(0j)r}$ is the output of domestic good *l* by industry *j* in region *r*; $x_{(l1)}^{(u)r}$ is the demand of the domestic good *l* by user *(u)* in region *r*; $Y(l,j,r)$ is the input-output flow measuring the basic value of output of domestic good *l* by industry *j* in region *r*; and $B(l,1,(u),r)$ is the input-output flow measuring the basic value of domestic good *l* used by *(u)* in region *r*.

Equation (12) imposes zero pure profits in importing. It defines the basic price of a unit of imported commodity i – the revenue earned per unit by the importer – as the international C.I.F. price converted to domestic currency, including import tariffs.

$$p_{(i(2))}^{(0)} = p_{(i(2))}^{(w)} - phi + t_{(i(2))}^{(0)}$$
$$i \in G \qquad (12)$$

where $p_{(i(2))}^{(0)}$ is the basic price in domestic currency of good *i* from foreign source; $p_{(i(2))}^{(w)}$ is world C.I.F. price of imported commodity i; phi is the nominal exchange rate; and $t_{(i(2))}^{(0)}$ is the power of the tariff. i.e. one plus the tariff rate, on imports of *i*.

Together with Equation (12), Equations (13) and (14) constitute the model's pricing system. The price received for any activity is equal to the costs per unit of output. As can be noticed, the assumption of constant returns to scale adopted here precludes any activity variable from influencing basic prices, i.e., unit costs are independent of the scale at which activities are conducted. Thus, Equation (13) defines the percentage change in the price received by producers in regional industry *j* per unit of output as being equal to the percentage change in *j*'s costs, which are affected by changes in technology and changes in input prices.

$$\sum_{l \in G} Y(l,j,r)\left(p_{(l1)}^{(0)r} + a_{(l1)}^{(0)r}\right) = \sum_{l \in G^*,F} \sum_{s \in S} V(l,s,(1j),r) p_{(ls)}^{(1j)r}$$
$$j \in H;\ r \in S^* \qquad (13)$$

where $p_{(l1)}^{(0)r}$ is the basic price of domestic good i in region *r*; $a_{(l1)}^{(0)r}$ refer to technological changes, measured as a weighted average of the different types of technical changes with influence on *j*'s unit costs; $p_{(ls)}^{(1j)r}$ is the unit cost of sector *j* in region *r*; $Y(l,j,r)$ is the input-output flow measuring the basic value of output of domestic good *l* by industry *j* in region *r*;

and $V(l, s, (1j), r)$ are input-output flows measuring purchasers' value of good or factor *l* from source *s* used by sector *j* in region *r*.

Equation (14) imposes zero pure profits in the distribution of commodities to different users. Prices paid for commodity *i* from region *s* in industry *j* in region *r* by each user equate to the sum of its basic value and the costs of the relevant taxes.

$$V(i, s, (u), r) p_{(is)}^{(u)r} = \left(B(i, s, (u), r) + T(i, s, (u), r)\right)\left(p_{(is)}^{(0)} + t_{(is)}^{(u)r}\right)$$
$$i \in G;\ s = 1\text{b}, 2;\ b, r \in S^*;\ u \in U \qquad (14)$$

where $p_{(is)}^{(u)r}$ is the price paid by user *(u)* in region *r* for good *(is)*; $p_{(is)}^{(0)}$ is the basic price of domestic good *(is)*; $t_{(is)}^{(u)r}$ is the power of the tax on sales of commodity *(is)* to user *(u)* in region *r*; $V(i, s, (u), r)$ are input-output flows measuring purchasers' value of good *i* from source *s* used by user *(u)* in region *r*; $B(i, s, (u), r)$ is the input-output flow measuring the basic value of good *(is)* used by *(u)* in region *r*; and $T(i, s, (u), r)$ is the input-output flow associated with tax revenue of the sales of *(is)* to *(u)* in region *r*.

The theory of the allocation of investment across industries is represented in Equations (15) to (18). The comparative-static nature of the model restricts its use to short-run and long-run policy analysis. When running the model in the comparative-static mode, there is no fixed relationship between capital and investment. The user decides the required relationship on the basis of the requirements of the specific simulation. Equation (15) defines the percentage change in the current rate of return on fixed capital in regional sectors. Under static expectations, rates of return are defined as the ratio between the rental values and the cost of a unit of capital in each industry – defined in Equation (16) –, minus the rate of depreciation.

$$r_{(j)}^{r} = \psi_{(j)}^{r}\left(p_{(g+1,2)}^{(1j)r} - p_{(k)}^{(1j)r}\right)$$
$$j \in H;\ r \in S^* \qquad (15)$$

where $r_{(j)}^{r}$ is the regional-industry-specific rate of return; $p_{(g+1,2)}^{(1j)r}$ is the rental value of capital in sector *j* in region *r*; $p_{(k)}^{(1j)r}$ is the cost of constructing units of capital for regional industries;

and $\psi_{(j)}^{r}$ is a regional-industry-specific parameter referring to the ratio of the gross to the net rate of return.

Equation (16) defines $p_{(k)}^{(1j)r}$ as:

$$V(\bullet,\bullet,(2\mathrm{j}),\mathrm{r})\left(p_{(k)}^{(1j)r}-a_{(k)}^{(1j)r}\right)=\sum_{i\in G}\sum_{s\in S}V(\mathrm{i},\mathrm{s},(2\mathrm{j}),\mathrm{r})\left(p_{(is)}^{(2j)r}-a_{(is)}^{(2j)r}\right)$$

$$j\in H;\ r\in S^{*} \qquad (16)$$

where $p_{(is)}^{(2j)r}$ is the price paid by user *(2j)* in region *r* for good *(is)*; $a_{(k)}^{(1j)r}$ and $a_{(is)}^{(2j)r}$ are technical terms; and $V(\mathrm{i},\mathrm{s},(2\mathrm{j}),\mathrm{r})$ represents input-output flows measuring purchasers' value of good *i* from source *s* used by user *(2j)* in region *r*.

Equation (17) says that if the percentage change in the rate of return in a regional industry grows faster than the national average rate of return, capital stocks in that industry will increase at a higher rate than the average national stock. For industries with lower-than-average increase in their rates of return to fixed capital, capital stocks increase at a lower-than-average rate, i.e., capital is attracted to higher return industries. The shift variable, $f_{(k)}^{(1j)r}$, exogenous in long-run simulation, allows shifts in the industry's rates of return.

$$r_{(j)}^{r}-\omega=\varepsilon_{(j)}^{r}\left(x_{(g+1,2)}^{(1j)r}-x_{(g+1,2)}^{(\bullet)r}\right)+f_{(k)}^{(1j)r}$$

$$j\in H;\ r\in S^{*} \qquad (17)$$

where $r_{(j)}^{r}$ is the regional-industry-specific rate of return; ω is the overall rate of return on capital; $x_{(g+1,2)}^{(1j)r}$ is the capital stock in industry *j* in region *r*; $f_{(k)}^{(1j)r}$ the capital shift term in sector *j* in region *r*; and $\varepsilon_{(j)}^{r}$ measures the sensitivity of capital growth to rates of return of industry *j* in region *r*.

Equation (18) implies that the percentage change in an industry's capital stock, $x_{(g+1,2)}^{(1j)r}$, is equal to the percentage change in industry's investments in the period, $z^{(2j)r}$.

$$z^{(2j)r} = x^{(1j)r}_{(g+1,2)} + f^{(2j)r}_{(k)}$$

$$j \in H;\ r \in S^* \qquad (18)$$

where $f^{(2j)r}_{(k)}$ allows for exogenous shifts in sectoral investments in region *r*.

In the specification of labor market, Equation (19) defines the regional aggregation of labor prices (wages) across industries. Equation (20) shows movements in regional wage differentials, $wage\_diff^{(r)}$, defined as the difference between the movement in the aggregate regional real wage received by workers, and the national real wage.

$$V(\mathrm{g}+1,1,\bullet,\mathrm{r})\left(p^{(\bullet)r}_{(g+1,1)} - a^{(\bullet)r}_{(g+1,1)}\right) = \sum_{j\in H} V(\mathrm{g}+1,1,(1\mathrm{j}),\mathrm{r})\left(p^{(1j)r}_{(g+1,1)} - a^{(1j)r}_{(g+1,1)}\right)$$

$$r \in S^* \qquad (19)$$

where $p^{(1j)r}_{(g+1,1)}$ is the wage in sector *j* in region *r*, $a^{(1j)r}_{(g+1,1)}$ is a technical term, and $V(\mathrm{g}+1,1,(1\mathrm{j}),\mathrm{r})$ represents input-output flows measuring sectoral labor payments in region *r*.

$$wage\_diff^{(r)} = p^{(\bullet)r}_{(g+1,1)} - cpi - natrealwage$$

$$r \in S^* \qquad (20)$$

where cpi is the national consumer price index, computed as the weighted average of $p^{(3)r}_{(is)}$ across regions *r* and consumption goods *(is)*; and $natrealwage$ is the national consumer real wage.

