



Research Article

Estimates of Input-Output Multipliers for the Maltese Economy Based on the Symmetric Input-Output Table for 2010

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Abstract. The study presents the estimates of industry specific multipliers which are derived utilizing a highly disaggregated symmetric input-output table for the Maltese Economy for 2010, published by the National Statistics Office of Malta in 2016. The aim of this study is to derive and analyse a set of output, value added, income and employment multipliers, which illustrate how an exogenous shock to the final demand of each industry would affect the production activities of the Maltese economy on the basis of the Leontief demand driven model. Both the open, as well as the closed Leontief demand driven model are utilized in order to derive the simple and total multipliers. The study presents a comparative analysis of the direct, indirect and induced multiplier effects in terms of the output, value added, income and employment generation for each industry within the Maltese economy. Although there is a considerable degree of heterogeneity in the results obtained across the various multiplier measures, when considering the complete set of multiplier results, a number of industries do feature as relatively strong performers across all categories of multipliers. The accommodation and food services activities feature in the top 15 in almost all categories of multipliers under consideration, confirming the historic tendency for the tourism sector to feature as a key important economic driver. The sectors associated with the public sector, more specifically the public administration, education and human health sectors, were also found to consistently exhibit relatively strong multiplier effects.

Keywords: Input-output analysis, Leontief demand driven model multipliers, Maltese Economy

1 Introduction

This study presents the derivation and analysis of both simple and total output (production), income (income-output), value added (value added-output) and employment (employment-output) multipliers for the Maltese economy. These estimates are based on the symmetric input-output table (SIOT) for 2010 published by the National Statistics Office (NSO) of Malta in May 2016, which adheres to Eurostat System of National and Regional Accounts 2010 (Eurostat, 2013). The estimates derived in this study will allow for a deeper undertaking of underlying inter-industry linkages, which characterize the production structure and are of aid to policy makers during the process of identifying potential strategies for economic development. These multiplier estimates are underpinned by the interrelations between production sectors, and their strength or weakness strongly influences sectoral growth, which in turn has a significant impact on the overall economic activity of the country (Hirschman, 1958). The analysis conducted within this study is based on the input-output methodology originally put forward by the Nobel prize winning economist Wassily Leontief (Leontief, 1941). Over the years, input-output analysis has grown into one of the most widely accepted methods of economic planning and decision making (Baumol, 2000). It should however be noted that only a limited number of studies have been undertaken which apply input-output analysis to the Maltese economy. These can be subdivided into two main categories. The first category relating to studies which aim to shed light on the production structure of the Maltese economy by analysing inter-industry linkages, either via the derivation of industry specific multipliers (Cassar, 2015; Gravino, 2012), or via the

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application of hypothetical extraction analysis (Cassar, 2017), whilst studies within the second category aim to assess the economic impact or contribution of tourism (Briguglio, 1992; Blake, Sinclair, Sugiyarto & DeHann, 2003; Sinclair, Blake, Gooroochurn & DeHann, 2005; Cassar, Vella & Buttigieg, 2016).

2 Data and Methodology

The application of input-output techniques requires the utilization of Symmetric Input-Output Table (SIOT) as its main dataset. An SIOT is an observed dataset illustrating the inter-industry transactions for a specific geographic region, measured for a particular time period (usually one year), and which is generally recorded in monetary terms. The multipliers derived in this analysis are based on an industry-by-industry SIOT, in million Euro, for the reference year of 2010, published by the NSO (National Statistics Office of Malta (NSO), 2016). The SIOT employed in this study for Malta for the reference year of 2010, kindly provided by the NSO, has a 40 industry level of disaggregation and to a great extent follows the classification according to the European Statistical Classification of Economic Activities (NACE) Rev.2. A SIOT records the economy's inter-industry transactions via the disaggregation of the economic activity into ' n ' sectors or industries representing the various producing sectors of the economy. The core data required to populate the Leontief demand driven model consists of the flow of products from each of the ' n ' producing sectors, to each of the ' n ' sectors purchasing input requirements in order to undertake the production of output. The flow of products amongst the ' n ' producing sectors of the economy is what is referred to as inter-industry flows (or transactions). The input-output table is therefore a data-set which essentially traces the monetary values of the numerous transactions amongst the pairs of sectors (for each sector ' i ' to each sector ' j ') for a given year.

This section shall proceed with a description of the methodology, pertaining to the derivation of the open Leontief demand driven model, from which it is possible to obtain what are referred to as simple output multipliers. The term simple is employed given that they reflect only direct and indirect effects on production caused by exogenous changes to final demand. This is because they omit the notion that increased production requires more labour input, which in turn increases household income, which further increases demand and consequently production. These so-called induced effects can be internalised through the derivation of the closed Leontief model, which endogenizes household behaviour within the input-output system (Cassar, 2015). The multipliers derived from the closed Leontief demand driven model also capture the inter-relationships between rev-

enue, income, and expenditure flows made by households and the productive sector. Hence, the resultant multipliers, also known as total multipliers, include the induced effects relating to the additional impact on domestic production caused by the demand for goods and services made by households. Such demands are induced through the additional income which is obtained via the production of the new output, originally associated with the initial exogenous shock to final demand.

