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Measuring the influence of energy prices within the price formation mechanism

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Abstract

Environmental economics has proposed the taxation on energy as an effective way to mitigate the pollution caused by the production and use of energy based on fossil fuels. From a practical point of view, however, taxes on energy are thought to have a detrimental impact on the economy that reduce competitiveness and diminish economic welfare, especially if the tax burden is (completely or partially) translated to final prices. This paper provides a method to analyse by how much energy prices influence the price formation mechanism of an economy. The model used, which captures the general equilibrium channels existing among energy activities, the rest of the production system and households, is based on the accounting identities reflected in a Social Accounting Matrix (SAM). The SAM price model allows to identify the role of energy prices into the cost transmission and the price definition process. The empirical application, which is for the Catalan economy, shows a considerable influence of energy prices on both production and final prices. The results also show that the different forms of energy exert asymmetric impacts on the costs of sectors and consumers.

Keywords: energy prices, cost linkages, price transmission, social accounting matrix.

JEL Classification: C69. D58. Q41.

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1. Introduction

During the last century, the significant increase in the use of energy obtained from fossil fuels has generated negative consequences on the environment. Among them, the most alarming environmental impact is the process of temperature rise, known as climate change. If there is not an effective and imminent solution to this phenomenon, there will be incalculable consequences for humanity and unpredictable costs in the near future. Indeed, climate change is one of the most crucial problems that the global institutions will face in the coming years.

In parallel, the recent history of the international forums to fight against climate change has revealed the reluctance of some industrialised countries, such as the United States and China, to accept measures that could endangering their local agents and local industries. A latent argument defended by these countries is that environmental regulations could harm the local products and local industry in favour of other countries that apply weak environmental standards.

From a theoretical point of view, Pigou (1920) firstly proposed environmental taxation as an effective instrument to reduce the damage caused by the negative externalities on the environment. As taxes artificially approach the private costs of production to the corresponding social costs, taxing the polluting goods leads to reductions in its harmful production and/or consumption. And among the huge set of goods produced and consumed in an economy, the most damaging for the ecosystems are related to the production and use of energy obtained from fossil fuels.

Implementing taxes on the dirty forms of energy, therefore, is viewed as an efficient solution to reduce pollution. New taxation on energy would generate a rise in its effective price that would incentive other (cleaner) forms of energy, would move the economic system towards energy efficiency and would diminish the negative impacts on the environment. Nonetheless, in practice some countries show reluctance to establish new taxes on the production and/or the consumption of energy. The reasons are based on the idea that energy is an important component of the production costs and, accordingly, this kind of intervention would reduce the competitiveness of local products in global markets.

The purpose of this paper is to evaluate the contribution of energy prices within the price formation mechanism by quantifying by how much energy costs affect the production and consumption prices. This quantification allows to precise and clarify the a priori predicted (negative) impacts of energy taxation.

The influence of energy prices and energy costs on the final price levels has extensively been analysed in the literature. For instance, Mork and Hall (1980) evaluated by how much the US recession in the seventies was attributed to the energy shock caused by the rise in the world oil price implemented by the OPEC. Catsambas (1982) used an input-output price model to analyse the consequences of changing the US petroleum taxation. Hughes (1986) proposed an input-output model to quantify the impact of fuel prices and tax changes on the price levels of Thailand. Uri and Boyd (1996) examined the impact of an increase in the prices of gasoline and electricity on the Mexican economy through the use of a general equilibrium model. Gohin and Chantret (2010) provided an empirical analysis of the long-run relationship between food prices and energy prices using a world computable general equilibrium model. Nazlioglu and Soytas (2011) analysed both the short-run and the long-run interdependences between world oil prices and agricultural prices in Turkey. Venditti (2013) studied the influence of the weekly gasoline and gasoil prices to the final consumption oil prices in the US. Germany.

France. Italy and Spain. Obadi and Korcek (2014) analysed the world long run relationship between crude oil and food prices and the possible causality between them from 1975 to 2013. Valadkhani (2014) presented an empirical analysis of the relationship between the price of crude oil and the consumption energy prices in Canada and the US during the period 1961-2013. Also for the US, Wang and McPhail (2014) examined the impacts of energy price shocks on the agricultural commodity prices during the period 1948-2011. More recently. Bardazzi et al. (2015) estimated the fuel demand elasticities for industrial sectors in Italy.

Most of these contributions have mainly focused on oil prices and its effects on the commodity prices of the economy. Moreover, most of the existing analyses focus on partial aspects of all the possible components involved in energy issues. It should be borne in mind, however, that the price formation mechanism is a complex process of cost transmission among economic agents that deserves the use of a precise and broad framework to be completely captured. By limiting the study to oil markets, energy shocks are not fully analysed, because other forms of energy, such as electricity or gas, can exert a significant influence on prices as well. This makes necessary the use of a general equilibrium approach able to represent the complexities of the underlying connexions within an economic system on the one hand, and able to take into account the complete links among the different forms of energy, on the other.

The price version of the social accounting matrix (SAM) model represents the transmission channels existing in an economy, by providing a linear general equilibrium perspective that extends the input-output framework to include not only production but also factors and households. Despite the undoubtedly usefulness of the SAM approach, there are not many contributions in the literature using this model to analyse price effects. The first contribution is in Roland-Holst and Sancho (1995), where it was proposed an alternative price approach to the traditional SAM quantity-oriented model. After this pioneering contribution, Llop and Pié (2011) used a SAM price model to simulate the effects of alternative environmental policies applied to Catalonia. Also for the Catalan economy, Llop (2012) proposed a SAM method to detach the effects of the saving-investment within the price determination mechanism. More recently, Saari et al. (2016) use the SAM price model to evaluate the distributional impacts among ethnic groups in Malaysia due to a rise in the oil prices.

This paper uses the SAM price approach to identify the contribution of energy prices to the prices of the economy and proposes a multiplier decomposition of the price effects that specifically focuses on the role of energy activities. The empirical application is for the Catalan economy through the use of a regional social accounting matrix for 2011. This analysis extends the literature in several ways. First, it completes the existing partial equilibrium contributions of energy prices by using a broader general equilibrium perspective of the price impacts. Second, it proposes a new method to detach the importance of energy prices within the complex price transmission process by identifying the relevant components within the circular flow that exert influence on prices. Finally, the analysis takes into consideration all the forms of energy, not only individually studying each one but also analysing the existing connexions among them and the rest of economic agents.

The paper is organised as follows. The next section describes the SAM price model and the third section decomposes the total price impacts into different interdependence relationships that allow to identify the role of energy prices. The fourth section describes the 2011 Social Accounting Matrix for the Catalan economy and the fifth section shows the empirical results. A conclusion section ends the paper.

2. Analytical Framework

The influence of energy within the price formation mechanism is analysed through the use of a SAM price model able to jointly define the relations among production prices and consumption prices. The SAM price model is constructed from the accounting identities reflected in a social accounting matrix, by following a linear structure of price impacts.