Regional population is defined through the interaction of demographic variables, including interregional migration. Links between regional population and regional labor supply are provided. Demographic variables are usually defined exogenously, and together with the specification of some of the labor market settings, labor supply can be determined together with either interregional wage differentials or regional unemployment rates. In summary, either labor supply and wage differentials determine unemployment rates, or labor supply and unemployment rates determine wage differentials.

Equation (21) defines the percentage-point change in regional unemployment rates in terms of percentage changes in labor supply and persons employed.

$$LABSUP(r)del\_unr^{(r)} = EMPLOY(r)\left(labsup^{(r)} - x_{(g+1,1)}^{(\bullet)r}\right)$$
$$r \in S^* \qquad (21)$$

where $del\_unr^{(r)}$ measures percentage-point changes in regional unemployment rate; $labsup^{(r)}$ is the variable for regional labor supply; and the coefficients $LABSUP(r)$ and $EMPLOY(r)$ are the benchmark values for regional labor supply and regional employment, respectively. The variable $labsup^{(r)}$ moves with regional workforce participation rate, proportional to the regional population, and population of working age. Equation (22) defines regional population changes in the model as ordinary changes in flows of net regional migration ($d\_rm^{(r)}$), net foreign migration ($d\_fm^{(r)}$), and natural population growth ($d\_g^{(r)}$).

$$POP(r)pop^{(r)} = d\_rm^{(r)} + d\_fm^{(r)} + d\_g^{(r)}$$
$$r \in S^* \qquad (22)$$

where $POP(r)$ is a coefficient measuring regional population in the benchmark year.

Equation (23) shows movements in per-household utility differentials, $util\_diff^{(r)}$, defined as the difference between the movement in regional utility, and the national overall utility (agg_util), including a shift variable, $futil^{(r)}$.

$$util\_diff^{(r)} = utility^{(r)} - agg\_util + futil^{(r)}$$
$$r \in S^* \qquad (23)$$

Finally, we can define changes in regional output as weighted averages of changes in regional aggregates, according to Equation (24) below:

$$GRP^r grp^r = C^r x^{(3)r}_{(\bullet\bullet)} + INV^r z^{(2\bullet)r} + GOV^r x^{(5)r}_{(\bullet\bullet)} + \left(FEXP^r x^{(4)r}_{(\bullet\bullet)} - FIMP^r x^{(\bullet)r}_{(\bullet 2)}\right) + \left(DEXP^r x^{(\bullet)s}_{(\bullet(1r))} - DIMP^r x^{(\bullet)r}_{(\bullet(1s))}\right)$$

$$r \in S^*; s \in S^* \text{ for } s \neq r \quad (24)$$

where grp^r is the percentage change in real Gross Regional Product in region *r*; and the coefficients GRP^r INV^r, GOV^r, $FEXP^r$, $FIMP^r$, $DEXP^r$ and $DIMP^r$ represent, respectively, the following regional aggregates: investments, government spending, foreign exports, foreign imports, domestic exports and domestic imports. National output, GDP, is, thus, the sum of GRP^r across all regions *r*. Notice that regional domestic trade balances cancel out.

To close the model, we set the following variables exogenously, which are usually exogenous both in short run and long run simulations: $a^{(1j)r}_{(g+1,s)}$, $a^{(1j)r}_{(i)}$, $a^{(2j)r}_{(i)}$, $a^{(3)r}_{(i\bullet)}$, $fq^{(4)r}_{(is)}$, $fp^{(4)r}_{(is)}$, $f^{(5)r}_{(is)}$, $f^{(5)r}$, $f^{(5)}$, f_i, $f_i^{(u)}$, $f_i^{(u)r}$, $p^{(w)}_{(i(2))}$, $t^{(0)}_{(i(2))}$, $a^{(0)r}_{(l1)}$, $a^{(1j)r}_{(k)}$, $a^{(2j)r}_{(is)}$, $a^{(\bullet)r}_{(g+1,1)}$, ω, $f^{(2j)r}_{(k)}$, $d\_fm^{(r)}$, $d\_g^{(r)}$, and $futil^{(r)}$. To complete the short run environment, used in our forthcoming exercises, we also set unchanged current stocks of capital ($x^{(1j)r}_{(g+1,2)}$), the national real wage ($natrealwage$), regional wage differentials, ($wage\_diff^{(r)}$), and regional population, by keeping regional migration unchanged ($d\_rm^{(r)}$).[5]

There are other definitions of variables computed by using outcomes from simulations based on the system of equations (1)-(23). Of special interest to our discussion is the definition of regional/national GDP and its components, whose results will be reported later on.

[5] In a long run closure, the assumptions on interregional mobility of capital and labor are relaxed by swapping variables $x^{(1j)r}_{(g+1,2)}$, $natrealwage$, $wage\_diff^{(r)}$ and $d\_rm^{(r)}$, for $f^{(1j)r}_{(k)}$, $del\_unr^{(r)}$ and $util\_diff^{(r)}$.

Calibration

The calibration of the model requires two subsets of data to define its numerical structure so that we implement the model empirically. First, we need information from an absorption matrix derived from interregional input-output sources (Table 1) to calculate the coefficients of the model based on the following input-output flows:

- $B(i, 1b, (u), r)$, with $i \in G^*, (u) \in U, b, r \in S^*$
- $T(i, s, (u), r)$, with $i \in G^*, s \in S, F, (u) \in U, r \in S^*$
- $V(i, s, (u), r)$, with $i \in G^*, s \in S, F, (u) \in U, r \in S^*$
- $Y(i, j, r)$, with $i \in G^*, j \in H, r \in S^*$

We complete this information with supplementary demographic data from EUROSTAT to calibrate the coefficients $LABSUP(r)$, $EMPLOY(r)$ and $POP(r)$, with $r \in S^*$. Because these estimates are based on snapshot observations for a single year revealing the economic structure of the economic system, this subset of data is denoted "structural coefficients" (Haddad et al., 2002).

The second piece of information necessary to calibrate the model is represented by the subset of data defining various parameters, mainly elasticities. These are called "behavioral parameters". Empirical estimates for some of the parameters of the model are not available in the literature. We have thus relied on "best guesstimates" based on usual values employed in similar models. We set to 1.5 the values for both regional trade elasticities, $\sigma 1_{(i)}^{(u)r}$ in Equation (1) and international trade elasticities, $\sigma 2_{(i)}^{(u)r}$ in Equation (2). Substitution elasticity between primary factors, $\sigma 3_{(g+1)}^{(1j)r}$ in Equation (3) was set to 0.5. The current version of the model runs under constant returns to scale, so that we set to 1.0 the values of $\mu_{(g+1,\bullet)}^{(1j)r}$ in Equation (4). The marginal budget shares in regional household consumption, $\beta_{(i)}^{r}$ in Equation (6), were calibrated from the input-output data, assuming the average budget share to be equal to the marginal budget share, and the subsistence parameter $\gamma_{(i)}^{r}$, also in Equation (6), was associated with a Frisch parameter equal to -3.7. We have set to -2.0 the export demand elasticities, $\eta_{(is)}^{r}$ in Equation (8). The ratio of gross to net rate of return, $\psi_{(j)}^{r}$ in

Equation (15), was set to 1.2. Finally, we set to 3.0 the parameter for sensitivity of capital growth to rates of return, $\varepsilon_{(j)}^{r}$ in Equation (17).