The open Leontief demand driven model applied within this study follows the methodology presented within Miller and Blair (2009) and employed in Cassar (2015). At the core of the Leontief demand driven model is the concept of technical coefficients denoted by ' a'_{ij} '

$$a_{ij} = \frac{z_{ij}}{x_j}, \quad i, j = 1, \dots, n. \quad (1)$$

Technical coefficients may thus be derived from the ratio of the inputs produced by sector i purchased by industry j , z_{ij} , to the total input used by sector j , x_j . For each industry in the economy, technical coefficients show the proportional value of inputs purchased from all sectors in the economy (including itself) per monetary unit of output. On the basis of this definition of the representation of technical coefficients within the input-output system we can now derive, utilizing matrix algebra notation, a matrix of technical coefficients as follows:

$$A = Z\hat{x}^{-1}, \quad (2)$$

where Z denotes an $(n \times n)$ matrix of inter-industry flows, x denotes an $(n \times 1)$ column vector of output such that \hat{x}^{-1} represents the inverse of the diagonal matrix obtained from vector x , and A represents the matrix of technical coefficients. The technical coefficients matrix is viewed as a means with which to analyse the direct inter-industry linkages that tie the economy together, since for each individual sector it shows the direct effects on output, in terms of the additional demand for input requirements that is generated by an increase in the value of output by one monetary unit.

The solution to the Leontief demand driven model may be obtained by applying the following equation

$$x = (I - A)^{-1}f = Lf. \quad (3)$$

The solution to the input-output system implies that, for a given Leontief Inverse, the amount of total output x produced in the economy is determined solely by the structure of final demand, f , where f is a column vector $(n \times 1)$ of total final demand absorbed by each of the n sectors in the economy.

$$L = (I - A)^{-1} = [l_{ij}]. \quad (4)$$

The Leontief inverse incorporates the concept that the production process required to produce one unit of output for use by final demand, does not only entail an initial or direct output increase, but also requires the production of output by other industries for use as intermediate inputs. Furthermore, the production of these additional intermediate inputs requires subsequent increased rounds of production, since output has to be produced to satisfy the second round of input requirements. All these rounds of additional increases in output are referred to as the indirect effects of an exogenous increase in final demand on total output production.

The derivation of total output multipliers requires solving the Leontief demand driven model for the household augmented technical coefficients matrix, which would generate a Leontief inverse matrix of dimension $(n + 1) \times (n + 1)$, in which each element would now capture the direct and indirect, as well as the induced effects in output production caused by an increase in exogenous final demand (Miller & Blair, 2009)

$$\tilde{x} = (I_{n+1} - \tilde{A})^{-1} f, \quad (5)$$

such that the corresponding Leontief inverse matrix for the closed Leontief model is specified as

$$\tilde{L} = (I_{n+1} - \tilde{A})^{-1} = [\tilde{l}_{ij}], \quad (6)$$

Following Eq. (7), the simple output multipliers (O^S) which capture solely the direct and indirect effects, can be derived via the summation of the column elements of the Leontief inverse matrix derived in Eq. (4)

$$O^S(j) = \sum_{i=1}^n l_{ij}. \quad (7)$$

A simple output multiplier for a given sector 'j' may be defined as the total value of production in all sectors of the economy that is necessary in order to satisfy a 1 Euro worth of final demand for sector 'j's' output. In other words, the output multiplier measure captures the total sum of direct and indirect input requirements from all sectors, needed to supply 1 Euro worth of sector 'j's' output to final demand.

Total output multipliers (O^T) are derived via the summation of the column elements of the truncated household endogenized Leontief inverse matrix derived in Eq. (6). The term truncated refers to the fact that the final row ($n+1$), as well as the final column ($n+1$) of the Leontief inverse, are not included within the calculation of the total output (production) multipliers. The total output multipliers which account for the direct, indirect and the induced effects that a 1 Euro increase in final demand of a specific industry will have on overall

output production, are derived as follows in Eq. (8)

$$O^T(j) = \sum_{i=1}^n \tilde{l}_{ij}. \quad (8)$$

Output multipliers illustrate where increases in final demand could have the largest impact in terms of Euro of output production generated throughout the economy. However, policy makers may be more concerned with the impact that additional spending may have in terms of increased value added, jobs created, or additional household income generated. This study shall therefore derive and assess the resultant income-output, value added-output and physical employment-output multipliers for the Maltese economy based on the SIOT for the reference year of 2010. These multiplier measures directly convert the total Euro value of new final demand expenditure into the respective additional value added, income generated and new employment created.

The derivation of these multipliers requires the computation of the respective row vectors of value added input coefficients, labour input coefficients and employment output ratios. The elements of these row vectors are obtained following Eqs. (9)–(11)

$$a_{va,i} = \frac{va_j}{x_j}, \quad (9)$$

$$a_{inc,i} = \frac{inc_j}{x_j}, \quad (10)$$

$$a_{emp,i} = \frac{emp_j}{x_j}. \quad (11)$$

The value added input coefficients and the labour input coefficients reflect the amount of value added, or income generated per euro of output (production) for each sector in the economy, whilst the employment-output ratio illustrates the number of (average) jobs (for the reference year of 2010) per million Euro of output produced for each sector in the economy. The computed three coefficients/ratios, which are presented in Appendix A, reflect the direct effects in terms of the additional amount of value added, as well as the income and jobs created by each sector in response to a marginal increase in production.