A SAM shows the income and expenditure flows of an economy in a square format in which the rows and columns add up to the same quantity.[1] In this matrix, the receipts appear in the rows and the expenditures appear in the columns. The different accounts reflect different economic agents and are placed in an identical order horizontally and vertically.

Table 1 summarises the set of transactions reflected in a social accounting matrix that will be subsequently used for the analysis of price impacts. In the first row, X_{11} is a square matrix containing the intermediate consumption among the energy activities; X_{12} shows the intermediate transactions of the non-energy production sectors, which are materialised in goods coming from the energy activities, and has as columns as the number of non-energy sectors in the SAM and as rows as the number of energy sectors; matrix X_{13} shows the final consumption of energy goods with a number of columns equal to the different households reflected in the SAM; finally, X_{14} contains the other possible destinations of energy production: exports, investment and public expenditure.

[1] See. for example. Pyatt (1988).

Table 1. Structure of a Social Accounting Matrix

	1. Energy Activities	2. Rest of Activities	3. Households	4. Rest of Accounts	Total
1. Energy Activities	X_{11}	X_{12}	X_{13}	X_{14}	Y_1
2. Rest of Activities	X_{21}	X_{22}	X_{23}	X_{24}	Y_2
3. Households	X_{31}	X_{32}	X_{33}	X_{34}	Y_3
4. Rest of Accounts	X_{41}	X_{42}	X_{43}	X_{44}	Y_4
Total	Y_1	Y_2	Y_3	Y_4	

The first column in Table 1 refers to the costs of energy activities: matrix X_{21} shows the energy intermediate consumption coming from the rest of activities, matrix X_{31} shows the factorial income of consumers for the energy accounts, and matrix X_{41} shows the taxes on energy and energy imports from abroad.

Also in Table 1, X_{22} is a squared matrix with a dimension equal to the number of non-energy activities. This element shows the intermediate consumption among non-energy sectors. Matrix X_{32} contains the non-energy sectoral income to consumers and X_{42} the non-energy imports from abroad. Additionally, X_{23} shows the non-energy private consumption and X_{24} contains the investment, public expenditure and exports for the non-energy sectors.

In the households account, matrix X_{33} reflects the internal transactions of income among consumers; matrix X_{34} shows the private income coming from abroad and the public transfers to consumers; and matrix X_{43} shows the payment of income taxes.

Finally, the last block in Table 1 (X_{44}) refers to the transactions among the rest of accounts: the government, the capital account and the foreign agent.

The SAM price model is constructed from the structure reflected in Table 1 and adopting some hypothesis about the relationships among sectors and agents. Specifically, the income and payments are assumed to have a constant structure. Also the accounts of the SAM are divided into two different categories: endogenous accounts and exogenous accounts.[2] In order to show the circuits through which energy takes part within the price and cost definition mechanism, the model definition considers endogenous the first three accounts in Table 1.[3] In addition, as the SAM used in the empirical application shows a unique aggregated account for households, the block X_{33} is assumed to be null.

Reading down the columns of Table 1 and using matrix notation, it can be defined the following model of prices:[4]

$$\begin{aligned} P &= PA + v \\ &= v[I - A]^{-1} = vM. \end{aligned} \tag{1}$$

In this expression, A is the matrix of normalized coefficients and has the following structure:

$$A = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & 0 \end{bmatrix},$$

where A_{ij} represent the column coefficients calculated by dividing the transactions in the SAM (X_{ij}) by the corresponding column total (Y_i). In addition, $P =$

[2] The traditional endogeneity assumption in the SAM quantity-based models (Pyatt and Round, 1979) endogenously considers sectors, households and factors of production. The same criterion of endogeneity is used in the price version of the SAM model proposed by Roland-Holst and Sancho (1995). On the other hand, Llop (2012) extended the endogenous accounts to reflect the price transmission of saving and investment by including the capital account in the endogenous part of the SAM price model.

[3] This endogeneity assumption, which in fact endogenously defines production, consumption and value added, is in line with Roland-Holst and Sancho (1995). Differently to Roland-Holst and Sancho approach, however, the present division of agents focuses on the energy sectors and individually isolates the corresponding energy accounts.

[4] See Roland-Holst and Sancho (1995) and Llop (2012) for details.

$(P_1 . P_2 . P_3)$ denotes the row vector of prices for the endogenous accounts, and $v = P_4 A_4$ is the vector of exogenous costs where $A_4 = [A_{41} \quad A_{42} \quad A_{43}]$.

In expression (1) above, $M = [I - A]^{-1}$ is the matrix of price multipliers. Despite this matrix coincides with the multipliers' matrix in the SAM quantity models, the interpretation of the elements in the two approaches is completely different. The SAM price model reflects the cost transmission so that M is read down the columns; on the contrary, the SAM quantity model reflects the income impacts so that M is read across the rows.[5]

3. Dividing the Total Price Effects

In order to isolate the energy contribution within the price formation mechanism, this section offers details on the decomposition of the total price multipliers. The starting point consists of dividing matrix A of structural coefficients into two submatrices that show different economic channels. Specifically, the coefficients corresponding to energy production (A_1) are separated from the coefficients of the other sectors of production and consumption (A_2). This leads to the following division of matrix A:

$$A = A_1 + A_2 = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & 0 & 0 \\ A_{31} & 0 & 0 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ 0 & A_{22} & A_{23} \\ 0 & A_{32} & 0 \end{bmatrix}.$$

Expression (1) can then be modified by applying the division of the matrix of coefficients, as follows:

$$\begin{aligned} P &= v[I - A_1 - A_2]^{-1} \\ &= v[(I - A_2(I - A_1)^{-1}(I - A_1)]^{-1} \\ &= v(I - A_1)^{-1}[I - A_2(I - A_1)^{-1}]^{-1} \\ &= v(I - A_1)^{-1}(I - D)^{-1} \end{aligned}$$

[5] Roland-Holst and Sancho (1995).

$$= v(I - A_1)^{-1}(I + D)(I + D)^{-1}(I - D)^{-1}$$

$$= v(I - A_1)^{-1}(I + D)(I - D^2)^{-1}$$

$$= vM_1M_2M_3. \quad (2)$$

where $D = A_2(I - A_1)^{-1}$, $M_1 = (I - A_1)^{-1}$, $M_2 = (I + D)$ and $M_3 = (I - D^2)^{-1}$. In expression (2), M has been split into three multiplicative matrices containing different economic channels of price transmission.[6]

By applying the matrix algebra, the block M_1 has the following structure:

$$M_1' = \begin{bmatrix} A_{11}^* & A_{21}A_{11}^* & A_{31}A_{11}^* \\ A_{11}^*A_{12} & A_{22}^* & A_{31}A_{11}^*A_{12} \\ A_{11}^*A_{13} & A_{21}A_{11}^*A_{13} & A_{33}^* \end{bmatrix}.$$

being:

$A_{11}^* = [I - (A_{11} + A_{13}A_{31} + A_{12}A_{21})]^{-1}$.

