Assessing changes in inter-municipality commuting: The Portuguese case

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Abstract

Recent changes in travelling patterns have largely increased the importance of transportation and mobility. According with the last data available (based on 2001 Census), 23,7% of Portuguese inhabitants needed to travel daily to another municipality in order to work or study. In 2007, Portuguese households spent approximately 10% of their total expenditures, in goods and services associated with car use. 7,33% of households budget was spent in car buying or repairing, while 3,72% was spent in diesel or gasoline. Moreover, in the same period, Portuguese families have spent 1,37% of their budget with road and rail passengers transportation services.

Despite the relatively high share of expenses with car use by the Portuguese household's, most of the products associated with automobile use are mainly imported or incorporate many imported inputs throughout their production. In fact, in 2007, cars' production in Portugal was mainly to satisfy foreign demand (97,5%), while more than 99% of the cars bought by households resident in Portugal were imported. Additionally, fuel refining was made using oil as the main input (77,3% of intermediate consumption) which is not produced in the Portuguese territory.

The main objective of this work is to assess economic impacts of inter-municipality commuting in Portugal. For this, we assume a hypothetical scenario based on the assumption that Portuguese households do not travel between different municipalities for commuting purposes considering corresponding changes in private final consumption. Accordingly, we expect to assess the direct, indirect and induced impacts of inter-municipality commuting and understand how the Portuguese economy would react if all inhabitants live in the same municipality where they work or study. For this, we will use an Input-Output table with a Supply and Use (SUT) format at basic prices and representing domestic flows. Our purpose is to evaluate the macroeconomic net benefits of commuting according to different criteria (e.g., employment, GVA, taxes, international imports).

1. Introduction

Through the last century, urban population has consistently grown worldwide. In every continent, large metropolitan areas grew in terms of population and dimension. This process however did not happen homogeneously in the territory. In most of European and American cities, the population in suburbs has largely increased while the population living in Central Business Districts has generally shrunk. Portugal was not an exception. Between 1980 and 2011, Lisbon and Oporto municipalities lost 33% and 27% of their population, respectively. On the other hand, the population of Great Lisbon and Great Oporto metropolitan areas has increased more than 14% and 15%, respectively. This phenomenon is most of the times referred as urban sprawling.

One of the major consequences of urban sprawling is the increasing necessity of residents to travel larger distances between their homes and jobs. Most of this increase in commuting was sustained by economic circumstances that allowed residents to buy fuel at relatively low prices. Simultaneously, society was not widely aware of several negative externalities associated with intensive car commuting (e.g.: loss of urban quality of life, congestion, greenhouse gas emissions, lack of productivity and sustainability of public urban transportation, increasing needs of road infra-structures). Although these externalities, which incorporate economic, social and environmental costs, are usually considered in cost-benefit analysis, we will consider a different approach.

Portuguese households spend an important share of their available income in goods and services associated with commuting. In 2007, Portuguese households spent approximately 10% of their total expenditures, in goods and services associated with car use. 7,33% of household's budget was spent in car buying or repairing, while 3,72% was spent in diesel or gasoline. Moreover, in the same period, Portuguese families have spent 1,37% of their budget with road and rail passengers transportation services.

As with other products, the consumption of these products has an effect on GDP, GVA, Employment, Imports and Tax collection. However, in the Portuguese economy, most of these goods are mainly imported or have a large amount of imported inputs in their process of production contributing to negative impacts in the balance of payments. In 2007, cars' production in Portugal was mainly to satisfy foreign demand (97,5%), while more than 99% of the cars bought to satisfy national demand were imported, implying no direct link between demand and domestic production. Additionally, fuel refining was made using oil as the main input (77,3% of intermediate consumption) which is 100% imported from abroad.

Accordingly, our proposal here is to assess macroeconomic costs of inter-municipality commuting. For this, we will assume a hypothetical standard scenario where no inter-municipality commuting occurs. Although this is not a 'realistic scenario' it is our believe that it may help us to understand additional consequences of the current model of urbanization and commuting. In this sense, the macroeconomic costs of commuting are considered to be the differences (in the estimated indicators) between the current situation (in 2007, our base year) and the fictional scenario driven.