Table 1. Aggregate Flows in the Absorption Matrix: Greece, 2010 and 2013 (values in current EUR millions)

LABELS	User (1j)^r	User (2j)^r	User (3)^r	User (4)	User (5)^r	User (6)	TOTAL
i∈G, s∈S*	B(i,1b,(1j),r)	B(i,1b,(2j),r)	B(i,1b,(3),r)	B(i,1b,(4))	B(i,1b,(5),r)	B(i,1b,(6))	B(i,1b,(•),•)
i∈G, s∈S-S*	B(i,2,(1j),r)	B(i,2,(2j),r)	B(i,2,(3),r)	B(i,2,(4))	B(i,2,(5),r)	B(i,2,(6))	B(i,2,(•),•)
i∈G, s∈S	T(i,s,(1j),r)	T(i,s,(2j),r)	T(i,s,(3),r)	T(i,s,(4))	T(i,s,(5),r)	-	T(i,s,(•),•)
s∈F	V(g+1,s,(1j),r)	-	-	-	-	-	V(g+1,s,(•),•)
TOTAL	Y(•,•,r)	V(•,•,(2j),r)	V(•,•,(3),r)	V(•,•,(4))	V(•,•,(5),r)	-	V(•,•,(•),•)

2010	User (1j)^r	User (2j)^r	User (3)^r	User (4)	User (5)^r	User (6)	TOTAL
i∈G, s∈S*	111,959	27,693	124,223	37,064	50,913	2,782	354,633
i∈G, s∈S-S*	34,605	9,239	22,842	-	3,677	-	70,364
i∈G, s∈S	8,425	3,046	12,428	2,164	364	-	26,427
s∈F	199,644	-	-	-	-	-	199,644
TOTAL	354,633	39,977	159,493	39,229	54,954	2,782	651,068

2013	User (1j)^r	User (2j)^r	User (3)^r	User (4)	User (5)^r	User (6)	TOTAL
i∈G, s∈S*	93,069	15,980	106,257	39,186	39,697	-1,713	292,476
i∈G, s∈S-S*	32,736	4,109	17,627	-	1,868	-	56,341
i∈G, s∈S	6,434	1,865	9,342	2,680	302	-	20,624
s∈F	160,237	-	-	-	-	-	160,237
TOTAL	292,476	21,953	133,226	41,866	41,868	-1,713	529,677

Source: Haddad, E. A. et al. (2017)

4. Discussion of Results

Let us first define local and nationwide multipliers in the context of our model specification. We compute output (value added) multipliers based on an overall increase in government spending equivalent to 1 percent of GDP. We impose regional-specific changes in $f^{(5)r}$, the shift term for government expenditures in region *r*, that are proportional to GRP in each region, such that:

$$\Delta GOV^r = (0.01) GRP^r$$
$$r \in S^* \tag{25}$$

where ΔGOV^r is the ordinary change in government spending in region *r*, used to compute values for $f^{(5)r}$.

We focus our analysis on the impacts of government spending on changes in output. The simulations provide outcomes for percentage changes in GRP^r and GDP, so that we can compute the associated ordinary changes, ΔGRP^r and ΔGDP, as follows:

$$\Delta GRP^r = GRP^r grp^r$$
$$\Delta GDP = \sum_r \Delta GRP^r$$
$$r \in S^* \tag{26}$$

Since the typical simulation involves several different regional shocks, we can divide the total change in any endogenous variable between the various shocks. We can thus decompose the changes in output according to the contribution of each regional government demand shock. We add a subscript to ordinary changes in GRP in each region to include information on the different origins of the exogenous change in government spending that may affect that regional output. Equation (27) makes it explicit that there are spillovers from local government spending to other regions in the system.

$$\Delta GRP_{\bullet}^r = \frac{\Delta GRP^r}{\Delta GOV^1} + \frac{\Delta GRP^r}{\Delta GOV^2} + \cdots + \frac{\Delta GRP^r}{\Delta GOV^s} = \sum_s \Delta GRP_s^r$$
$$r, s \in S^* \tag{27}$$

We define the local multiplier, $K_{(s)}^{(r)}$, in the usual way, as the change in local output due to a change in government spending in the own region:

$$K_{(s)}^{(r)} = \frac{\Delta GRP^r}{\Delta GOV^s}$$
$$r, s \in S^*, \text{ for } r = s \quad (28)$$

The definition of $K_{(s)}^{(r)}$ only takes into account intra-regional effects of local spending. Nonetheless, there are potential effects on other regions' output, so that we can compute the nationwide multiplier related to government spending in the region:

$$K_{(s)}^{(\bullet)} = \frac{\sum_r \Delta GRP_s^r}{\Delta GOV^s}$$
$$r, s \in S^* \quad (29)$$

We can then compute the usual nationwide multiplier, $K_{(\bullet)}^{(\bullet)}$, as the aggregation of the intra and interregional effects of the sum of government spending in each region.

$$K_{(\bullet)}^{(\bullet)} = \frac{\sum_r \sum_s \Delta GRP_s^r}{\sum_s \Delta GOV^s} = \frac{\Delta GDP}{\Delta GOV^\bullet}$$
$$r, s \in S^* \quad (30)$$

For completeness, we also define the government spending interregional multiplier, $K_{(s)}^{(t)}$, as the impact of government local demand outside the region:

$$K_{(s)}^{(t)} = \frac{\sum_t \Delta GRP_s^t}{\Delta GOV^s}$$
$$t, s \in S^* \text{ for } t \neq s \quad (31)$$

Table 2 presents the results for the nationwide multiplier, based in information for two different benchmark years, 2010 and 2013. In addition to the multipliers computed under our general equilibrium specification, we have also computed, for the sake of comparison, value added multipliers using the input-output model with endogenous households calibrated with the same databases. The input-output framework provides our multiregional and multisectoral system with a demand-driven mechanical approach to calculate multipliers based on an intricate plot of different average propensities to consume and to import, with rigid relative prices and no supply constraints.

Moving beyond mechanically rule-of-thumb agents seems to influence the magnitude of the multipliers. The accounting-based input-output multipliers are one order of magnitude higher than their general equilibrium counterparts. Given the closure of the general equilibrium model, which defines the adjustment mechanisms of the economy to the exogenous shock, the imposition of supply constraints play an important role to explain such differences.

Considering the changes in mechanical propensities to consume and to import embedded in the complex systems of interregional relations in the two benchmarks, the results reveal that the national multiplier for Greece would have increased by 9.6% from 2010 to 2013. However, the general equilibrium multiplier is slightly lower in 2013 than in 2010.

Table 2. Government Spending Output Multipliers: Greece, 2010 and 2013

Benchmark	*Input-output*	*General equilibrium*
2010	1.76	0.34
2013	1.93	0.32

Structural features of different states of an economy during the business cycle are often neglected in the debate on the impact multipliers of government spending, specially their influence on the supply responsiveness of the system. According to our model, in the short run closure, with fixed capital stocks, the supply elasticity can be approximated by the expression in Equation (32), reflecting its close connection with the elasticity of substitution between capital and labor, the shares of labor and capital in primary factor costs, and the share of primary factors in total costs. In other words, for given values of the substitution elasticity, supply is more elastic as either the labor/capital ratio is higher, or the share of materials in total cost is higher (Dixon et al., 1982).

$$\sigma 3_{(g+1)}^{(1j)r} \left(\frac{V(g+1, \text{"}labor\text{"}, (1j), r)}{V(g+1, \bullet, (1j), r)} \right) \Bigg/ \left(\frac{V(g+1, \text{"}capital\text{"}, (1j), r)}{V(g+1, \bullet, (1j), r)} \right) \left(\frac{V(g+1, \bullet, (1j), r)}{V(\bullet, \bullet, (1j), r)} \right)$$

$j \in H;\ r \in S^*$ (32)

In Greece, changes in factor income were the main factors that help explaining the reduction in the supply side elasticity and, consequently, the output multiplier during the recession. The share of primary factors in total costs decreased from 0.566, in 2010, to 0.546, in 2013. In the same period, the ratio of labor payments to capital payments fell from 0.693 to 0.597. Such structural changes reflect the policy choices that led to recession. The rapid deterioration of wages and profit rates in the first years of the Greek crisis led to lower intensity in value added generation in the economy, with a heavier burden on workers.

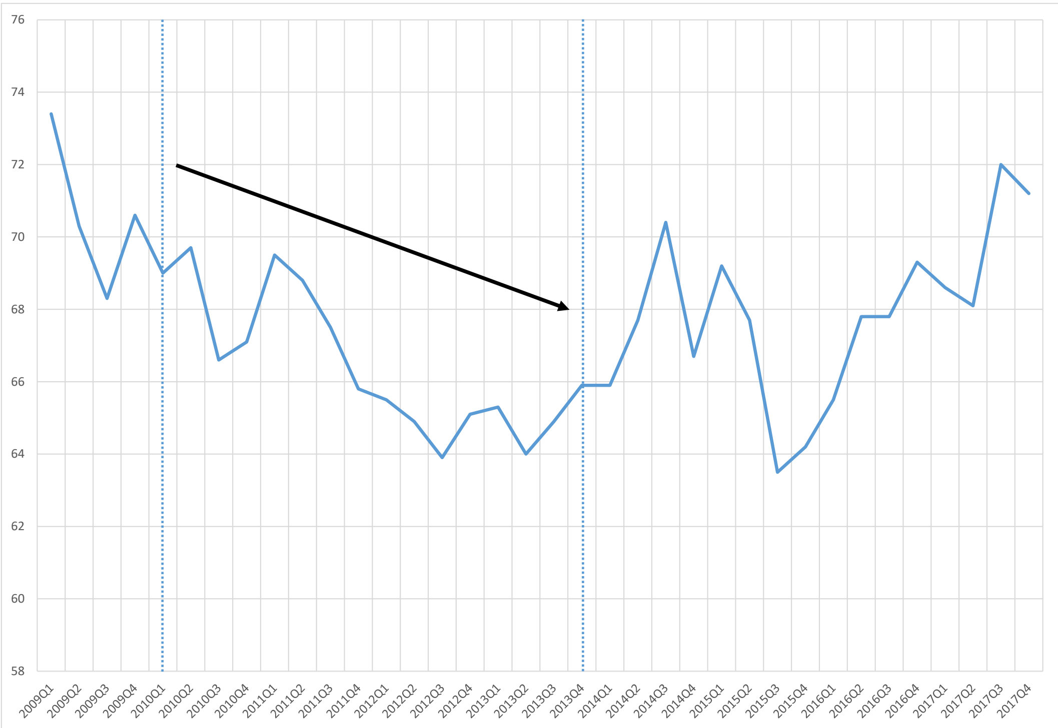
Taking into account price effects is also important to distinguish between nominal and real effects. With lower sort-run supply elasticity, prices would have responded more sharply to the demand shocks in 2013, reducing the relative real output impact of government spending. While nominal GDP rose by 3.18% in the 2010 simulation, and to 3.42% in the 2013, GDP deflator would have increased, respectively, 2.84% and 3.10%, leading to a smaller real output multiplier in the more recent year.