$A_{22}^* = [I - A_{21}(I - A_{11} - A_{13}A_{31})^{-1}A_{12}]^{-1}$, and finally

$A_{33}^* = [I - A_{31}(I - A_{11} - A_{12}A_{21})^{-1}A_{13}]^{-1}$.

The block M_1 shows the *transfers effects* that are activated between energy prices, non-energy prices and households' prices. Reading down the columns in this matrix shows the price effects on the model's components when there is an exogenous and unitary increase in the costs of the corresponding agent in the column after the interdependences with the rest of agents have concluded. For instance, the elements in the first column quantify the effects of an exogenous cost shock in energy on energy costs (A_{11}^*), on the costs of the non-energy activities ($A_{11}^*A_{12}$) and, finally, on consumption costs ($A_{11}^*A_{13}$). This first column is, in fact, a measure of the direct price impacts caused by the exogenous shocks in energy accounts on the endogenous components of the SAM model.

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[6] As shown in the related literature, the decomposition of the multipliers matrix can widely vary depending on the division of the coefficients' matrix. In particular, the SAM price model has been used to reflect the price channels between production, consumption and factors (Roland-Holst and Sancho, 1995; Llop and Pié, 2011) and to detach the price effects of saving-investment (Llop, 2012).

Moreover, given that all the elements in the transfers block are compounded by coefficients relating energy activities, the block M_1' can be interpreted a measure of the price shocks received by all the components of the model in which energy is directly involved.

The multiplicative matrix *M'₂* in equation (2) responds to:

$$M_2' = \begin{bmatrix} I & \tilde{A}_{21} & \tilde{A}_{31} \\ 0 & I + \tilde{A}_{22} & \tilde{A}_{32} \\ 0 & \tilde{A}_{23} & I + \tilde{A}_{33} \end{bmatrix},$$

where the elements in this block are equal to:

$\tilde{A}_{21} = A_{22}A_{21}A_{11}^{*} + A_{23}A_{31}A_{11}^{*}$.

$\tilde{A}_{31} = A_{32}A_{21}A_{11}^{*}$.

$\tilde{A}_{22} = A_{22}A_{22}^{*} + A_{23}A_{31}A_{11}^{*}A_{12}$.

$\tilde{A}_{32} = A_{32}A_{22}^{*}$.

$\tilde{A}_{23} = A_{22}A_{21}A_{11}^{*}A_{13} + A_{23}A_{33}^{*}$, and finally

$\tilde{A}_{33} = A_{32}A_{21}A_{11}^{*}A_{13}$.

The multipliers in this block are the *open effects* of non-energy activities and consumers. In particular, the second column in M_2' shows the effects on the energy prices ($\tilde{A}_{21}$), on non-energy prices ($I + \tilde{A}_{22}$) and consumption prices ($\tilde{A}_{23}$) when there is an exogenous cost rise in the non-energy activities. In parallel, the elements in the third column contain the price impacts on the endogenous accounts of an exogenous cost increase affecting households. Notice that, from the definitions above, the open effects capture the indirect links existing between sectors and consumers with the energy activities.

Finally, the last component in expression (2) is equal to:

$$M_3' = \begin{bmatrix} I & \hat{A}_{21} & \hat{A}_{31} \\ 0 & \hat{A}_{22} & \hat{A}_{32} \\ 0 & \hat{A}_{23} & \hat{A}_{33} \end{bmatrix},$$

where each $\hat{A}_{ji}$ represent a non-null entry in the multipliers' matrix.[7] This multiplicative component contains the *circular effects* activated among energy, non-energy sectors and consumers. Specifically, the circular multipliers quantify the interaction between the accounts, by capturing the impacts that an exogenous cost increase starting in the non-energy activities (second column) and in the households' account (third column) has on the other parts of the system once the interactions with all the components of the model have finished. That is, the block M_3' incorporates the feedback between energy sectors, non-energy sectors and households.

The decomposition of multipliers in expression (2) follows a multiplicative formula. To make it easier the interpretation of the results and be able to isolate each of the three cost channels, the multiplicative multiplier decomposition can be transformed into the following additive expression:

$$M - I = (M_1 - I) + M_1(M_2 - I) + M_1 M_2 (M_3 - I) = N_1 + N_2 + N_3. \qquad (3)$$

where $(M - I)$ is the *net multiplier*, which is equal to the sum of $N_1 = (M_1 - I)$, or the *net transfers effects*, $N_2 = M_1(M_2 - I)$, or the *net open effects* and, finally, $N_3 = M_1 M_2 (M_3 - I)$, or the *net circular effects*.[8]

4. The SAM for Catalonia

The price model is empirically applied to Catalonia, through the use of a social accounting matrix for the year 2011. This database was previously constructed by

[7] The definition of these multipliers is not given for the sake of simplicity. Nonetheless, they are available from the author upon request.

[8] Note that the multipliers in expression (3) are in net terms as they show the impacts after the exogenous and unitary shock that starts the multiplier process has been subtracted from the total impacts.

using the information in the latest Input-Output Table available, published by the regional statistics office (IDESCAT, 2016a). The SAM was completed with other additional data related to the regional institutional agents (IDESCAT, 2016b).[9]

Table 2. Accounts in the Social Accounting Matrix for Catalonia

Block 1. Energy Activities	19. Railway transport
1. Extraction of minerals	20. Land transport
2. Coke, petroleum and fuel	21. Maritime transport
3. Electric energy	22. Air transport
4. Extraction and distribution of gas	23. Services linked to transport activities
5. Distribution of water	24. Finance
Block 2. Non-Energy Activities	25. Education
6. Agriculture	26. Medical assistance and social services
7. Livestock	27. Public administration
8. Fishing	28. Other private services
9. Food production	***Block 3. Consumers***
10. Textiles	29. Households
11. Manufactures of wood	***Block 4. Exogenous Accounts***
12. Paper	30. Saving-investment
13. Chemistry	31. Product taxes
14. Electric equipment and machinery	32. Production taxes
15. Automobiles and transport material	33. Income taxes
16. Other industries	34. Public administration
17. Construction	35. Rest of Spain
18. Commerce	36. Rest of the world

Table 2 shows the accounts reflected in each block of the model that coincide with the accounts in the regional SAM. In relation to the endogenous accounts, sectors of production are divided into two categories: energy activities and non-energy

[9] The complete database used in the empirical application is in the appendix.

activities. The energy activities are decomposed into five different accounts: Extraction of minerals (Sector 1), Coke, petroleum and fuel (Sector 2). Electric energy (Sector 3), Gas (Sector 4) and Water (Sector 5). The non-energy activities are divided into twenty-three sectors: three primary activities (Sectors 6 to 8), eight industrial activities (Sectors 9 to 17), and eleven service activities (Sectors 18 to 28). Finally, there is an endogenous aggregated account for the regional consumers (Sector 29).