In our hypothetical scenario, as commuting vanishes the consumption of Portuguese households in cars, fuel and other products is reduced and, conversely, their spending in other products non-related with commuting is increased. To assess the overall effects in the economy of this fictional scenario we apply an Input-Output (I/O) table with a Supply and Use (SUT) format at basic prices and representing domestic flows developed by a Portuguese research project called DEMOSPIN[1] (in which the authors participate). The results will be presented according with different economic and social indicators (e.g.: GDP, GVA, Imports, VAT, Other taxes on products and Employment).

The next section offers a brief literature review, highlighting the leading attempts to address the impacts of commuting on the economy, environment and energy consumption. The third section presents the methodology chosen, structured in three parts, considering the procedures to estimate fuel consumption associated with inter-municipality commuting as well as to assess the impact on the other products in the economy and, finally, a brief description of the I/O model adopted. The fourth section presents several indicators in order to understand and discuss the macroeconomic costs associated with inter-municipality commuting.

2. Literature Review

In recent decades, people have become increasingly aware of critical issues as energy consumption and greenhouse gas emissions. Accordingly, some studies have focused their attention on the issue of passenger transportation, arguing their responsibility in 20% of the world primary energy use and in 13% of energy-related CO_2 emissions (IEA, 2006; Zhao et al., 2011). Regarding the Portuguese situation, it is worth mention that, in 2009, the share of final energy consumption due to the transportation sector was 40.3% of the overall, while this sector 'responsibility' for greenhouse gases emissions corresponded to a share of 25.3% (EUROSTAT, 2011). This importance, particularly associated with passenger transportation, has been into a large extent related with urban forms and cities densities.

On the other hand, as the frictions to travelling larger distances relaxed, cities have expanded and become less dense. City centers have many times assisted to a decrease in population while the suburbs have largely increased without concerns on urban planning or on the adequate development of public transportation services. This phenomenon led to a rapid increase in car ownership and use (Glaeser and Kahn, 2001; Zhao et al., 2011).

Several other constraints have been associated with urban sprawling and the decrease in urban density, such as, e.g.: infrastructure costs, public service costs, distance travelled,

[1] DEMOSPIN is funded by the Portuguese Foundation for Science and Technology (FCT PTDC/CS-DEM/100530/2008).

energy consumption, downtown deterioration, reduction in operating efficiency, congestion, loss of land and natural habitat preservation, loss of equity (Ewing, 1997; Gordon and Richardson, 1997). Camagni et al. (2002), regarding the Milan metropolitan area, showed that higher environmental impacts are associated with low densities, sprawling development or, more recently, urbanization processes.

These studies, together with others focused on energy consumption (Naess et al., 1995; Naess, 2010) or on the environmental consequences (Muñiz and Gallardo, 2005) had come to similar conclusions regarding the importance of the effects of residential location on travel distances, modal split and energy use. However, few studies have tried to understand how the economies would react to changes in commuting patterns. Anas, Arnett and Small (1998) is considered as a seminal contribution concerning the study of transportation and urban structure impacts. In this work, the authors explore the changes in technology agglomeration due to the new advantages of information processing and telecommunications, discussing the positive and negative externalities felt within an urban area. This work has largely contributed to the appearance of new studies based on Regional Economic models, whose main aim is, broadly, to assess the impacts of changes which are felt within a specific region.

Among the most relevant approaches for understanding and capturing existing inter-relationships between several economic sectors one can find the I/O models. Accordingly, several I/O models have been widely applied to study environmental impacts, either regarding resources requirements and/or emissions generated (see, e.g., Cruz et al., 2005; Barata, 2009). In the field of transportation economics, the use of this modeling approach is still recent and relatively scarce. Among these one should highlight the use of I/O models by HDR Corporation (2008), regarding the costs of road congestion in Toronto and Hamilton Area, to assess the impacts of a new regional transport plan (although exclusively assuming an increase in exogenous final demand due to the corresponding increase in Gross Fixed Capital Formation). More recently, Viñuela and Estéban (2011) used an I/O model, applied to the metropolitan areas of Barcelona and Madrid, with the aim of estimating the impacts of in-migration and commuting (in order to analyze workers and their earnings displacement effects and the consequent impact in these economies).