We recall that we kept the same behavioral parameters of the model in the two simulations. However, one important component of Equation (32) is the substitution elasticity, $\sigma 3_{(g+1)}^{(1j)r}$, set to 0.5 in both benchmark years. Another caveat relates to the treatment of idle resources in the model. If, on one side, we do take into account the level of unemployment in the workforce, on the other side we do not consider differences in the utilization of the capacity of existing capital stocks. It is clear from Figure 2 that the drop in capacity utilization from 2010 to 2013 may suggest a relatively less costly adjustment to capital use in the latter year. Having nothing to say in order to explicitly address this issue in our modeling framework, we can play with the model's parameters to mimic a more flexible supply-side adjustment with the existing levels of capital stocks and different levels of capacity utilization in the economy. To circumvent this methodological limitation, we carry out sensitivity analysis exercises with the value of the elasticity of substitution parameter. Higher values for $\sigma 3_{(g+1)}^{(1j)r}$, in given structural settings, would potentially lead to higher labor absorption in the short run, i.e. with fixed capital stocks, pushing the supply overall responsiveness of the economic system.

Table 3 presents the results for different values of the primary factor elasticity of substitution. In addition to the benchmark value (0.5), we also run the two models using alternative higher values (1.0 and 2.0), mimicking progressive lower rates of capacity utilization in the "two

Greek economies". It is noteworthy that higher parameter values relates to higher multipliers in each structural setting. Due to the lack of empirical evidence, we can only make conjectures about the likely differences of the values of the parameter in the two points in time. In light of Figure 2, it would be reasonable to assume that its value in 2013 would be higher than that in 2010, given the fairly lower rate of capacity utilization in 2013. Accepting that means that, given the simulated outcomes in Table 2, there would be a threshold difference in the magnitude of both years' parameters that would reverse the conclusion on the magnitude of the multiplier in the different states of the Greek economy. In other words, we cannot conclude, under this level of numerical uncertainty in our modeling framework, whether the multiplier is smaller in the recession.

Figure 2. Industrial Capacity Utilization Rate in Greece: 2009-2017



Source: EUROSTAT

Table 3. General Equilibrium Government Spending Output Multipliers under Different Hypotheses on "Capacity Utilization": Greece, 2010 and 2013

Benchmark	*Parameter value*		
	0.5	*1.0*	*2.0*
2010	0.34	0.42	0.48
2013	0.32	0.39	0.44

Table 4 reveals the regional dimensions of the nationwide multiplier in the context of integrated multiregional systems. As shown in Equations (28)-(31), the multiregional approach can provide the reconciliation between local and nationwide multipliers by taking into account both intra and interregional effects of government spending. In our neoclassical general equilibrium model, both local income effects and interregional substitution effects can influence the adjustment of the system to government spending demand shocks in the local economies. From the supply side, regional structural characteristics from Equation (32) play different roles. We calculated, for each of the 13 Greek NUTS-2 regions, the labor to capital ratio and the aggregate share of primary factors in total costs. On one hand, we found, for both years, strong positive correlation between the latter and the nationwide, source-specific shock, multipliers, $K_{(s)}^{(\bullet)}$ (58.4% in 2010, and 62.9% in 2013), with no meaningful correlation with the local multipliers, $K_{(s)}^{(r)}$. On the other hand, the correlation between the regional ratio of labor payments to capital payments and the local multipliers was meaningful in both years and more relevant in 2013 (25.7% in 2010, and 46.2% in 2013). This first set of results suggest that, in our context, national output is more influenced by the overall value added content in regional production systems, while local effects depend more heavily on the ability of regional suppliers to respond promptly to the local demand shocks.

Table 4. Local Government Spending Output Multipliers: Greece, 2010 and 2013

Origin of Government Spending	*2010*			*2013*		
	Intraregional $K_{(s)}^{(r)}$	*Interregional* $K_{(s)}^{(t)}$	*Total* $K_{(s)}^{(\bullet)}$	*Intraregional* $K_{(s)}^{(r)}$	*Interregional* $K_{(s)}^{(t)}$	*Total* $K_{(s)}^{(\bullet)}$
R1 Attica	0,51	-0,16	0,35	0,52	-0,19	0,33
R2 North Aegean	0,83	-0,50	0,33	0,85	-0,54	0,32
R3 South Aegean	0,64	-0,26	0,38	0,63	-0,19	0,43
R4 Crete	0,65	-0,29	0,36	0,67	-0,27	0,40
R5 Eastern Macedonia and Thrace	0,78	-0,43	0,35	0,82	-0,50	0,32
R6 Central Macedonia	0,68	-0,35	0,33	0,73	-0,43	0,30
R7 Western Macedonia	0,69	-0,37	0,31	0,73	-0,46	0,26
R8 Epirus	0,78	-0,48	0,30	0,82	-0,56	0,26
R9 Thessaly	0,76	-0,45	0,30	0,80	-0,51	0,29
R10 Ionian Islands	0,65	-0,29	0,36	0,66	-0,28	0,38
R11 Western Greece	0,74	-0,42	0,32	0,80	-0,50	0,30
R12 Central Greece	0,62	-0,30	0,32	0,68	-0,37	0,31
R13 Peloponnese	0,70	-0,40	0,30	0,73	-0,45	0,27
GREECE	-	-	0,34	-	-	0,32

Government spending is heavily concentrated in the purchase of local goods.[6] One of its consequences is to put pressure on prices of local goods to increase relative to prices of goods

[6] Tables in the Annex provide model-based empirical evidence for the arguments in the forthcoming discussion.

produced elsewhere, generating a domestic terms of trade effect that switches expenditures away from local goods. In the case of the potential impacts of government spending in a specific region, we expect to see a reduction in regional exports in interregional trade and an increase in imports from other parts of the country.[7] Another consequence is the rise of local agents' income that increase their expenditure not only on locally produced but also on external goods, irrespective of changes in relative prices (Chodorow-Reich, 2017).

Finally, given the supply-constrained short run environment in this cost-competitiveness approach, the rise of local prices also affects the international trade balance, hampering international exports and increasing import penetration. This movement is important to switch the allocation of resources towards components of domestic demand.

5. Concluding Remarks

In this paper we developed a neoclassical multiregional model for Greece to simulate the short run impacts of temporary deficit-financed rises in government spending. It has long been recognized that the fiscal multiplier is a function of structural features of the economy and policy reaction parameters. Moreover, the debate on the magnitude of the multiplier along the business cycle has also been the subject of disputed debates. On these grounds, we looked at the Greek case by calibrating the model using data for distinct states of the Greek economy during the development of the recent crisis. Whether this matters for local and nationwide multipliers depends on qualitative differences of the numerical structures of the model. Our results imply that structural coefficients have a strong effect on government spending impact multipliers. In the case of Greece, lack of information on the changing magnitudes of behavioral parameters over time adds another layer of uncertainty to this debate.

[7] The strength of the substitution effect depends on the structure of interregional trade and on the size of the regional trade elasticity [$\sigma 1_{(i)}^{(u)r}$ in Equation (1)]. Table 8A in the Annex shows the sensitivity analysis of results presented in Table 3 on setting the parameter value twice as high. In such case, the size of the local multipliers is reduced at the expense of the interregional multipliers.