The exogenous components of the model comprise seven accounts of the SAM: the saving-investment of the regional economy (Sector 30), three different taxes (on products -Sector 31-, on production –Sector 32- and income taxes –Sector 33), a government account (Sector 34) and finally, the external relations of the Catalan economy that explicitly show the rest of Spain (Sector 35) and the rest of the world (Sector 36).

5. Empirical Results

The empirical application is based on an initial computation of the model that, making all the prices equal to unity, constitutes the benchmark situation. This allows an easy interpretation of the values in matrix M' by directly showing the percentage of variation in prices. Then, an individual element of M' quantifies the effects on the price index of an account j when there is one monetary unit increase in the exogenous costs of account i. The information provided by the model reflects the impacts on the endogenous prices (i. e. energy production prices. non-energy production prices and consumption prices) after the exogenous cost shocks received, such as changes in the costs of imports from abroad or changes in the taxation system.

Among the extensive set of results provided by the model, the next sections are limited to show the influence of the exogenous cost pushes in energy activities on the endogenous prices.

5.1. Effects on the Production Prices of Primary Sectors

How the prices of the production system are affected by the exogenous shocks received by energy is an interesting question to evaluate the competitiveness impact that energy exerts on activities. This section focuses on the effects that unitary cost increases in energy cause on the prices of the primary sectors. This perspective of price effects allows to identify the changes in the relative prices of agriculture, livestock and fishing, which are individually considered in the empirical application.

Table 3 shows the impacts (in net terms) on the prices of Sectors 6 to 8 of an exogenous and unitary shock in the costs of energy. In this table, the total price multipliers are additively divided into net transfers effects, net open effects and net circular effects.

The price effects received by primary sectors are of a limited magnitude. Specifically, the largest value in Table 3 is for the price multiplier of Livestock after a cost shock in Electricity, which is quantified in 0.0774. This means that one monetary unit of cost increase in Electricity would increase the cost of Livestock by 0.0774 monetary units. Also from Table 3, the different forms of energy have different quantitative impacts; while Coke, petroleum and fuel and Electricity are the most influential components in the three primary sectors, the rest of energy goods show a smaller influence.

Table 3. Price Effects on Primary Sectors and Decomposition

Price Effect (*j*)	Cost increase (*i*)	*M-I*	N_1	N_2	N_3
6. Agriculture	1. Minerals	0.0247	0.0016	0.0045	0.0186
			6.5%	18.2%	75.3%
	2. Coke, petroleum and fuel	0.0356	0.0028	0.0072	0.0257
			7.8%	20.2%	72.0%
	3. Electricity	0.0419	0.0032	0.0059	0.0328
			7.6%	14.1%	78.3%
	4. Gas	0.0128	0.0005	0.0023	0.0100
			3.9%	18.0%	78.1%
	5. Water	0.0181	0.0096	0.0017	0.0068
			53.0%	9.4%	37.6%
7. Livestock	1. Minerals	0.0451	0.0053	0.0055	0.0343
			11.8%	12.2%	76.0%
	2. Coke, petroleum and fuel	0.0631	0.0079	0.0073	0.0479
			12.5%	11.6%	75.9%
	3. Electricity	0.0774	0.0085	0.0100	0.0589
			11.0%	12.9%	76.1%
	4. Gas	0.0238	0.0022	0.0033	0.0184
			9.2%	13.8%	77.0%
	5. Water	0.0171	0.0015	0.0029	0.0127
			8.8%	16.9%	74.3%
8. Fishing	1. Minerals	0.0437	0.0226	0.0030	0.0181
			51.7%	6.9%	41.4%
	2. Coke, petroleum and fuel	0.0424	0.0126	0.0045	0.0253
			29.7%	10.6%	59.7%
	3. Electricity	0.0433	0.0072	0.0051	0.0311
			16.6%	11.8%	71.6%
	4. Gas	0.0391	0.0279	0.0016	0.0096
			71.3%	4.1%	24.6%
	5. Water	0.0087	0.0011	0.0011	0.0065
			12.6%	12.6%	74.8%

The additive decomposition of multipliers in Table 3 illustrates the significance of the different channels captured by the SAM price model. In most cases, the net circular effects (N_3) dominate in terms of its contribution to total price impacts. This means that the feedback interdependence between energy production, non-energy production and consumers exerts the largest price increases in agricultural sectors. The net transfers effects (N_1), capturing the price impacts due to the direct relations with energy, and the net open effects (N_2), capturing the indirect cost linkages of primary sectors with energy costs, show in general similar contributions to total price increases. Table 3 contains, however, some interesting exceptions to this general result. Specifically, the transfers effects dominate among the cost-pushes received by Agriculture after a cost increase in Water (53.0%). And also the transfers effects dominate the price impacts on Fishing when there is a cost rise in Minerals and Gas (51.7% and 71.3%. respectively).

5.2. Effects on the Industrial Production Prices

Table 4 shows the influence of the exogenous cost shocks in energy on the prices of the industrial activities (sectors 9 to 17). How price raises in energy affects the costs of industry is an interesting question of industrial policy, as it evaluates the influence of energy on manufacturing costs. Thus, this information helps to illustrate the energy impact on industrial competitiveness.

The results in Table 4 not only show non-negligible impacts on the industrial costs, but also a large quantitative range of the net price multipliers, that goes from 0.0115 to 0.1145. In particular, the lowest value (0.0115) corresponds to the impact on Automobiles after an exogenous cost increase in Water and the highest value (0.1145) corresponds to the impact on Paper after a cost rise in Electricity. The other figures in Table 4 fall within these two extreme values.

In relation to the different energy activities, Electricity is the most influencing component in all industries, with the exception of Chemistry that receive the highest impact from a cost push in Coke and petroleum. On the opposite, Water generates the smallest impact in all the industries except in Paper production, that reflects Gas as the least contributing cost component.