The simple and total value added, income and employment multipliers for each sector in the economy are

thereafter derived respectively following Eqs. (12)–(14)

$$VA^S(j) = \sum_{i=1}^n a_{va,i} l_{ij}, \quad VA^T(j) = \sum_{i=1}^n a_{va,i} \tilde{l}_{ij}, \quad (12)$$

$$INC^S(j) = \sum_{i=1}^n a_{inc,i} l_{ij}, \quad INC^T(j) = \sum_{i=1}^n a_{inc,i} \tilde{l}_{ij}, \quad (13)$$

$$EMP^S(j) = \sum_{i=1}^n a_{emp,i} l_{ij}, \quad EMP^T(j) = \sum_{i=1}^n a_{emp,i} \tilde{l}_{ij}. \quad (14)$$

The simple value added, income and employment multipliers are obtained by multiplying the respective vectors of the derived value added input coefficients, labour input coefficients and employment output ratios, with the Leontief inverse obtained from the open Leontief demand driven model. The simple value added and income multipliers illustrate the increase, in terms of additional value added and income generated throughout the economy, in response to a one Euro increase in final demand for the output of sector ‘*j*’, taking into account all of the direct and indirect effects on the production. $VA^S(j)$ and $INC^S(j)$ represent the simple value added multiplier and simple income multiplier for sector ‘*j*’, respectively. The simple employment multiplier for each sector ‘*j*’, denoted by $EMP^S(j)$, measures the additional physical employment that is generated by the direct and indirect effects on production, due to an additional million Euro worth of final demand for sector ‘*j*’.

The total value added, income and employment multipliers are similarly derived by multiplying the respective vectors of the derived value added input coefficients, labour input coefficients and employment output ratios with the truncated Leontief inverse, obtained from the closed Leontief demand driven model. The total value added and total income multipliers denoted by $VA^T(j)$ and $INC^T(j)$, for sector ‘*j*’, illustrate the increase, in terms of additional value added and additional income generated throughout the economy, in response to an additional Euro of final demand for the output of sector ‘*j*’ taking into account not only the direct and indirect effects, but also the additional induced effects on production which are caused by the increase in the demand for goods and services made by households, induced through the additional income generated as a result of the various rounds of production activities across the economy needed to satisfy the increase in the final demand for sector ‘*j*’. Similarly, the total employment multiplier for a sector ‘*j*’, denoted by $EMP^T(j)$, measures the additional physical employment that is generated by the direct, indirect, as well as the induced effects

on production, due to an additional million Euro worth of final demand for sector ‘*j*’.

It is also possible to decompose the direct, indirect and induced effects for each of the three total multipliers just discussed, namely, the value added, income and employment total multipliers. Since the value added input coefficient, labour input coefficient and employment output ratio for each sector ‘*j*’ denote the direct effects generated in response to a one Euro increase in final demand for the sector, the separate indirect effects may be obtained as the difference between the simple multiplier, incorporating both the direct and indirect effects, with the corresponding coefficient/ratio. Similarly, the separate induced effects, caused by the added household endogeneity, may be derived as the difference between the simple and the total multipliers.

3 Results

Table 1 lists the 15 highest ranking industries in terms of their output simple multipliers. The main factor affecting the magnitude of simple multipliers is the relative share of primary inputs in the total output of each sector. The higher the share of imports, labour compensation and gross operating surplus for each sector, the higher the leakages from the domestic inter-industry system, implying a lower simple multiplier. With a multiplier of 2.09, the industry with the largest simple multiplier is (26): Other professional, scientific and technical activities, followed by (12): Electricity, gas, steam and air conditioning supply, water collection, treatment and supply, with a multiplier of 1.95. The highest ranking manufacturing sector is (7): Manufacture of other non-metallic products, with a multiplier of 1.79. This is followed by industry (13): Mining, quarrying and construction, while sector (18) Accommodation and food services activities ranks 8th, with a simple output multiplier of 1.90. Sector (14): Wholesale and retail trade ranks 13th, with an output multiplier of 1.53.

Fig. 1¹ portrays the 15 highest ranking industries in terms of total output multipliers, as well as the disaggregation between direct, indirect and induced effects. The highest ranking industry is (28): Employment activities, with a total output multiplier of 2.91. Thus, a one Euro exogenous increase in the final demand of employment activities generates an average total production of Euro 2.91, out of which only Euro 0.17 are direct effects, Euro 1.07 are indirect effects and Euro 1.67 are due to induced effects generated through the consumption patterns of households. The high ranking of this relatively small industry is in line with results published in Cassar (2015) using symmetric input output tables for 2008 consistent with ESA 1995 data.

¹The simple and total output multipliers for all 40 sectors are presented in Appendix B.