Some other regional studies, using I/O modeling approaches, though inserted on General Equilibrium models, have also been applied to address the impacts of building new transportation infra-structures (see, e.g., Almeida et al., 2010, with an application for a Brazilian region) or the discussion on the positive and negative effects for a specific region of road developments (Bayar et al., 2011).

To sum up, several studies have been done, using the I/O approach, in order to understand the economic and environmental impacts of specific changes in the economies. More recently there is growing interest directed towards the objective of relating urban forms, modal split, car use and energy consumption and related emissions. Nonetheless, the use of these I/O models to address commuting and transportation effects on the economy is still scarce and, therefore, this work also aims to contribute for the dissemination of its use, namely by demonstrating the richness of this type of analysis.

3. Methodology

In this section, the methodology used to estimate the macroeconomic costs of inter-municipality commuting is explained. Our main purpose is then to describe how our fictional scenario, where inter-municipality commuting wipes out, is built. In this scenario, the household final consumption pattern changes significantly which given the interdependence between industries has an impact on the Portuguese economy. Our approach can be broken in three major steps. First, to estimate fuel consumption expenditure related with inter-municipality commuting. Second, to estimate two main different consumption structures, in order to differentiate households which intensively commute from the others. This step aims to understand how the consumption of other specific products can be influenced by changes in commuting patterns. Finally, such information is incorporated in an I/O table, at domestic flow and basic prices, in order to assess the direct, indirect and induced impacts that the assumed changes in households consumption can generate in the Portuguese economy.

3.1. Distance Travelled and Fuel Consumption

The initial objective was the estimation of fuel consumption by the Portuguese households due to inter-municipality commuting. For this, the information on the number of commuters and travel distances per day is essential. The recentness information on the number of commuters between the 308 Portuguese municipalities is still based in Census 2001 (INE, 2003). In order to remove outliers that may result from statistical errors, only the commuters recorded in Census 2001 which live less than 70 kilometers from their workplace or school were considered.

Accordingly, nearly 23.7% of the Portuguese population (which indicate that works or studies), have to travel daily to a different municipality. Commuters in the Metropolitan Areas of Oporto and Lisbon are approximately 55% of the Portuguese commuters. Indeed, in the Metropolitan Area of Lisbon 43% of the workers or students residents had to commute to a different municipality while in other Portuguese regions this value was consistently under 12%.

Then, the information on the modal share in the 308 municipalities was used. The objective was to estimate the number of inter-municipality commuters by transportation type. In this case, it was assumed that in order to commute to different municipalities, commuters always use a motorized transportation (i.e. other transportation means were excluded from this calculation). With this methodology we produced a 308x308 matrix with an estimation of the number of car user commuters between municipalities.

The following step consisted in the calculation of the average distances travelled by car commuters. For this, using geo-referenced data regarding the fastest road way between two points, two 308x308 matrices representing kilometric and time distances between all Portuguese municipalities (Ferreira et al., 2012).

In terms of distance, the daily value travelled by commuters is approximately 80 million kilometers. In terms of time spent travelling, it was estimated a ‘waste’ of more than 1335 thousand hours per day in commuting. Once more, almost 50% of the kilometers traveled by Portuguese commuters occurred in the Lisbon Metropolitan Area. This fact highlights the evidence that in this metropolitan area more people commute and do this from/for more remote places relatively with the other Portuguese commuting patterns. After considering the weight of cars in the modal share by municipality it is estimated a total of 51 million kilometers travelled by car each day, nationwide.

The next step consisted in transforming the kilometers travelled in liters of fuel consumption. According with the methodology proposed by Carvalho *et al.* (2012) and using information of the Portuguese Automobile Association (ACAP, 2009) a estimation regarding the average fuel consumption per kilometer for each type of car (gasoline or diesel) was made. For this, it was used 2007 statistical information regarding the most sold vehicles by brand and model, in order to calculate global average fuel consumption per kilometer adjusted by the average age fleet in Portugal (8,9 years old, in 2007). The results indicate average consumptions of 7,1 and 6,7 l/100 Km for gasoline and diesel, respectively. Accordingly the estimates indicate that Portuguese car commuters spent more than 3 million liters of fuel per day (52% gasoline and 48% diesel).