Table 4. Price Effects on Industry and Decomposition

Price Effect (*j*)	Cost increase (*i*)	*M - I*	N_1	N_2	N_3
9. Food production	1. Minerals	0.0423	0.0033	0.0060	0.0330
			7.8%	14.2%	78.0%
	2. Coke, petroleum	0.0555	0.0007	0.0087	0.0461
			1.2%	15.7%	83.1%
	3. Electricity	0.0768	0.0114	0.0090	0.0564
			14.9%	11.7%	73.4%
	4. Gas	0.0248	0.0039	0.0032	0.0177
			15.7%	12.9%	71.4%
	5. Water	0.0159	0.0011	0.0025	0.0123
			6.9%	15.7%	77.4%
10. Textiles	1. Minerals	0.0414	0.0036	0.0062	0.0316
			8.7%	15.0%	76.3%
	2. Coke, petroleum	0.0541	0.0019	0.0084	0.0438
			3.5%	15.5%	81.0%
	3. Electricity	0.0764	0.0125	0.0100	0.0539
			16.4%	13.1%	70.5%
	4. Gas	0.0240	0.0034	0.0036	0.0170
			14.2%	15.0%	70.8%
	5. Water	0.0143	0.0011	0.0019	0.0113
			7.7%	13.3%	79.0%
11. Wood	1. Minerals	0.0461	0.0019	0.0064	0.0378
			4.1%	13.9%	82.0%
	2. Coke, petroleum	0.0617	0.0003	0.0089	0.0525
			0.5%	14.4%	85.1%
	3. Electricity	0.0839	0.0083	0.0107	0.0649
			9.8%	12.8%	77.4%
	4. Gas	0.0256	0.0020	0.0034	0.0202
			7.8%	13.3%	78.9%
	5. Water	0.0161	0.0003	0.0021	0.0137
			1.9%	13.0%	85.1%
12. Paper	1. Minerals	0.0579	0.0107	0.0090	0.0382
			18.5%	15.5%	66.0%
	2. Coke, petroleum	0.0619	0.0008	0.0094	0.0517
			1.3%	15.2%	83.5%
	3. Electricity	0.1145	0.0319	0.0166	0.0660
			27.9%	14.5%	57.6%
	4. Gas	0.0361	0.0094	0.0058	0.0209
			26.0%	16.1%	57.9%
	5. Water	0.0407	0.0186	0.0069	0.0152
			45.7%	16.9%	37.4%
13. Chemistry	1. Minerals	0.0706	0.0274	0.0116	0.0316
			38.8%	16.4%	44.8%
	2. Coke, petroleum	0.0908	0.0323	0.0150	0.0435
			35.6%	16.5%	47.9%
	3. Electricity	0.0786	0.0173	0.0105	0.0508
			22.0%	13.4%	64.6%
	4. Gas	0.0442	0.0194	0.0074	0.0174
			43.9%	16.7%	39.4%
	5. Water	0.0145	0.0020	0.0019	0.0106
			13.8%	13.1%	73.1%
14. Electric equipment	1. Minerals	0.0459	0.0092	0.0069	0.0298
			20.1%	15.0%	64.9%
	2. Coke, petroleum	0.0506	0.0020	0.0078	0.0408
			4.0%	15.4%	80.6%
	3. Electricity	0.0722	0.0123	0.0092	0.0507
			17.1%	12.7%	70.2%
	4. Gas	0.0229	0.0038	0.0033	0.0158

			16.6%	14.4%	69.0%
	5. Water	0.0128	0.0006	0.0016	0.0106
			4.7%	12.5%	82.8%
15. Automobiles	1. Minerals	0.0365	0.0013	0.0058	0.0294
			3.6%	15.9%	80.5%
	2. Coke, petroleum	0.0468	0.0003	0.0066	0.0399
			0.7%	14.1%	85.2%
	3. Electricity	0.0627	0.0058	0.0080	0.0489
			9.2%	12.8%	78.0%
	4. Gas	0.0203	0.0013	0.0032	0.0158
			6.4%	15.8%	77.8%
	5. Water	0.0115	0.0002	0.0012	0.0101
			1.8%	10.4%	87.8%
16. Other industries	1. Minerals	0.0390	0.0008	0.0066	0.0316
			2.1%	16.9%	81.0%
	2. Coke, petroleum	0.0528	0.0002	0.0089	0.0437
			0.3%	16.9%	82.8%
	3. Electricity	0.0715	0.0074	0.0098	0.0543
			10.4%	13.7%	75.9%
	4. Gas	0.0208	0.0005	0.0034	0.0169
			2.4%	16.3%	81.3%
	5. Water	0.0137	0.0003	0.0020	0.0114
			2.2%	14.6%	83.2%
17. Construction	1. Minerals	0.0704	0.0076	0.0091	0.0537
			10.8%	12.9%	76.3%
	2. Coke, petroleum	0.0857	0.0016	0.0105	0.0736
			1.9%	12.2%	85.9%
	3. Electricity	0.1104	0.0061	0.0122	0.0921
			5.5%	11.1%	83.4%
	4. Gas	0.0355	0.0028	0.0042	0.0285
			7.9%	11.8%	80.3%
	5. Water	0.0227	0.0008	0.0025	0.0194
			3.5%	11.0%	85.5%

The additive decomposition of multipliers indicates that the circular net effects (N_3) explain the highest part of the price impacts received by most sectors. It is interesting to point out that the majority of circular multipliers represent more than 75% of the total effect in 31 impacts (64% of values). The results also show that the open net multipliers (N_2) contribute with a higher value than the transfers multipliers, but at a great distance of the circular impacts. Nonetheless, there are two important exceptions to this general rule: the impact of Water on Paper industry and the impact of Gas on Chemistry. In these two specific cases the transfers net multipliers (N_1) are the most influential components.

5.3. Effects on the Production Prices of Services

Table 5 contains the influence that shocks on energy prices have on the costs and prices of services. From this table, services are clearly sensitive to the price increases in energy. The highest influence is on Air transport after a unitary raise in the price of Coke and petroleum, which is quantified in 0.2159. On the contrary, the lowest impact in Table 5 is received by Air transport due to a unitary increase in the price of Water, being quantified in 0.0120.

In relation to the different energy sectors, Water is the least influential component on the prices of all services without exception while Coke and petroleum and Electricity exert the greatest impact.

These results allow to conclude that the response of services to the energy price shocks is very asymmetric and no general patterns can be traced. In particular, the impacts received by services depend on both the type of energy good that suffers the cost-push and the specific activity under consideration.

The comparison of the multipliers' values in Table 4 and Table 5 illustrates that the service sectors respond more intensively to the energy costs pushes in relation to industrial sectors. This comparison, therefore, suggests that the tertiary activities would generate a higher inflation under increases in the energy prices than the industrial sectors, being the latter less sensitive to energy cost rises than the former.