Table 1: Top 15 simple output multipliers.

No.	Industry	Simple Output Multiplier
26	Other professional, scientific and technical activities...	2.09
12	Electricity, gas, steam and air conditioning supply, ...	1.95
29	Travel agency, tour operator reservation service...	1.81
36	Sports activities and amusement and recreation activities	1.79
7	Manufacture of other non-metallic mineral products	1.79
13	Mining and quarrying and construction	1.75
25	Architectural and engineering activities; ...	1.73
18	Accommodation and food service activities	1.70
17	Land transport and transport via pipelines, ...	1.63
1	Crop and animal production, hunting and related service...	1.58
27	Rental and leasing activities	1.54
3	Manufacture of food products, beverages and tobacco...	1.53
14	Wholesale and retail trade and repair of motor vehicles...	1.52
16	Retail trade, except of motor vehicles and motorcycles	1.52
39	Other personal service activities	1.51

Source: Authors' own calculations.

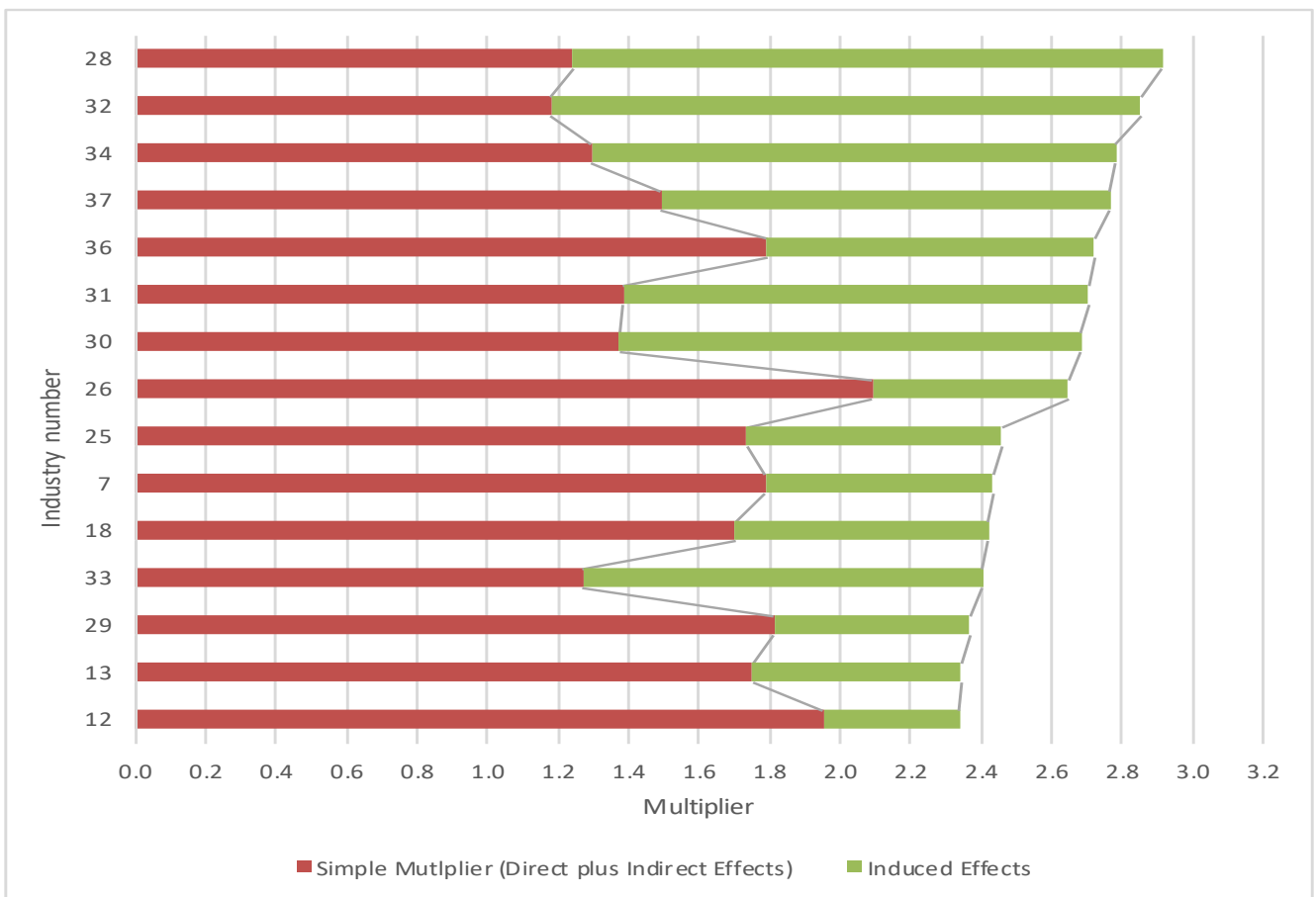


Figure 1: Decomposition of the top 15 total output multipliers. Source: Authors' own calculations.

The second highest ranking industry is (32): Education, followed by (34): Social work activities, with total multipliers of 2.85 and 2.78 respectively. These results are underpinned by the fact that these three sectors exhibit the strongest induced effects out of the industries under consideration.