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ANNEX

Table 1A. Regional Composition of Local Government Spending: Greece, 2010 and 2013

2010

Source of Goods	*Origin of Government Spending*												
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
R1 Attica	0,846	0,057	0,027	0,040	0,069	0,080	0,105	0,090	0,094	0,044	0,106	0,134	0,145
R2 North Aegean	0,002	0,819	0,001	0,001	0,003	0,003	0,003	0,002	0,002	0,001	0,001	0,002	0,002
R3 South Aegean	0,004	0,006	0,885	0,003	0,006	0,004	0,006	0,004	0,003	0,002	0,003	0,003	0,003
R4 Crete	0,009	0,008	0,003	0,866	0,008	0,005	0,009	0,007	0,006	0,003	0,005	0,006	0,006
R5 Eastern Macedonia and Thrace	0,005	0,006	0,002	0,002	0,790	0,010	0,011	0,007	0,006	0,004	0,004	0,006	0,004
R6 Central Macedonia	0,019	0,017	0,005	0,005	0,027	0,780	0,080	0,033	0,039	0,013	0,013	0,027	0,012
R7 Western Macedonia	0,002	0,002	0,000	0,001	0,002	0,006	0,656	0,006	0,004	0,002	0,002	0,003	0,001
R8 Epirus	0,003	0,002	0,001	0,001	0,003	0,005	0,012	0,748	0,004	0,004	0,003	0,004	0,003
R9 Thessaly	0,009	0,005	0,001	0,002	0,007	0,016	0,021	0,011	0,750	0,004	0,005	0,017	0,005
R10 Ionian Islands	0,002	0,003	0,000	0,001	0,003	0,003	0,007	0,007	0,003	0,846	0,002	0,002	0,002
R11 Western Greece	0,010	0,003	0,001	0,002	0,004	0,005	0,008	0,008	0,005	0,003	0,779	0,006	0,008
R12 Central Greece	0,009	0,004	0,002	0,004	0,008	0,012	0,012	0,007	0,016	0,004	0,004	0,718	0,004
R13 Peloponnese	0,010	0,003	0,001	0,003	0,005	0,004	0,007	0,005	0,004	0,002	0,005	0,005	0,741
Foreign	0,069	0,065	0,070	0,070	0,065	0,066	0,064	0,065	0,064	0,069	0,067	0,066	0,064
TOTAL	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

2013

Source of Goods	*Origin of Government Spending*												
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
R1 Attica	0,866	0,057	0,024	0,037	0,071	0,077	0,106	0,089	0,093	0,041	0,102	0,135	0,138
R2 North Aegean	0,002	0,832	0,001	0,001	0,003	0,003	0,003	0,002	0,002	0,001	0,001	0,002	0,002
R3 South Aegean	0,005	0,008	0,915	0,003	0,007	0,004	0,006	0,004	0,004	0,002	0,003	0,004	0,003
R4 Crete	0,010	0,010	0,003	0,896	0,010	0,006	0,010	0,008	0,006	0,003	0,006	0,007	0,006
R5 Eastern Macedonia and Thrace	0,005	0,007	0,002	0,002	0,801	0,010	0,011	0,007	0,006	0,004	0,004	0,006	0,004
R6 Central Macedonia	0,019	0,018	0,004	0,005	0,029	0,802	0,083	0,034	0,040	0,012	0,012	0,027	0,012
R7 Western Macedonia	0,002	0,002	0,000	0,001	0,003	0,007	0,665	0,006	0,004	0,002	0,002	0,003	0,002
R8 Epirus	0,003	0,002	0,001	0,001	0,003	0,005	0,013	0,764	0,004	0,004	0,003	0,004	0,003
R9 Thessaly	0,009	0,005	0,001	0,002	0,007	0,017	0,022	0,011	0,768	0,004	0,005	0,018	0,005
R10 Ionian Islands	0,003	0,003	0,001	0,001	0,004	0,003	0,008	0,009	0,003	0,874	0,002	0,003	0,002
R11 Western Greece	0,010	0,004	0,001	0,002	0,005	0,005	0,009	0,009	0,005	0,004	0,805	0,007	0,008
R12 Central Greece	0,010	0,003	0,001	0,004	0,008	0,012	0,011	0,006	0,016	0,003	0,004	0,736	0,004
R13 Peloponnese	0,011	0,004	0,001	0,003	0,006	0,005	0,007	0,006	0,005	0,002	0,005	0,005	0,769
Foreign	0,046	0,044	0,045	0,045	0,044	0,045	0,044	0,044	0,044	0,045	0,045	0,044	0,044
TOTAL	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Table 2A. Impact on Exports Volume in Interregional Trade, by Origin of Exports: Greece, 2010 and 2013 (in percentage change)

2010

Origin of Exports	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	-0,543	0,021	0,011	0,020	0,062	0,208	0,044	0,045	0,101	0,010	0,088	0,072	0,094	0,233
R2 North Aegean	0,425	-0,767	0,013	0,018	0,069	0,210	0,039	0,033	0,066	0,009	0,045	0,040	0,041	0,240
R3 South Aegean	0,274	0,013	-0,353	0,012	0,034	0,105	0,021	0,018	0,036	0,004	0,029	0,022	0,028	0,243
R4 Crete	0,429	0,015	0,011	-0,535	0,039	0,122	0,026	0,025	0,049	0,006	0,045	0,034	0,044	0,311
R5 Eastern Macedonia and Thrace	0,241	0,018	0,009	0,007	-0,496	0,165	0,029	0,022	0,042	0,006	0,022	0,025	0,019	0,109
R6 Central Macedonia	0,265	0,016	0,006	0,006	0,055	-0,443	0,065	0,038	0,094	0,007	0,027	0,037	0,022	0,194
R7 Western Macedonia	0,104	0,005	0,001	0,001	0,017	0,103	-0,146	0,020	0,030	0,003	0,013	0,012	0,009	0,172
R8 Epirus	0,245	0,009	0,004	0,006	0,028	0,145	0,045	-0,393	0,049	0,008	0,034	0,027	0,025	0,233
R9 Thessaly	0,199	0,006	0,002	0,002	0,020	0,152	0,030	0,019	-0,389	0,003	0,013	0,035	0,012	0,105
R10 Ionian Islands	0,260	0,009	0,004	0,008	0,028	0,126	0,032	0,039	0,045	-0,383	0,034	0,026	0,028	0,255
R11 Western Greece	0,381	0,008	0,004	0,007	0,022	0,083	0,021	0,024	0,032	0,005	-0,479	0,026	0,039	0,173
R12 Central Greece	0,135	0,001	0,000	-0,002	0,003	0,035	0,008	0,006	0,029	0,001	0,005	-0,204	0,004	0,022
R13 Peloponnese	0,293	0,010	0,007	0,013	0,026	0,049	0,017	0,021	0,035	0,006	0,043	0,025	-0,342	0,202

2013

Origin of Exports	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	-0,618	0,023	0,008	0,018	0,072	0,251	0,056	0,052	0,120	0,009	0,097	0,086	0,109	0,283
R2 North Aegean	0,500	-0,876	0,012	0,018	0,080	0,252	0,051	0,039	0,081	0,009	0,052	0,050	0,050	0,318
R3 South Aegean	0,252	0,011	-0,261	0,009	0,030	0,095	0,021	0,016	0,033	0,003	0,025	0,021	0,026	0,282
R4 Crete	0,417	0,014	0,007	-0,511	0,038	0,120	0,028	0,024	0,049	0,005	0,041	0,034	0,043	0,310
R5 Eastern Macedonia and Thrace	0,312	0,020	0,007	0,009	-0,539	0,209	0,039	0,027	0,057	0,006	0,029	0,033	0,027	0,236
R6 Central Macedonia	0,319	0,017	0,005	0,006	0,065	-0,494	0,083	0,043	0,113	0,006	0,031	0,045	0,027	0,267
R7 Western Macedonia	0,142	0,006	0,001	0,002	0,022	0,129	-0,162	0,023	0,039	0,003	0,017	0,018	0,014	0,256
R8 Epirus	0,273	0,010	0,003	0,005	0,032	0,164	0,054	-0,433	0,057	0,007	0,036	0,031	0,029	0,267
R9 Thessaly	0,264	0,008	0,003	0,004	0,028	0,197	0,042	0,024	-0,452	0,004	0,020	0,046	0,019	0,206
R10 Ionian Islands	0,268	0,009	0,002	0,006	0,028	0,130	0,035	0,039	0,047	-0,348	0,034	0,027	0,029	0,307
R11 Western Greece	0,459	0,010	0,004	0,008	0,029	0,110	0,029	0,030	0,044	0,005	-0,568	0,034	0,049	0,243
R12 Central Greece	0,230	0,003	0,001	0,001	0,012	0,070	0,016	0,012	0,047	0,002	0,013	-0,259	0,014	0,161
R13 Peloponnese	0,332	0,006	0,003	0,006	0,017	0,051	0,014	0,015	0,024	0,003	0,031	0,020	-0,337	0,185

Table 3A. Impact on Imports Volume in Interregional Trade, by Destination of Imports: Greece, 2010 and 2013 (in percentage change)