Table 5. Price Effects on Services and Decomposition

Price Effect (*j*)	Cost increase (*i*)	*M – I*	N_1	N_2	N_3
18. Commerce	1. Minerals	0.0722	0.0054	0.0113	0.0555
			7.4%	15.7%	76.9%
	2. Coke, petroleum	0.0973	0.0027	0.0175	0.0771
			2.8%	18.0%	79.2%
	3. Electricity	0.1379	0.0255	0.0158	0.0966
			18.5%	11.4%	70.1%
	4. Gas	0.0396	0.0042	0.0057	0.0297
			10.6%	14.4%	75.0%
	5. Water	0.0275	0.0033	0.0038	0.0204
			12.0%	13.8%	74.2%
19. Railway transport	1. Minerals	0.0531	0.0070	0.0076	0.0385
			13.2%	14.3%	72.5%
	2. Coke, petroleum	0.0786	0.0135	0.0119	0.0532
			17.2%	15.1%	67.7%
	3. Electricity	0.0996	0.0233	0.0098	0.0665
			23.4%	9.8%	66.8%
	4. Gas	0.0249	0.0009	0.0035	0.0205
			3.6%	14.1%	82.3%
	5. Water	0.0164	0.0001	0.0023	0.0140
			0.6%	14.0%	85.4%
20. Land transport	1. Minerals	0.0977	0.0468	0.0077	0.0432
			47.9%	7.9%	44.2%
	2. Coke, petroleum	0.1765	0.1028	0.0125	0.0612
			58.2%	7.1%	34.7%
	3. Electricity	0.0943	0.0098	0.0112	0.0733
			10.4%	11.9%	77.7%
	4. Gas	0.0390	0.0127	0.0036	0.0227
			32.6%	9.2%	58.2%
	5. Water	0.0188	0.0010	0.0024	0.0154
			5.3%	12.8%	81.9%
21. Maritime transport	1. Minerals	0.0596	0.0171	0.0064	0.0361
			28.7%	10.7%	60.6%
	2. Coke, petroleum	0.0864	0.0264	0.0096	0.0504
			30.6%	11.1%	58.3%
	3. Electricity	0.0866	0.0140	0.0101	0.0625
			16.1%	11.7%	72.2%
	4. Gas	0.0329	0.0104	0.0033	0.0192
			31.6%	10.1%	58.3%
	5. Water	0.0163	0.0009	0.0022	0.0132
			5.6%	13.4%	81.0%
22. Air transport	1. Minerals	0.0974	0.0640	0.0035	0.0299
			65.7%	3.6%	30.7%
	2. Coke, petroleum	0.2159	0.1674	0.0056	0.0429
			77.5%	2.6%	19.9%
	3. Electricity	0.0578	0.0013	0.0067	0.0498
			2.2%	11.6%	86.2%
	4. Gas	0.0198	0.0027	0.0016	0.0155
			13.6%	8.1%	78.3%
	5. Water	0.0120	0.0002	0.0012	0.0106
			1.7%	10.0%	88.3%
23. Transport services	1. Minerals	0.0652	0.0019	0.0122	0.0511
			2.9%	18.7%	78.4%
	2. Coke, petroleum	0.0973	0.0023	0.0225	0.0725
			2.4%	23.1%	74.5%
	3. Electricity	0.1091	0.0097	0.0125	0.0869
			8.9%	11.4%	79.7%
	4. Gas	0.0320	0.0006	0.0046	0.0268
			1.9%	14.4%	83.7%

	5. Water	0.0217	0.0008	0.0027	0.0182
			3.7%	12.4%	83.9%
24. Finance	1. Minerals	0.0628	0.0010	0.0094	0.0524
			1.6%	15.0%	83.4%
	2. Coke, petroleum	0.0894	0.0013	0.0154	0.0727
			1.5%	17.2%	81.3%
	3. Electricity	0.1101	0.0053	0.0131	0.0917
			4.8%	11.9%	83.3%
	4. Gas	0.0328	0.0003	0.0045	0.0280
			0.9%	13.7%	85.4%
	5. Water	0.0228	0.0001	0.0033	0.0194
			0.4%	14.5%	85.1%
25. Education	1. Minerals	0.0764	0.0018	0.0141	0.0605
			2.3%	18.5%	79.2%
	2. Coke, petroleum	0.1072	0.0008	0.0230	0.0834
			0.7%	21.5%	77.8%
	3. Electricity	0.1342	0.0085	0.0184	0.1073
			6.3%	13.7%	80.0%
	4. Gas	0.0410	0.0015	0.0069	0.0326
			3.7%	16.8%	79.5%
	5. Water	0.0294	0.0019	0.0051	0.0224
			6.5%	17.3%	76.2%
26. Medical Assistance	1. Minerals	0.0744	0.0021	0.0131	0.0592
			2.8%	17.6%	79.6%
	2. Coke, petroleum	0.1028	0.0008	0.0202	0.0818
			0.8%	19.6%	79.6%
	3. Electricity	0.1325	0.0114	0.0177	0.1034
			8.6%	13.4%	78.0%
	4. Gas	0.0404	0.0017	0.0068	0.0319
			4.2%	16.8%	79.0%
	5. Water	0.0282	0.0021	0.0044	0.0217
			7.4%	15.6%	77.0%
27. Public Administration	1. Minerals	0.0735	0.0037	0.0120	0.0578
			5.1%	16.3%	78.6%
	2. Coke, petroleum	0.1017	0.0026	0.0193	0.0798
			2.5%	19.0%	78.5%
	3. Electricity	0.1417	0.0238	0.0162	0.1017
			16.8%	11.4%	71.8%
	4. Gas	0.0388	0.0020	0.0058	0.0310
			5.2%	14.9%	79.9%
	5. Water	0.0281	0.0025	0.0043	0.0213
			8.9%	15.3%	75.8%
28. Other services	1. Minerals	0.0635	0.0017	0.0102	0.0516
			2.7%	16.1%	81.2%
	2. Coke, petroleum	0.0878	0.0009	0.0157	0.0712
			1.0%	17.9%	81.1%
	3. Electricity	0.1130	0.0081	0.0145	0.0904
			7.2%	12.8%	80.0%
	4. Gas	0.0340	0.0012	0.0051	0.0277
			3.5%	15.0%	81.5%
	5. Water	0.0244	0.0014	0.0039	0.0191
			5.7%	16.0%	78.3%

In general, the multipliers' decomposition indicates that the circular net effects (N_3) dominate in the total effects. Specifically, the circular impacts show a contribution upper 60% in 48 values (87% of total) and upper 75% in 39 values

(70% of total). At a great distance of the circular effects, the open multipliers (*N_2*) are placed in the second order of importance and, finally, the transfers effects (*N_1*) explain the lowest impact. One important exception is Land transport after a unitary increase in the cost of Petroleum and fuel. In this sector, the net transfers effects contribute by 58.2% to the total impact and the circular and open effects contribute by 34.7% and 7.1%, respectively. This result suggests that the direct impact on the price of Land transport caused by the cost rise in petroleum is the most relevant link to explain price formation in this sector.

5.3. Effects on the Consumers' Prices

Considering the households' account as an endogenous component of the model gives rise to analyse by how much the prices of consumers, or the cost-of-living indices, are affected by the exogenous price shocks in energy.

Table 6 illustrates that energy prices are an important element of the consumers' prices. Final prices would increase the most after a rise in the price of Electricity that is quantified in 0.1305 after a unitary cost shock in electrical energy, Coke and petroleum, with a value of 0.1113, shows a significant influence on the cost-of-living indices as well.