By comparing the ranks for simple and total output multipliers it can be noted that internalising household consumption patterns leads to significant changes in terms of the industry's rankings. Indeed, out of the top five industries ranked by total multipliers, only one industry, (36): Sports activities and amusement and recreation activities, features in the top five simple multipliers.

While output multipliers are useful when analysing the degree of industry interdependence, they are not particularly relevant when the analyst is interested in measuring the impact of an exogenous change in the final demand of a given industry on Gross Domestic Product (GDP) or on household welfare. Since value added and GDP are conceptually equivalent, value added multipliers are often deemed more relevant than output multipliers. Results in Table 2 show the 15 highest ranking simple value added multipliers; it is immediately noticeable that value added multipliers are significantly smaller than their output counterparts. The industry with the highest simple multiplier is (40): Activities of households as employers, with a multiplier of 0.99. This is followed by (32): Education, and (28): Employment activities, with simple value added multipliers of 0.91 and 0.88 respectively.

Sectors (32): Education, and (28): Employment activities, also score highly in terms of total value added multipliers, ranking 1st and 2nd respectively, followed by (34): Social work activities. Results illustrated in Fig. 2 show that a one Euro exogenous increase in the final demand of these three sectors will lead to an increase of Euro 1.61, Euro 1.59 and Euro 1.45 in Maltese value added, as a result of the sectors' underlying direct, indirect and induced effects.

A comparison of the results for the total and simple value added multipliers, found in Appendix C, show that there have been shifts at the top of the rankings, however, these are not as pronounced as, for example, those seen in the case of output multipliers. It is also interesting to note that the simple value added multipliers for all sectors are less than one, implying that when only considering direct and indirect effects, an exogenous increase in the final demand for all sectors will translate into a lower increase in value added. This has important policy implications, especially with respect to the fiscal multipliers. A fiscal expansion through, say, a one million Euro increase in public administration expenditure, will create Euro 0.78 million increase in GDP through direct and indirect effects, and Euro 0.56 million increase in GDP through induced effects brought about by household consumption patterns.

The income and employment multipliers, presented in Appendix D and Appendix E respectively, are especially useful for policymakers that seek to trace the impact exogenous changes in sectorial demand might have on household welfare. The income multiplier illustrates the effect on labour income generated from an exogenous increase of one Euro in the final demand for each sector.

Table 2: Top 15 simple value added multipliers.

No.	Industry	Simple Value Added Multiplier
40	Activities of households as employers; ...	0.99
32	Education	0.91
28	Employment activities	0.88
8	Manufacture of basic metals	0.87
23	Real estate activities	0.86
34	Social work activities	0.82
30	Security and investigation activities; services to buildings...	0.82
24	Legal and accounting activities; activities of head offices...	0.81
33	Human health activities	0.81
37	Activities of membership organisations	0.80
31	Public administration and defence; compulsory social security	0.78
16	Retail trade, except of motor vehicles and motorcycles	0.78
15	Wholesale trade, except of motor vehicles and motorcycles	0.77
25	Architectural and engineering activities; ...	0.73
14	Wholesale and retail trade and repair of motor vehicles...	0.72

Source: Authors' own calculations.