2010

Destination of Imports	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	0,749	-0,019	-0,028	-0,051	-0,046	-0,167	-0,027	-0,032	-0,066	-0,017	-0,060	-0,038	-0,055	0,142
R2 North Aegean	-0,373	1,334	-0,032	-0,038	-0,039	-0,118	-0,019	-0,025	-0,055	-0,014	-0,047	-0,033	-0,045	0,496
R3 South Aegean	-0,150	-0,009	0,675	-0,018	-0,022	-0,061	-0,010	-0,014	-0,030	-0,006	-0,025	-0,019	-0,023	0,287
R4 Crete	-0,281	-0,013	-0,016	0,698	-0,033	-0,113	-0,019	-0,023	-0,049	-0,009	-0,041	-0,031	-0,040	0,029
R5 Eastern Macedonia and Thrace	-0,468	-0,018	-0,030	-0,041	1,170	-0,150	-0,025	-0,032	-0,069	-0,016	-0,058	-0,042	-0,056	0,164
R6 Central Macedonia	-0,492	-0,019	-0,025	-0,038	-0,045	1,046	-0,009	-0,030	-0,062	-0,017	-0,063	-0,042	-0,061	0,142
R7 Western Macedonia	-0,221	-0,008	-0,014	-0,019	-0,020	-0,058	0,958	-0,011	-0,030	-0,010	-0,026	-0,019	-0,027	0,496
R8 Epirus	-0,375	-0,015	-0,020	-0,031	-0,039	-0,112	-0,006	1,194	-0,053	-0,018	-0,047	-0,032	-0,046	0,398
R9 Thessaly	-0,383	-0,016	-0,020	-0,032	-0,042	-0,099	-0,013	-0,025	1,133	-0,013	-0,053	-0,024	-0,051	0,363
R10 Ionian Islands	-0,141	-0,008	-0,010	-0,016	-0,019	-0,042	-0,001	-0,002	-0,022	0,762	-0,019	-0,015	-0,021	0,447
R11 Western Greece	-0,353	-0,015	-0,019	-0,032	-0,042	-0,139	-0,023	-0,026	-0,061	-0,012	1,167	-0,037	-0,047	0,361
R12 Central Greece	-0,415	-0,018	-0,015	-0,028	-0,046	-0,147	-0,027	-0,032	-0,060	-0,012	-0,059	0,682	-0,058	-0,235
R13 Peloponnese	-0,306	-0,012	-0,014	-0,024	-0,034	-0,127	-0,021	-0,023	-0,052	-0,009	-0,043	-0,032	1,036	0,337

2013

Destination of Imports	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	0,871	-0,019	-0,020	-0,047	-0,049	-0,189	-0,033	-0,035	-0,071	-0,015	-0,063	-0,042	-0,060	0,228
R2 North Aegean	-0,438	1,427	-0,027	-0,037	-0,042	-0,139	-0,025	-0,029	-0,063	-0,013	-0,052	-0,040	-0,053	0,468
R3 South Aegean	-0,157	-0,007	0,598	-0,014	-0,020	-0,062	-0,011	-0,014	-0,030	-0,004	-0,024	-0,020	-0,025	0,209
R4 Crete	-0,269	-0,011	-0,011	0,787	-0,030	-0,112	-0,020	-0,021	-0,047	-0,007	-0,038	-0,031	-0,039	0,151
R5 Eastern Macedonia and Thrace	-0,536	-0,019	-0,024	-0,039	1,257	-0,170	-0,031	-0,036	-0,078	-0,015	-0,064	-0,050	-0,065	0,129
R6 Central Macedonia	-0,576	-0,020	-0,019	-0,035	-0,049	1,193	-0,010	-0,034	-0,068	-0,016	-0,070	-0,051	-0,072	0,171
R7 Western Macedonia	-0,278	-0,010	-0,011	-0,019	-0,023	-0,068	1,152	-0,013	-0,036	-0,010	-0,031	-0,025	-0,033	0,596
R8 Epirus	-0,442	-0,016	-0,016	-0,030	-0,044	-0,136	-0,009	1,297	-0,062	-0,017	-0,053	-0,039	-0,054	0,379
R9 Thessaly	-0,460	-0,017	-0,017	-0,031	-0,047	-0,121	-0,017	-0,029	1,288	-0,013	-0,059	-0,031	-0,059	0,387
R10 Ionian Islands	-0,146	-0,007	-0,007	-0,013	-0,018	-0,043	0,001	0,000	-0,022	0,743	-0,019	-0,016	-0,023	0,430
R11 Western Greece	-0,425	-0,017	-0,016	-0,032	-0,048	-0,168	-0,029	-0,030	-0,072	-0,012	1,358	-0,046	-0,056	0,409
R12 Central Greece	-0,404	-0,016	-0,010	-0,022	-0,043	-0,142	-0,028	-0,031	-0,055	-0,010	-0,056	0,876	-0,058	0,002
R13 Peloponnese	-0,331	-0,013	-0,010	-0,023	-0,039	-0,143	-0,027	-0,027	-0,061	-0,009	-0,050	-0,040	1,118	0,346

Table 4A. Impact on Domestic Terms of Trade, by Region: Greece, 2010 and 2013 (in percentage change)

2010

Region	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	0,311	-0,005	-0,019	-0,035	-0,007	-0,043	-0,005	-0,006	-0,013	-0,009	-0,019	-0,012	-0,019	0,117
R2 North Aegean	-0,104	0,605	-0,021	-0,020	-0,010	-0,014	-0,001	-0,006	-0,013	-0,007	-0,010	-0,008	-0,012	0,379
R3 South Aegean	0,562	0,020	0,300	0,013	0,052	0,221	0,044	0,038	0,078	0,007	0,068	0,047	0,063	1,515
R4 Crete	0,299	0,008	-0,004	0,443	0,021	0,090	0,020	0,018	0,035	0,002	0,034	0,022	0,031	1,019
R5 Eastern Macedonia and Thrace	-0,345	-0,014	-0,023	-0,029	0,364	-0,118	-0,020	-0,024	-0,051	-0,012	-0,041	-0,032	-0,041	-0,385
R6 Central Macedonia	-0,380	-0,014	-0,018	-0,026	-0,035	0,237	-0,015	-0,025	-0,053	-0,013	-0,046	-0,035	-0,045	-0,468
R7 Western Macedonia	-0,116	-0,004	-0,009	-0,011	-0,006	-0,050	0,118	-0,007	-0,019	-0,006	-0,011	-0,012	-0,015	-0,147
R8 Epirus	-0,245	-0,009	-0,012	-0,019	-0,024	-0,076	-0,008	0,304	-0,034	-0,014	-0,029	-0,021	-0,029	-0,216
R9 Thessaly	-0,268	-0,010	-0,012	-0,019	-0,026	-0,076	-0,012	-0,017	0,284	-0,009	-0,032	-0,022	-0,032	-0,251
R10 Ionian Islands	0,434	0,013	0,003	0,011	0,037	0,206	0,051	0,056	0,074	0,316	0,062	0,042	0,051	1,354
R11 Western Greece	-0,211	-0,008	-0,011	-0,019	-0,021	-0,072	-0,012	-0,014	-0,032	-0,008	0,368	-0,020	-0,026	-0,085
R12 Central Greece	-0,230	-0,009	-0,009	-0,014	-0,023	-0,066	-0,013	-0,017	-0,027	-0,007	-0,031	0,144	-0,031	-0,334
R13 Peloponnese	-0,281	-0,009	-0,010	-0,017	-0,025	-0,094	-0,016	-0,018	-0,038	-0,007	-0,033	-0,026	0,240	-0,333

2013

Region	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	0,321	-0,006	-0,016	-0,034	-0,006	-0,052	-0,007	-0,008	-0,013	-0,009	-0,020	-0,011	-0,020	0,119
R2 North Aegean	-0,043	0,674	-0,020	-0,020	-0,005	0,017	0,005	-0,001	-0,003	-0,007	-0,003	-0,002	-0,005	0,585
R3 South Aegean	0,832	0,026	0,227	0,012	0,073	0,329	0,070	0,057	0,116	0,008	0,095	0,072	0,093	2,011
R4 Crete	0,497	0,013	-0,008	0,424	0,034	0,157	0,036	0,031	0,061	0,003	0,054	0,040	0,052	1,394
R5 Eastern Macedonia and Thrace	-0,412	-0,015	-0,019	-0,029	0,383	-0,138	-0,027	-0,029	-0,061	-0,012	-0,048	-0,040	-0,051	-0,497
R6 Central Macedonia	-0,463	-0,016	-0,013	-0,025	-0,042	0,240	-0,019	-0,030	-0,062	-0,012	-0,054	-0,045	-0,056	-0,597
R7 Western Macedonia	-0,102	-0,003	-0,005	-0,008	-0,001	-0,034	0,129	-0,005	-0,013	-0,005	-0,008	-0,009	-0,012	-0,076
R8 Epirus	-0,306	-0,011	-0,010	-0,019	-0,030	-0,095	-0,012	0,320	-0,043	-0,014	-0,035	-0,028	-0,037	-0,319
R9 Thessaly	-0,326	-0,011	-0,010	-0,019	-0,031	-0,089	-0,015	-0,021	0,317	-0,009	-0,038	-0,027	-0,040	-0,321
R10 Ionian Islands	0,653	0,018	-0,003	0,010	0,051	0,300	0,077	0,077	0,107	0,289	0,085	0,064	0,074	1,802
R11 Western Greece	-0,265	-0,009	-0,010	-0,020	-0,027	-0,093	-0,017	-0,017	-0,041	-0,008	0,421	-0,027	-0,033	-0,146
R12 Central Greece	-0,244	-0,010	-0,007	-0,013	-0,025	-0,071	-0,016	-0,019	-0,028	-0,006	-0,034	0,183	-0,036	-0,326
R13 Peloponnese	-0,356	-0,012	-0,008	-0,018	-0,035	-0,121	-0,025	-0,025	-0,054	-0,007	-0,046	-0,037	0,217	-0,526