Finally, using the 2007 average annual price per liter of fuel type (1,32€ for gasoline and 1,08€[2] for diesel - DGEG, 2012) daily expenditure in fuel was estimated (at 2007 prices). According with the average working days in Portugal, this value was then converted in approximately 485 million Euros for gasoline and 362 million Euros for diesel spent by Portuguese households, in the year of 2007, regarding inter-municipality commuting. In relative terms, this value corresponds to 25,2% of the accumulated expenditure with gasoline by households below 65 years old, and 24% of their total expenditure with diesel.

3.2.Households Consumption Changes

Commuting existence has further impact on household’s final consumption than the direct consumption of refined petroleum products. Indeed, there are several other products that have their consumption affected by commuting. To study this phenomenon it was used the Portuguese Household Budget Survey (2005/2006), disaggregated by 199 different products. It is worth mentioning that in the Portuguese case, this survey has not available explicit information regarding commuting patterns or the location of each household workplace. Thus, for analyzing each household commuting behavior we had to analyze each household’s specific consumption of particular transportation products. In order to accomplish this we divided our sample

[2] Market price including VAT and other taxes and subsidies.

and estimated two different household consumption structures. One was considered to be the consumption pattern of a commuting-intensive household, while the other was considered to be the consumption pattern of households that do not commute.

This was done using two different criteria. Firstly, the amount of money spent in fuel: if among the households which consume fuels, the household spent more than the expenditure median value it was considered that there are commuters in this specific household. The second criterion had the intention of identifying non-car user commuters, which spent more in public transportation services. In this sense, any household that purchased every month a "combined ticket pass[3]" was deemed needing to travel larger distances to work or school. On the other hand, households who were considered as non-commuters by the first criterion and spent in "train pass" more than 12 times the price of the minimum monthly travel pass of "Comboios de Portugal[4]" were also considered to commute daily.

It is important to state that these rough assumptions were only used in order to understand how the consumption of related products can modify if the commuting patterns of Portuguese households change. Thus, several changes were identified, namely in expenditures with car purchase, car maintenance, car insurance, restaurants and coffee shops, tolls, public road transportation services or other transport expenditures.

Comparing the consumption structure of households which do not commute and the consumption structure of those which commute, several differences were observed in products related with transportation, insurance and expenditures in restaurants and coffee shops. In Table 1 are presented the changes considered for several products and that were taken into account in the modeling exercise.

Table 1: Changes in households' consumption

Product	Change in consumption
Manufacture of motor vehicles	-16 %
Wholesale, Retail Trade and Repair of motor vehicles and motorcycles	-25 %
Passenger interurban transport via railways	-9,5%
Other Passenger Land Transport (urban)[5]	+21,21%
Warehousing and Support Activities for Transportation	-24,8%
Food and Beverage Service Activities (on restaurants)	-7,66%
Non-Life Insurance	-9,6%

The changes in these products' consumption and the reduction in fuel consumption represented a decrease of approximately 2.100 million Euros (about 2,7% of household's final consumption). In order to compensate this decrease in consumption,

[3] A ticket pass that integrates several transportation operators.
[4] Relatively to the most important Portuguese railway company.
[5] This value is positive due to the increase in the use of public urban transportation inside metropolitan areas.

the household's remaining consumption was increased maintaining stable the overall propensity to consume (and consequently the propensity to save).