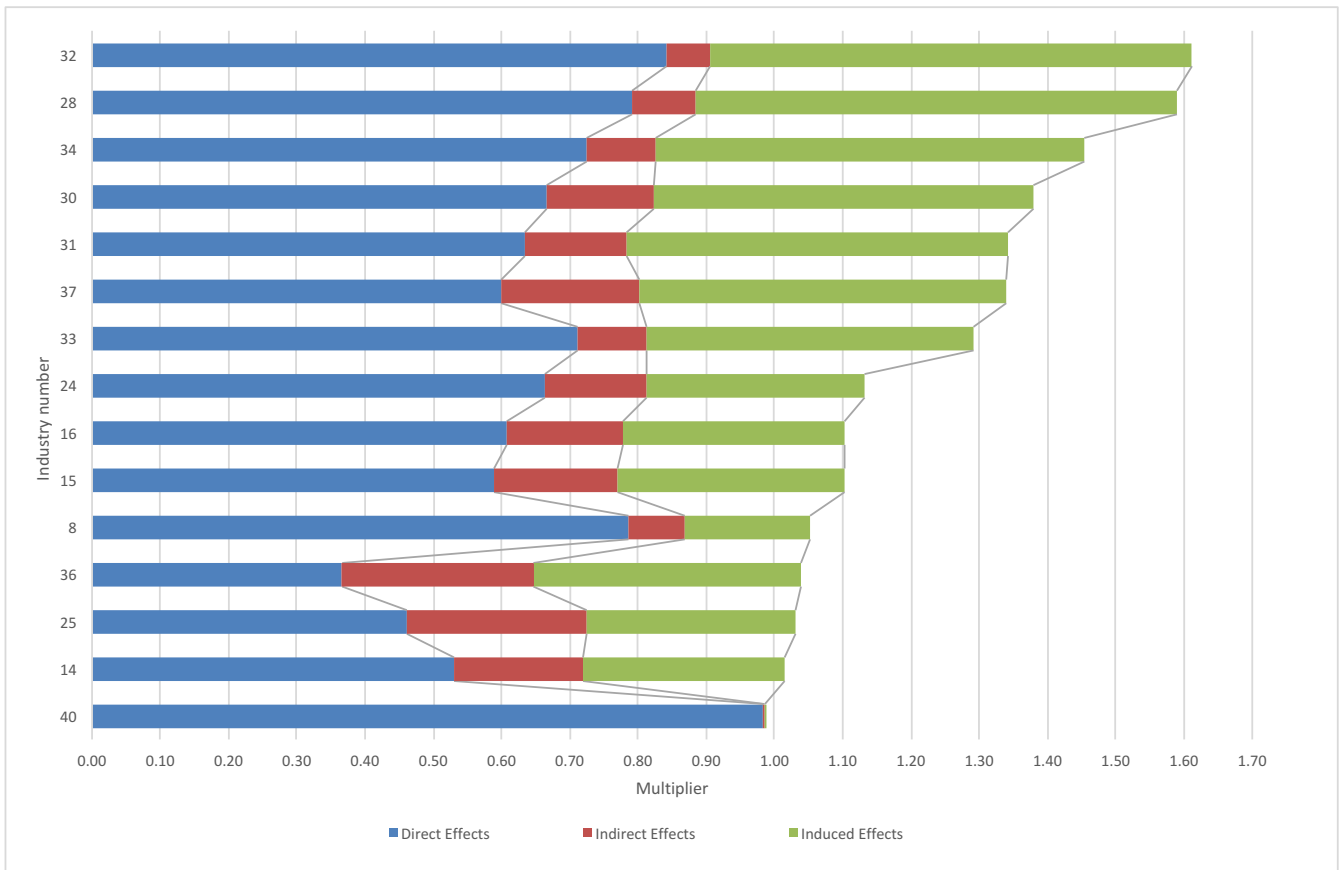


Figure 2: Decomposition of the top 15 total value added multipliers. Source: Authors' own calculations

Table 3: Top 15 simple income multipliers.

No.	Industry	Simple Income Multiplier
28	Employment activities	0.79
32	Education	0.79
34	Social work activities	0.70
31	Public administration and defence; compulsory social security	0.62
30	Security and investigation activities; services to buildings...	0.62
37	Activities of membership organisations	0.60
33	Human health activities	0.53
36	Sports activities and amusement and recreation activities	0.44
15	Wholesale trade, except of motor vehicles and motorcycles	0.37
16	Retail trade, except of motor vehicles and motorcycles	0.36
11	Repair and installation of machinery and equipment	0.36
24	Legal and accounting activities; activities of head offices; ...	0.35
25	Architectural and engineering activities; ...	0.34
18	Accommodation and food service activities	0.34
14	Wholesale and retail trade and repair of motor vehicles...	0.33

Source: Authors' own calculations.

The resulting top 15 simple income multipliers and top 15 total income multipliers are presented in Table 3 and Fig. 3 respectively. As expected, the sectors that intrinsically have a relatively high wage share, such as (28): Employment activities, (32): Education, (34): Social work activities, and (31): Public administration, possess the highest simple and total income multipliers. Conversely, industries which are more capital intensive, such as the manufacturing industries, generate relatively weak income multiplier effects.

Employment multipliers are especially useful for tracing the employment effects of the expansion or contraction of specific industries. Industries with the highest employment output ratios tend to score relatively high employment multipliers. The resulting top 15 simple employment multipliers and top 15 total employment multipliers are presented in Table 4 and Fig. 4 respectively.

In line with the results for income multipliers, (28): Employment activities, (32): Education, (34): Social work activities, and (31): Public administration, rank amongst the top ten industries in terms of their simple and total employment multipliers. Driven by a significant

high employment to output ratio, (37): Activities of membership organisation, has the highest simple and total employment multipliers. Indeed, a one million Euro exogenous increase in the final demand of this sector creates almost 6 new jobs directly within the same industry, and another 90 jobs through indirect effects stemming from other sectors. When taking into consideration the relationship between household income and consumption, the number of new employees created rises to almost 110. Mirroring the results for the income multipliers and driven by relatively low employment to output ratios, manufacturing sectors score quite poorly in terms of employment multipliers.

4 Discussion and Conclusion

By assessing all the individual measures generated in this study it is possible to obtain a very clear picture of the strength of the inter-industry relations. It is also possible to identify how the strength of these relations impacted the Maltese economy in the reference year of 2010 in terms of productive output generated, value added, household income generated, and employment created. These measures can either be used to study the