Table 5A. Impact on Exports Volume in International Trade, by Origin of Exports: Greece, 2010 and 2013 (in percentage change)

2010

Origin of Exports	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	-1,269	-0,042	-0,025	-0,052	-0,107	-0,351	-0,071	-0,076	-0,160	-0,021	-0,137	-0,107	-0,143	-2,563
R2 North Aegean	-0,920	-0,799	-0,025	-0,049	-0,118	-0,378	-0,074	-0,076	-0,154	-0,021	-0,127	-0,098	-0,125	-2,963
R3 South Aegean	-0,959	-0,050	-0,618	-0,056	-0,123	-0,376	-0,075	-0,077	-0,157	-0,021	-0,131	-0,098	-0,130	-2,870
R4 Crete	-0,951	-0,043	-0,027	-0,565	-0,107	-0,340	-0,068	-0,073	-0,147	-0,020	-0,128	-0,095	-0,127	-2,691
R5 Eastern Macedonia and Thrace	-0,847	-0,045	-0,025	-0,047	-0,573	-0,360	-0,069	-0,072	-0,144	-0,021	-0,117	-0,091	-0,114	-2,522
R6 Central Macedonia	-0,806	-0,040	-0,022	-0,043	-0,105	-0,702	-0,083	-0,074	-0,160	-0,020	-0,111	-0,091	-0,107	-2,366
R7 Western Macedonia	-1,011	-0,048	-0,026	-0,054	-0,122	-0,483	-0,411	-0,102	-0,189	-0,027	-0,142	-0,110	-0,134	-2,859
R8 Epirus	-0,980	-0,044	-0,023	-0,050	-0,112	-0,414	-0,094	-0,534	-0,171	-0,027	-0,141	-0,105	-0,132	-2,828
R9 Thessaly	-0,932	-0,041	-0,023	-0,047	-0,104	-0,408	-0,080	-0,078	-0,486	-0,021	-0,122	-0,111	-0,120	-2,572
R10 Ionian Islands	-0,969	-0,046	-0,024	-0,051	-0,119	-0,408	-0,091	-0,104	-0,172	-0,574	-0,139	-0,105	-0,133	-2,934
R11 Western Greece	-1,023	-0,041	-0,023	-0,050	-0,102	-0,343	-0,070	-0,078	-0,149	-0,022	-0,640	-0,099	-0,137	-2,776
R12 Central Greece	-0,879	-0,037	-0,023	-0,048	-0,092	-0,326	-0,063	-0,067	-0,152	-0,020	-0,114	-0,245	-0,111	-2,176
R13 Peloponnese	-0,701	-0,032	-0,020	-0,042	-0,078	-0,225	-0,049	-0,056	-0,110	-0,017	-0,104	-0,072	-0,303	-1,808

2013

Origin of Exports	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	-1,243	-0,036	-0,008	-0,034	-0,102	-0,347	-0,075	-0,073	-0,156	-0,015	-0,128	-0,108	-0,142	-2,468
R2 North Aegean	-0,983	-0,846	-0,006	-0,032	-0,125	-0,406	-0,086	-0,079	-0,162	-0,015	-0,127	-0,106	-0,131	-3,106
R3 South Aegean	-1,076	-0,052	-0,554	-0,043	-0,138	-0,425	-0,092	-0,085	-0,174	-0,017	-0,137	-0,112	-0,144	-3,049
R4 Crete	-1,023	-0,042	-0,010	-0,581	-0,112	-0,361	-0,079	-0,076	-0,155	-0,015	-0,127	-0,104	-0,134	-2,818
R5 Eastern Macedonia and Thrace	-0,859	-0,040	-0,007	-0,029	-0,544	-0,370	-0,076	-0,070	-0,143	-0,014	-0,110	-0,093	-0,112	-2,467
R6 Central Macedonia	-0,764	-0,033	-0,006	-0,025	-0,097	-0,650	-0,086	-0,068	-0,151	-0,013	-0,096	-0,087	-0,098	-2,175
R7 Western Macedonia	-1,128	-0,046	-0,010	-0,039	-0,134	-0,542	-0,401	-0,108	-0,207	-0,022	-0,148	-0,124	-0,146	-3,054
R8 Epirus	-1,029	-0,040	-0,005	-0,031	-0,114	-0,437	-0,108	-0,551	-0,177	-0,021	-0,138	-0,113	-0,136	-2,899
R9 Thessaly	-0,911	-0,035	-0,005	-0,028	-0,099	-0,406	-0,085	-0,074	-0,489	-0,014	-0,110	-0,112	-0,114	-2,481
R10 Ionian Islands	-1,093	-0,046	-0,007	-0,036	-0,132	-0,466	-0,112	-0,117	-0,192	-0,536	-0,147	-0,120	-0,146	-3,151
R11 Western Greece	-1,067	-0,037	-0,005	-0,031	-0,101	-0,351	-0,079	-0,079	-0,150	-0,015	-0,690	-0,104	-0,140	-2,847
R12 Central Greece	-0,820	-0,028	-0,006	-0,027	-0,080	-0,296	-0,061	-0,057	-0,138	-0,012	-0,093	-0,248	-0,097	-1,964
R13 Peloponnese	-0,566	-0,019	-0,004	-0,019	-0,053	-0,175	-0,038	-0,038	-0,076	-0,008	-0,068	-0,052	-0,216	-1,333

Table 6A. Impact on Imports Volume in International Trade, by Destination of Imports: Greece, 2010 and 2013 (in percentage change)

2010

Origin of Exports	*Origin of Government Spending*													Total
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	1,060	0,012	0,005	0,013	0,029	0,096	0,021	0,022	0,046	0,006	0,042	0,036	0,046	1,434
R2 North Aegean	0,341	1,082	0,002	0,012	0,042	0,146	0,029	0,029	0,057	0,006	0,047	0,038	0,047	1,878
R3 South Aegean	0,449	0,020	0,872	0,024	0,048	0,163	0,033	0,033	0,066	0,009	0,058	0,043	0,058	1,875
R4 Crete	0,365	0,015	0,008	0,786	0,036	0,117	0,025	0,026	0,051	0,007	0,046	0,035	0,047	1,563
R5 Eastern Macedonia and Thrace	0,229	0,013	0,001	0,006	0,945	0,109	0,022	0,021	0,040	0,004	0,032	0,027	0,033	1,483
R6 Central Macedonia	0,222	0,012	0,002	0,008	0,031	0,889	0,032	0,024	0,051	0,005	0,030	0,029	0,029	1,363
R7 Western Macedonia	0,332	0,015	0,006	0,015	0,040	0,163	0,637	0,034	0,061	0,008	0,047	0,037	0,044	1,440
R8 Epirus	0,355	0,016	0,004	0,014	0,038	0,156	0,040	0,943	0,061	0,008	0,051	0,041	0,048	1,775
R9 Thessaly	0,307	0,013	0,003	0,009	0,030	0,149	0,031	0,026	0,932	0,005	0,037	0,044	0,037	1,625
R10 Ionian Islands	0,480	0,020	0,010	0,022	0,051	0,192	0,043	0,049	0,078	0,871	0,066	0,050	0,062	1,995
R11 Western Greece	0,392	0,014	0,005	0,014	0,033	0,116	0,025	0,028	0,050	0,007	0,968	0,036	0,050	1,739
R12 Central Greece	0,236	0,009	0,004	0,009	0,020	0,080	0,016	0,016	0,040	0,004	0,026	0,515	0,026	1,000
R13 Peloponnese	0,234	0,011	0,006	0,014	0,026	0,061	0,016	0,020	0,035	0,006	0,037	0,024	0,498	0,990