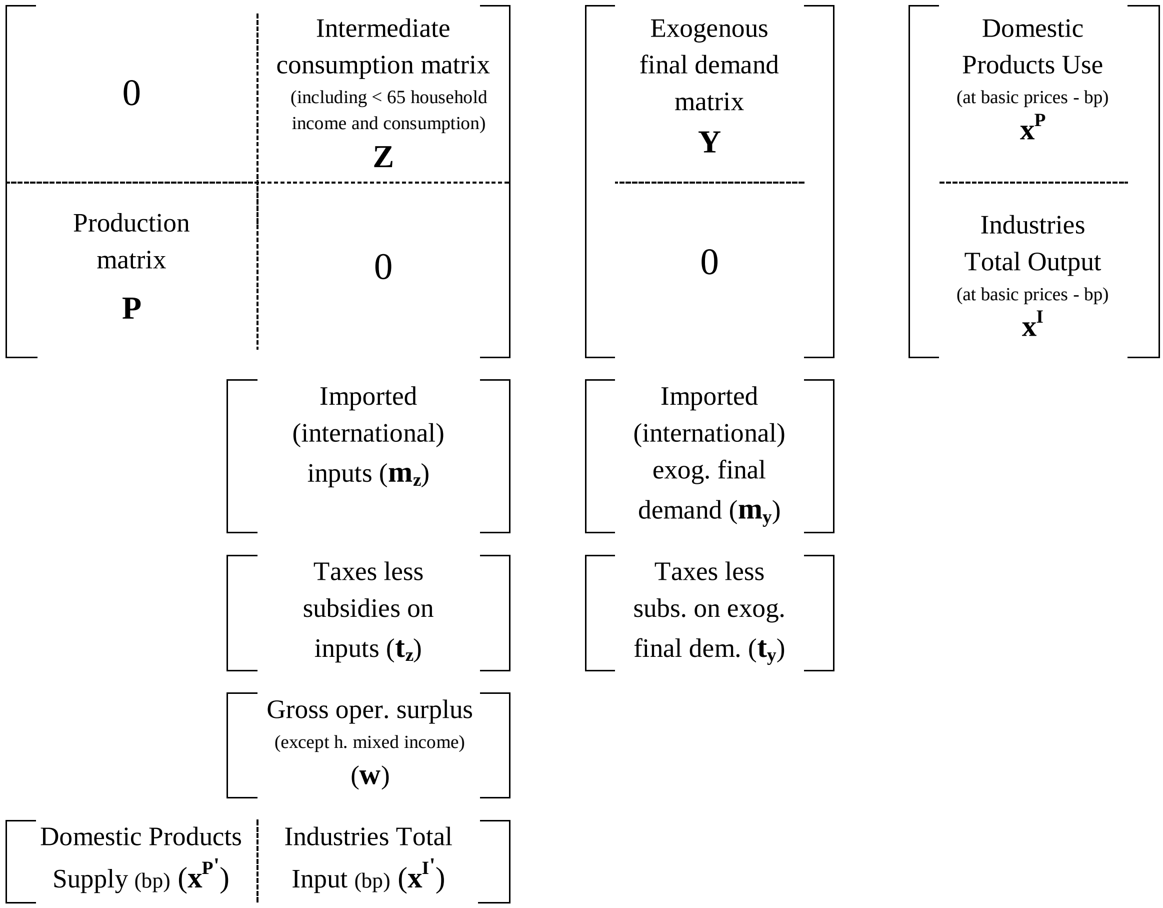
3.3.Input-Output Model – DEMOSPIN

After assessing the differences in household's final consumption resulting from a change in the commuting pattern, the main idea consisted in identifying the direct, indirect and induced impacts that could occur in the Portuguese economy according with our hypothetical scenario of non-existence of inter-municipality commuting.

Our approach was based in an I/O table (developed by the DEMOSPIN Project, already mentioned), whose structure is presented in Figure 1,. This I/O table, with 431 products and 125 sectors, at domestic flows and basic prices, takes as a starting point the Portuguese National Accounts Supply and Use Table (SUT), for the year 2007 (INE, 2011).

An important feature of this DEMOSPIN I/O table is the consideration of two households groups: those headed by a person with more than 65 years old, and the other by somebody less than 65 years old. The consumption division was based on detailed information from the Household Budget Survey, carried out by the Portuguese National Statistical Institute, to 2005-2006, allowing the split of 2007 private consumption vector (comprising 431 groups of different products) into two columns for the two households groups. We considered that only those below 65 years old commute to their school or workplace. In order to capture the direct, indirect and induced impacts the I/O table was 'closed' to the consumption of this households group. The consumption of households over 65 years old was considered in the exogenous part of the matrix.