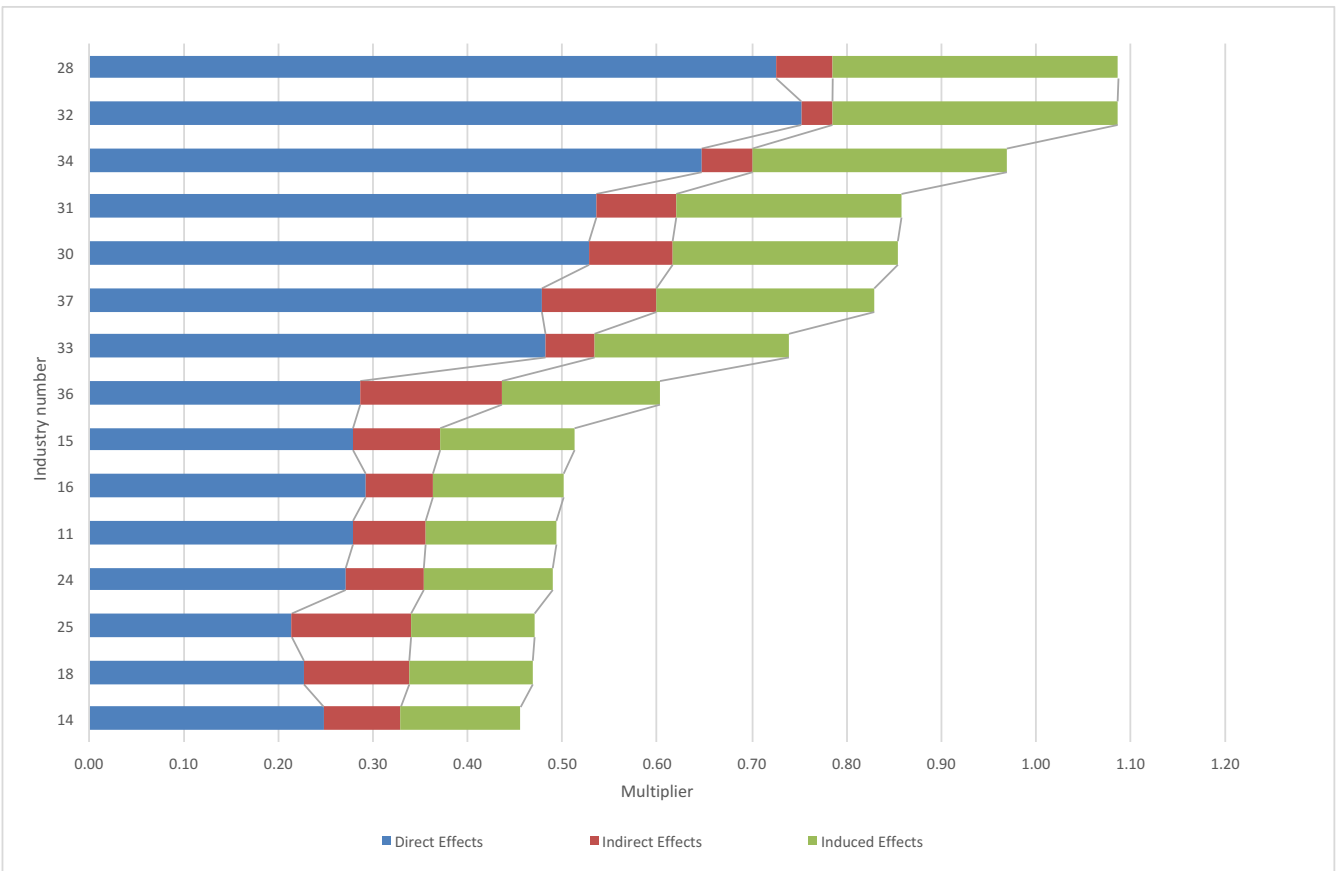


Figure 3: Decomposition of the top 15 total income multipliers. Source: Authors' own calculations.

Table 4: Top 15 simple employment multipliers.

No.	Industry	Simple Employment Multiplier
37	Activities of membership organisations	95.69
28	Employment activities	48.87
30	Security and investigation activities; services to buildings...	42.09
32	Education	38.24
36	Sports activities and amusement and recreation activities	36.93
34	Social work activities	36.36
31	Public administration and defence; compulsory social security	26.42
16	Retail trade, except of motor vehicles and motorcycles	26.04
18	Accommodation and food service activities	24.75
33	Human health activities	22.09
14	Wholesale and retail trade and repair of motor vehicles ...	21.27
15	Wholesale trade, except of motor vehicles and motorcycles	20.10
7	Manufacture of other non-metallic mineral products	19.37
9	Manufacture of fabricated metal products, ...	19.30
25	Architectural and engineering activities; ...	18.11

Source: Authors' own calculations.