2013

Origin of Exports	*Origin of Government Spending*													Total
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	0,964	0,007	-0,002	0,003	0,019	0,063	0,015	0,015	0,032	0,002	0,029	0,028	0,036	1,212
R2 North Aegean	0,292	1,135	-0,007	0,001	0,036	0,128	0,029	0,024	0,048	0,002	0,038	0,033	0,040	1,799
R3 South Aegean	0,409	0,016	0,779	0,015	0,043	0,147	0,032	0,029	0,058	0,005	0,048	0,039	0,051	1,671
R4 Crete	0,323	0,011	0,001	0,792	0,030	0,096	0,023	0,021	0,042	0,003	0,036	0,030	0,040	1,448
R5 Eastern Macedonia and Thrace	0,184	0,009	-0,007	-0,003	0,986	0,097	0,021	0,017	0,032	0,001	0,023	0,022	0,025	1,408
R6 Central Macedonia	0,135	0,007	-0,004	-0,001	0,022	0,854	0,030	0,017	0,038	0,001	0,016	0,020	0,017	1,151
R7 Western Macedonia	0,280	0,011	-0,001	0,006	0,034	0,151	0,707	0,030	0,054	0,004	0,037	0,033	0,036	1,383
R8 Epirus	0,292	0,011	-0,005	0,002	0,030	0,133	0,041	1,021	0,050	0,003	0,040	0,035	0,039	1,692
R9 Thessaly	0,249	0,009	-0,006	-0,001	0,024	0,133	0,031	0,022	1,040	0,001	0,027	0,040	0,029	1,598
R10 Ionian Islands	0,478	0,017	0,000	0,012	0,048	0,191	0,048	0,050	0,076	0,848	0,061	0,050	0,060	1,941
R11 Western Greece	0,339	0,010	-0,004	0,002	0,025	0,091	0,023	0,023	0,038	0,002	1,116	0,030	0,042	1,738
R12 Central Greece	0,226	0,006	-0,001	0,004	0,017	0,075	0,016	0,014	0,038	0,002	0,021	0,624	0,023	1,065
R13 Peloponnese	0,117	0,003	-0,001	0,001	0,006	0,014	0,005	0,005	0,007	0,001	0,011	0,007	0,353	0,531

Table 7A. Impact on Regional Activity Level: Greece, 2010 and 2013

(in percentage change)

2010

Region	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	0,460	-0,007	-0,007	-0,012	-0,016	-0,051	-0,008	-0,010	-0,019	-0,004	-0,015	-0,007	-0,010	0,295
R2 North Aegean	-0,122	0,742	-0,009	-0,015	-0,012	-0,034	-0,005	-0,009	-0,019	-0,005	-0,019	-0,012	-0,017	0,464
R3 South Aegean	-0,007	-0,002	0,606	-0,006	-0,004	-0,009	0,000	-0,003	-0,008	-0,002	-0,007	-0,005	-0,005	0,549
R4 Crete	-0,052	-0,005	-0,005	0,606	-0,012	-0,038	-0,005	-0,007	-0,016	-0,004	-0,013	-0,009	-0,012	0,427
R5 Eastern Macedonia and Thrace	-0,177	-0,007	-0,010	-0,018	0,692	-0,047	-0,008	-0,012	-0,027	-0,006	-0,026	-0,017	-0,024	0,313
R6 Central Macedonia	-0,154	-0,007	-0,009	-0,016	-0,015	0,597	0,003	-0,008	-0,014	-0,005	-0,024	-0,012	-0,023	0,312
R7 Western Macedonia	-0,058	-0,003	-0,005	-0,008	-0,005	0,015	0,529	0,002	-0,003	-0,001	-0,009	-0,005	-0,010	0,440
R8 Epirus	-0,110	-0,006	-0,008	-0,014	-0,015	-0,026	0,004	0,654	-0,016	-0,003	-0,015	-0,010	-0,016	0,420
R9 Thessaly	-0,108	-0,007	-0,009	-0,015	-0,016	-0,014	0,000	-0,008	0,621	-0,004	-0,021	-0,002	-0,019	0,399
R10 Ionian Islands	-0,015	-0,002	-0,005	-0,007	-0,004	0,002	0,006	0,007	-0,003	0,591	-0,004	-0,002	-0,005	0,559
R11 Western Greece	-0,067	-0,006	-0,008	-0,013	-0,017	-0,051	-0,007	-0,008	-0,022	-0,004	0,629	-0,012	-0,013	0,403
R12 Central Greece	-0,117	-0,008	-0,007	-0,013	-0,020	-0,052	-0,009	-0,012	-0,017	-0,005	-0,024	0,502	-0,023	0,195
R13 Peloponnese	-0,034	-0,005	-0,006	-0,009	-0,014	-0,047	-0,007	-0,008	-0,018	-0,003	-0,013	-0,010	0,599	0,425

2013

Region	*Origin of Government Spending*													*Total*
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*	
R1 Attica	0,481	-0,007	-0,005	-0,010	-0,018	-0,062	-0,011	-0,011	-0,023	-0,004	-0,017	-0,010	-0,013	0,290
R2 North Aegean	-0,156	0,772	-0,008	-0,014	-0,015	-0,047	-0,008	-0,011	-0,025	-0,005	-0,022	-0,016	-0,021	0,425
R3 South Aegean	-0,020	-0,001	0,603	-0,005	-0,005	-0,013	-0,001	-0,004	-0,009	-0,002	-0,008	-0,006	-0,007	0,522
R4 Crete	-0,059	-0,004	-0,004	0,631	-0,011	-0,043	-0,006	-0,008	-0,018	-0,003	-0,014	-0,010	-0,013	0,438
R5 Eastern Macedonia and Thrace	-0,213	-0,008	-0,009	-0,017	0,730	-0,059	-0,011	-0,015	-0,032	-0,006	-0,029	-0,021	-0,029	0,282
R6 Central Macedonia	-0,191	-0,008	-0,007	-0,014	-0,017	0,640	0,001	-0,011	-0,019	-0,005	-0,028	-0,016	-0,028	0,297
R7 Western Macedonia	-0,079	-0,003	-0,004	-0,007	-0,007	0,008	0,573	0,001	-0,005	-0,001	-0,011	-0,006	-0,012	0,447
R8 Epirus	-0,146	-0,007	-0,007	-0,013	-0,018	-0,039	0,002	0,698	-0,021	-0,003	-0,019	-0,013	-0,021	0,393
R9 Thessaly	-0,147	-0,007	-0,007	-0,014	-0,019	-0,027	-0,003	-0,010	0,669	-0,004	-0,024	-0,006	-0,024	0,375
R10 Ionian Islands	-0,020	-0,002	-0,004	-0,007	-0,005	-0,001	0,007	0,008	-0,004	0,607	-0,005	-0,003	-0,007	0,565
R11 Western Greece	-0,105	-0,007	-0,006	-0,013	-0,020	-0,066	-0,010	-0,010	-0,028	-0,004	0,682	-0,016	-0,018	0,378
R12 Central Greece	-0,115	-0,007	-0,005	-0,010	-0,019	-0,051	-0,010	-0,012	-0,016	-0,004	-0,023	0,545	-0,023	0,252
R13 Peloponnese	-0,057	-0,006	-0,004	-0,009	-0,017	-0,057	-0,010	-0,010	-0,024	-0,003	-0,017	-0,014	0,656	0,427

Table 8A. Local Government Spending Output Multipliers: Greece, 2010 and 2013 (Sensitivity Analysis to the Parameter of Interregional Trade Elasticity)

Origin of Government Spending	*2010*			*2013*		
	Intraregional $K_{(s)}^{(r)}$	*Interregional* $K_{(s)}^{(l)}$	*Total* $K_{(\bullet)}^{(\bullet)}$	*Intraregional* $K_{(s)}^{(r)}$	*Interregional* $K_{(s)}^{(l)}$	*Total* $K_{(\bullet)}^{(\bullet)}$
R1 Attica	0.47	-0.12	0.35	0.49	-0.16	0.33
R2 North Aegean	0.76	-0.44	0.33	0.80	-0.48	0.32
R3 South Aegean	0.60	-0.22	0.37	0.59	-0.16	0.43
R4 Crete	0.61	-0.25	0.36	0.63	-0.24	0.39
R5 Eastern Macedonia and Thrace	0.72	-0.36	0.35	0.76	-0.44	0.32
R6 Central Macedonia	0.62	-0.29	0.33	0.66	-0.36	0.30
R7 Western Macedonia	0.62	-0.30	0.31	0.66	-0.39	0.27
R8 Epirus	0.70	-0.39	0.30	0.74	-0.47	0.27
R9 Thessaly	0.67	-0.37	0.31	0.73	-0.44	0.29
R10 Ionian Islands	0.60	-0.24	0.36	0.61	-0.24	0.38
R11 Western Greece	0.67	-0.35	0.32	0.72	-0.42	0.30
R12 Central Greece	0.56	-0.23	0.33	0.61	-0.30	0.31
R13 Peloponnese	0.62	-0.32	0.30	0.66	-0.38	0.28
GREECE	-	-	0.34	-	-	0.32