Figure 1 – General framework of DEMOSPIN I/O table



Let us call **A** to the great matrix of Figure 1, composed of **Z**, **P** and the 0 filled quadrants. Let us call **x** the vector comprising $\mathbf{x}^{\mathbf{P}}$ and $\mathbf{x}^{\mathbf{I}}$. From Figure 1 it is patent that:

$$(2) \qquad \mathbf{A.i} + \mathbf{Y.i} = \mathbf{x}$$

where **i** denote 1-filled column vectors, of proper size, whose mission is to add up the different columns of **A** and **Y**. We may compute as well input coefficients in matrix **A**, dividing each of its cells by the entries in $\mathbf{x}^{\mathbf{P}'}$ and $\mathbf{x}^{\mathbf{I}'}$ located in the bottom of Figure 1 (that are the totals of the corresponding columns).

$b_{ij} = \frac{z_{ij}}{x_j^I}$ and $q_{ij} = \frac{p_{ij}}{x_j^P}$ are the two different sets of input coefficients representing the locally produced inputs (at basic prices) used in the production processes of industries and the shares of each industry in the production of each product (as principal or secondary products), respectively. When we call **C** the input coefficients matrix:

$$
\mathbf{C} = \left[\begin{array}{c|c} \mathbf{0} & \mathbf{B} \\ & (b_{ij}) \\ \hline \mathbf{Q} & \mathbf{0} \\ (q_{ij}) & \end{array} \right]
$$

we then may re-write (2) as:

(3) $\mathbf{C.x} + \mathbf{y} = \mathbf{x}$ ($\mathbf{y}$ is the vector $\mathbf{Y.i}$)

so

(4) $\mathbf{x} = (\mathbf{I} - \mathbf{C})^{-1} \mathbf{. y}$

The multipliers matrix $\mathbf{D} = (\mathbf{I} - \mathbf{C})^{-1}$ has in fact four different parts:

$$
\mathbf{D} = \left[\begin{array}{c|c} \mathbf{D}^1 & \mathbf{D}^2 \\ \hline \mathbf{D}^3 & \mathbf{D}^4 \end{array} \right]
$$

$\mathbf{D^1}$ and $\mathbf{D^3}$ represent the impacts respectively on product outputs and industry outputs of changes in exogenous final demand condensed in **y**. $\mathbf{D^2}$ and $\mathbf{D^4}$ refer to multipliers, measuring effects on $\mathbf{x^P}$ and $\mathbf{x^I}$ as well, of a reallocation of the final demand to the industries that fill it. In fact, the most important sub-matrix of **D** is $\mathbf{D^3}$, as the final demand consists of products but the GVAs are generated by the industries, as they are as well the employment impacts. According with the rules of partionned inverse matrixes, we can get $\mathbf{D^3}$ directly by[6]:

(5) $\mathbf{D^3} = \mathbf{Q.}(\mathbf{I} - \mathbf{B.Q})^{-1}$

In this paper, we do not proceed in the most common way, analyzing the impact of a change in **y** on the output $\mathbf{x^I}$ provided by $\mathbf{D^3}$. Otherwise, our approach consisted in modifying matrix **C**, namely the sub-matrix **B**, in the part corresponding to the consumption of households with less than 65 years old. As the total consumption is kept stable, the consumption change of products associated with commuting is compensated by a proportional change in the consumption of products which are non-related with commuting. In this sense, we assume that the propensity to consume (and to save) is stable. $\mathbf{D^3}$ was then recalculated with the modified **B** and **C** matrices, which allow to estimate the new output **x**, for the same final exogenous demand **y**.

According with our previous estimations, the consumption of several products was modified in the endogenous final consumption vector in order to assess our fictional scenario of no inter-municipality commuting. This allowed the estimation of the impacts in the output of the different industries. Then, the change in output also allowed

6 In this approach, D^3 corresponds to the so called “industry-technology assumption”. For a discussion of these hypothesis, and of the alternatively “commodity-technology assumption” please proceed to Sargento et al. (2011).

the estimation of changes in aggregated social and economic indicators as GDP, GVA, VAT, other Taxes on products less Subsidies, Imports and, finally, Employment.

4. Results and Discussion

In this section we present the most important results regarding the macroeconomic costs associated with inter-municipality commuting in the Portuguese economy. As explained before, the idea consisted in admitting a no inter-municipality commuting fictional scenario. In this case, households would consume fewer products associated with commuting and increase other products consumption.