Table 6. Price Effects on Consumers and Decomposition

Price Effect (*j*)	**Cost increase (*i*)**	***M - I***	***N_1***	***N_2***	***N_3***
29. Consumers	1. Minerals	0.0777	0.0161	0.0046	0.0570
			20.7%	5.9%	73.4%
	2. Coke, petroleum	0.1113	0.0268	0.0042	0.0803
			24.1%	3.8%	72.1%
	3. Electricity	0.1305	0.0203	0.0143	0.0959
			15.6%	10.9%	73.5%
	4. Gas	0.0412	0.0079	0.0030	0.0303
			19.2%	7.3%	73.5%
	5. Water	0.0285	0.0057	0.0020	0.0208
			20.0%	7.0%	73.0%

Again, the circular effects dominate in the price multipliers. Differently to the previous results (Table 3. Table 4 and Table 5), however, the transfers multipliers show a higher magnitude and are placed in the second order of influence. The direct connections between final prices and the prices of energy, then, gain relevance in relation to the influence of this cost component within the production system.

6. Conclusions

Implementing new taxes on energy is one of the possible measures that regulators have at hand to reduce harmful emissions. The new taxation would disincentive both the production and consumption of dirty forms of energy but, in parallel, this policy intervention would also raise energy prices.

This paper relies on the role that energy prices have within the price formation process of an economy. Specifically, it proposes a simple general equilibrium model of price impacts, which assumes linearity in the connections among agents, to evaluate the influence of energy costs on the price definition mechanism. The total price multipliers are split following an additive decomposition that allows to easily interpreting the contribution of the different transmission channels within the total cost impacts. The empirical application if for the Catalan economy and uses a social accounting matrix for 2011.

The outcomes in the paper reinforce the conventional wisdom that energy is an influential element of the price formation of an economy, as energy costs have non-negligible impacts on both the production prices and the consumption prices. In addition, the individual impacts on the different agents and sectors can differ widely depending on the energy good and the sector under consideration.

Specifically, the services of the Catalan economy show a greater sensitivity to energy prices than industrial activities.

The results are extremely helpful for environmental and energy policy interventions. Not only the influence of energy prices on the rest of the economic system are important, but also the influence of energy prices are very asymmetrical and depend, to a greater extent, on the specific sector and/or agent analysed.

Undoubtedly, the SAM price model used has advantages compared with the traditional input-output price model. In particular, the social accounting matrix framework captures the interdependence effects between production, consumption and value added, extending therefore the production relations defined by the input-output model.

The method proposed extends the knowledge about the influence of energy on the prices and its transmission circuits within an economic system. In particular, the analysis shed light on the inflationary potential of energy and the possible trade-off between environmental policy and the price control in an economy.

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References

Bardazzi. R.; Oropallo. F. and Pazienza. M. G. (2015). Do manufacturing firms react to energy prices? Evidence from Italy. *Energy Economics*. 49: 168-181.

Catsambas. T. (1982). Distributional implications of changes in US petroleum taxation. *Journal of Policy Modeling*. 4 (2): 211-222.

Gohin. A. and Chantret. F. (2010). The long-run impact of energy prices on world agricultural markets: The role of macro-economic linkages. *Energy Policy*. 38 (1): 333-339.

Hughes. G. A. (1986). A new method for estimating the effects of fuel taxes: An application to Thailand. *The World Bank Economic Review*. 1 (1): 65-101.

IDESCAT (2016a). *Taules input-output per a Catalunya 2011*. Barcelona.

IDESCAT (2016b). *Producte interior brut regional*. Barcelona.

Llop. M. and Pié. L. (2011). Capturing the multisectoral effects of environmental policies: A linear price model for Catalonia. *Environmental Economics*. 2 (1): 17-26.

Llop. M. (2012). The role of saving and investment in a SAM price model. *The Annals of Regional Science*. 48 (1): 339-357.

Mork. K. A. and Hall. R. E. (1980). Energy prices and the US economy in 1979-1981. *Energy Journal*. 1 (2): 41-53.

Nazlioghu. S. and Soytas. U. (2011). World oil prices and agricultural commodity prices: Evidence from an emerging market. *Energy Economics*. 33: 488-496.

Obadi. S. M. and Korcek. M. (2014). Are food prices affected by crude oil price: Causality investigation. *Review of Integrative Business and Economics*. 3 (1): 391-407.

Pigou. A. C. (1920). *The Economics of Welfare*. Macmillan. London.

Pyatt. G. (1988). A SAM approach to modeling. *Journal of Policy Modeling*. 10: 327-352.

Pyatt. G. and Round. J. (1979). Accounting and fixed price multipliers in a social accounting matrix framework. *The Economic Journal*. 89: 850-873.

Roland-Holst. D. and Sancho. F. (1995). Modeling prices in a SAM structure. *The Review of Economics and Statistics*. 77: 361-371.

Saari. M. Y; Dietzenbacher. E. and Los. B. (2016). The impacts of petroleum price fluctuations on income distribution across ethnic groups in Malaysia. *Ecological Economics*. 130: 25-36.

Uri. N. D. and Boyd. R. (1996). An evaluation of the economic effects of higher energy prices in Mexico. *Energy Policy*. 25 (2): 205-215.

Valadkhani. A. (2014). Dynamic effects of rising oil prices on consumer energy prices in Canada and the United States: Evidence from the last half a century. *Energy Economics*. 45: 33-44.

Venditti. F. (2013). From oil to energy prices: How much asymmetry along the way?. *Energy Economics*. 40: 468-473.

Wang. L. and PcPhail. L. L. (2014). Impacts of energy shocks on US agricultural productivity growth and commodity prices. *Energy Economics*. 46: 435-444.