As stated, the referred change in less than 65 years old household's consumption was modeled in our I/O table by transforming the endogenous final consumption vector. This change modified the technical coefficient matrix and consequently the Leontief inverse. After multiplying the new inverse by the "exogenous final demand", we had the new output by industries and we were able to estimate macroeconomic indicators as GDP, GVA, Employment, Taxes and Imports. The results are presented in Table 2.

Table 2 – Impacts of Commuting in the Portuguese Economy

	Initial value (with commuting)	Scenario (without inter-municipality commuting)	Change	%
GVA (10^6 euros)	145.698	147.004	1.307	0,90
Imports (10^6 euros)	66.867	66.771	- 96	- 0,14
Taxes on Products less Subsidies excluding VAT (10^6 euros)	8.549	8.192	- 357	- 4,18
VAT (10^6 euros)	14.333	14.241	- 92	- 0,64
GDP (10^6 euros)	167.714	168.570	856	0,51
Employment (Full-time equivalent)	4.986.499	5.018.661	32.162	0,65

Observing Table 2, it is possible to conclude that the overall results of a hypothetical scenario with no commuting between the Portuguese municipalities would be globally positive. According to our calculations, 116 of the 125 industries would increase their Output and GVA and globally the Portuguese GVA would increase approximately 0,9%. Some of the negatively affected industries would be the Manufacture of Refined Petroleum Products, the Food and Beverage Service Activities, Wholesale, Retail Trade and Repair of Motor Vehicles and Motorcycles, Warehousing and Support Activities for Transportation, Manufacture of Motor Vehicles and Manufacture of Beverages. On the other hand, between the industries which would probably increase more in terms of GVA are the Other Passenger Land Transport, Telecommunications, Real Estate Activities and Retail Trade, except of motor vehicles and motorcycles.

The overall impact on Imports is mitigated (only -0,14%) because the initial shock is compensated mainly by the effect of the increase in household's income and consequently in consumption (induced effects). This fact, together with the general increase of imported inputs used in other industries production, is one of the explanations for the small reduction regarding Imports.

Other interesting results are the expected reduction in Other Taxes on Products and VAT. The increase in consumption of the majority of the products and consequently on the Other Taxes on Products and VAT that burden them, does not compensate the reduction in the consumption of products with relatively high rates of Other Taxes and VAT, as it is the case of motor vehicles and petroleum products.

Finally, in terms of Employment the changes in the household consumption would result in a positive effect. In terms of industries, almost 15% of the employment generated would be associated with the Agriculture and Farming of Animals. Together with this industry, the Retail Trade (except of motor vehicles and motorcycles) and the Other Passenger Land Transport industries are the ones with more responsibility for Employment's growth.

Summing up, if households consumption is reallocated from products associated with commuting to the rest of the products it is expected that the economy grows because the former types of products are mainly imported (directly or indirectly) and bear relatively high tax rates. So, according with the results obtained the Portuguese GDP would increase 0,5% and Employment 0,6%. Note that the impact on GDP is relatively reduced compared with GVA, because GDP is evaluated at purchases prices and it is negatively affected by the decreases on VAT and other Taxes on products.

5. Conclusion

The objective of this work was to highlight the order of magnitude of commuting macroeconomic costs in Portugal. In this context, we considered a fictional scenario where inter-municipality commuting ceases (nevertheless other scenarios may be considered in future works for other purposes, particularly regional or municipality studies). Despite this, it was shown that the development of cities and regions when private car use is (direct or indirectly) encouraged may impose a significant macroeconomic burden in those economies where oil (or is derivatives) and cars are mainly imported. Additionally, increasing distances travelled by commuters in order to work or study also contribute to a contractionary impact in the economy.

If commuting between municipalities cease for Portuguese households, GDP, GVA and Employment are expected to grow in Portugal as a result of the modification on private consumption towards products which less imported inputs in the production process. Simultaneously, Portuguese workers and students would spare more than 400 million hours per year travelling between their houses and work or school places. On the other hand, it is important to note that environmental advantages are also expected, as a result of reductions in fuel requirements and related greenhouse gas emissions. These environmental impacts were not treated here, but they should be addressed in future work, in order to perform a more comprehensive analysis of commuting costs.

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