Table A1. The Social Accounting Matrix for Catalonia (SAMCAT2011)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	0	3,380.5	545.1	1,875.9	5.2	0	2.3	0.3	0	0	0.1	25.7	118.8	248.0	0	0	174.3	22.0	0
2	0	10.2	11.7	4.8	1.8	15.7	33.9	9.4	17.8	17.7	0.9	0.9	1,528.6	84.8	5.6	0.3	51.5	192.8	8.8
3	47.9	3.2	1,437.1	186.9	110.4	11.7	29.5	3.0	315.8	102.1	31.1	243.1	608.1	454.0	100.0	21.6	166.0	1,691.8	12.8
4	10.5	60.7	11.4	161.8	3.3	2.4	8.4	20.2	125.1	31.8	8.6	85.4	861.4	161.5	24.7	1.4	91.2	310.3	0.4
5	0.9	2.6	1.4	0	193.1	51.6	5.5	0.7	32.6	9.3	1.1	162.9	82.4	21.3	4.1	0.9	23.5	233.8	0
6	0	0	0	0	0	124.4	521.5	0	2,893.1	63.5	60.3	12.0	3.9	1.5	0	0	0	370.8	0
7	0	0	0	0	0	42.8	31.7	0	3,457.1	0.4	0	0	0	1.8	0	0	0	213.3	0.3
8	0	0	0	0	0	0	0	2.6	35.6	0	0	0	0	0	0	0	0	256.9	0
9	0	0	0	0	0	0	1,195.5	3.7	5,832.7	0.8	0	1.9	396.9	11.8	0	0	0	3,260.2	0
10	0	0	0	0	0.2	0.2	0.1	1.3	0.3	1,938.0	60.6	1.6	20.3	16.8	26.4	39.0	0.7	236.1	0
11	1.1	0	0	0	0	0.5	0.3	0.4	25.6	3.0	744.2	4.4	1.2	44.4	2.4	3.1	287.0	139.7	0
12	0	0	1.3	0	2.5	0.2	1.3	0	381.9	29.1	24.8	2,816.4	415.9	147.1	33.9	32.6	67.5	737.5	1.2
13	4.9	775.8	2.3	2.9	20.7	66.6	3.3	0.7	697.5	453.0	83.2	429.1	14,002.5	939.7	1,169.3	108.8	53.0	1,479.9	0
14	7.7	0	230.4	0.4	105.2	4.0	10.7	0.9	374.1	60.9	159.2	84.7	577.4	10,723.1	2,974.8	276.5	3,576.3	717.4	0.2
15	0	0	0	0	0	0	0	5.4	0	0	0	0	63.3	15.9	4,518.4	0	60.5	493.1	22.4
16	0	0	0	0	0	0	0	0	0.1	0.4	92.7	0	11.0	41.2	0	116.3	0	18.5	0
17	0	0	250.6	281.5	74.0	33.1	44.7	2.6	30.8	7.7	11.0	17.4	54.5	272.0	58.9	9.7	8,782.6	1,265.1	46.6
18	60.0	27.6	192.6	43.3	122.8	116.3	327.5	36.9	1,863.9	860.6	530.1	459.6	1,791.9	2,413.7	683.8	304.6	1,846.7	6,440.5	34.1
19	5.6	0	0	0	0	0	0	0	5.9	0.6	0	0	6.3	5.6	19.6	0.1	0.2	28.5	0
20	25.7	2.0	5.9	80.1	18.1	10.5	46.2	2.0	941.2	98.4	87.6	132.8	453.7	549.8	166.5	38.0	282.4	1,961.7	19.0
21	20.6	0	0	0	0	0	0.2	0	23.2	8.4	1.1	7.5	34.1	56.8	51.6	2.1	0	48.0	0
22	0	0	0	0	0	0	0.1	0	29.0	7.5	0.2	2.8	37.3	13.0	2.6	3.0	2.7	58.3	0.4
23	22.1	0	2.1	14.4	12.3	1.8	3.2	26.7	232.1	83.9	27.7	115.0	738.2	314.8	97.5	9.7	201.7	1,453.5	8.9
24	7.0	27.4	73.5	0	10.7	32.3	27.4	9.2	121.7	63.6	32.5	48.3	183.6	261.7	39.5	14.6	623.9	1,230.9	1.7
25	0	0.1	0	0	0.9	0.1	0	0.6	2.9	0.1	0	2.2	172.2	0.3	1.1	0	2.1	51.6	0
26	0	0	0	0	0.5	0	0	0.4	0.2	0	0.1	0.2	0	0	0.1	7.7	0	18.2	0.3
27	0.1	0	0	0	0	0	0	0	0.6	0.1	0	1.6	0	0.6	0	0.2	6.6	0.1	0
28	55.9	5.2	210.0	23.2	239.6	8.0	81.9	18.7	2,383.8	449.1	279.0	370.4	2,230.9	2,007.8	1,055.3	221.3	4,572.6	13,184.8	75.0
29	334.6	319.9	3,121.8	133.6	781.6	1452.4	870.8	108.0	4,741.9	1,932.8	1,005.6	2,192.6	7,274.7	8,809.3	2,719.5	818.0	11,446.9	41,787.7	208.7
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	2.1	1.0	15.3	0.7	13.4	-13.6	-81.2	2.0	-260.1	21.4	5.7	15.1	63.2	76.0	25.3	5.1	491.3	396.9	4.4
32	-2.4	2.9	21.2	9.8	-0.2	-144.5	-232.3	-1.9	4.2	-15.0	-6.5	0.5	42.6	-13.4	-32.8	-3.6	216.6	8.5	-0.7
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	264.0	513.4	2,562.8	252.0	0	2,541.9	1,002.8	317.8	5,938.8	805.3	1,001.4	1,261.0	3,465.2	7,065.4	1,867.4	243.3	1,985.2	2,325.2	218.0
36	5,801.0	3,952.6	80.6	0	0	1,723.9	432.6	198.0	4,504.0	3,165.9	403.0	1,462.2	12,822.3	11,525.0	5,741.3	1,281.0	154.6	1,394.7	5.8
Total	6,669.4	9,085.2	8,777.1	3,071.3	1,716.1	6,082.3	4,367.8	769.6	34,753.4	10,200.4	4,645.3	9,957.3	48,062.5	46,271.2	21,356.8	3,555.3	35,167.6	82,028.3	668.3

Table A1. The Social Accounting Matrix for Catalonia (SAMCAT2011) (continued)

	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total
1	2.1	0	0	0.7	0.3	0	0.5	0.5	16.4	3.6	5.0	0	0	0	0	71.8	170.3	6,669.4
2	1,095.9	13.9	436.3	37.2	18.4	6.6	9.9	25.8	82.8	2,909.8	-7.2	0	0	0	0	1,356.0	1,102.6	9,085.2
3	71.4	5.7	0.1	133.4	63.4	66.6	147.4	222.7	703.7	1,744.1	0	0	0	0	0	0	42.5	8,777.1
4	117.9	5.1	2.6	9.0	3.2	13.3	24.8	19.8	112.7	782.4	0	0	0	0	0	0	0	3,071.3
5	8.3	0.4	0	11.7	1.7	16.7	30.0	24.3	127.3	555.7	0	0	0	0	77.1	26.6	8.6	1,716.1
6	0	0	0	0.1	0.1	2.6	3.8	1.0	6.7	1,377.9	23.4	0	0	0	0	92.5	523.1	6,082.3
7	0	0	0	0	0	0.7	1.4	0.3	10.4	85.3	86.5	0	0	0	0	359.3	76.5	4,367.8
8	0	0	0	0.1	0	4.5	2.2	0.4	1.7	416.8	-0.6	0	0	0	0	20.6	28.8	769.6
9	0.1	0	0	0.2	0.3	10.1	75.0	16.5	84.9	10,420.1	76.7	0	0	0	0	8,543.7	4,822.3	34,753.4
10	1.3	0.5	0.7	1.3	1.3	4.5	11.6	10.9	56.7	2,693.1	-2.6	0	0	0	0	2,346.7	2,732.8	10,200.4
11	0.8	0	0	12.7	6.3	7.2	3.5	6.8	79.6	465.8	948.5	0	0	0	0	1,107.4	749.3	4,645.3
12	10.2	1.4	0.2															