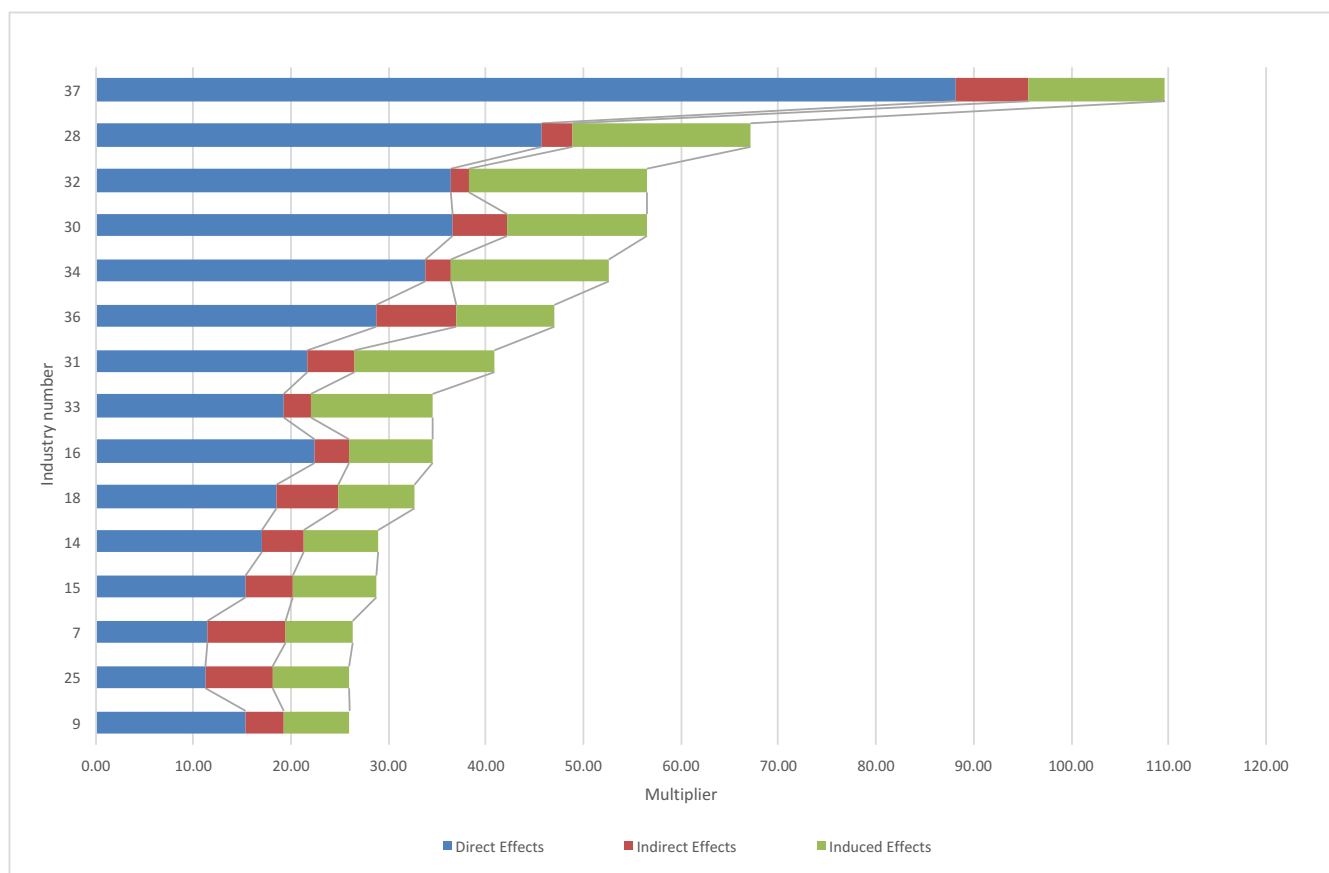


Figure 4: Decomposition of the top 15 total employment multipliers. Source: Authors' own calculations.

characteristics of the structure of production, or crucially can be of aid to policy makers for the identification of industry-specific policies aimed at improving Malta's competitiveness and economic resilience.

Overall there is considerable heterogeneity in the results. Indeed, when considering the complete set of multiplier results, one notes that there are considerable shifts at the top of the rankings, with a number of sectors featuring within the top 15 industries in specific multipliers while ranking relatively low down the list in others. However, a number of industries feature as relatively strong performers across all categories of multipliers. For instance, (18): Accommodation and food services activities, features in the top 15 in almost all categories of multipliers under consideration. This confirms the historic tendency for the tourism sector to feature as an important economic driver, even against the backdrop of the structural changes and the increased diversification that are currently shaping the Maltese economy. Strong results across all types of multipliers are also scored by the public sector, more specifically in (31): Public administration, (32): Education, and (33): Human health sectors. It is also particularly interesting to note that all multipliers pertaining to the financial services sector, including (20): Financial service activities except insurance, (21): Insurance and reinsurance, and (22) Activities auxiliary to financial activities, are amongst the lowest across all industries under consideration. This result contrasts sharply with results of Casar (2015) obtained from input-output tables for 2008 in ESA 95. Indeed, according to this study, the industries making up the financial sector score considerably higher multipliers. The low multipliers derived for the new input-output tables may be in part driven by the inclusion of Special Purpose Vehicles (SPEs) within ESA 2010 data. Since SPEs contain very high import contents their inclusion reduces the relative magnitude of the local intermediate input requirements of the sector, implicitly weakening the strength of the overall sectoral multiplier effects.

This result highlights that, while industry specific multipliers are very useful, especially to policymakers, their interpretation should take into consideration the limitations of this indicator as well as the assumptions that are at the core of the Leontief demand driven model. Firstly, the analysis presented in this paper is based on modelling multipliers which specifically measure the resultant effect on output, value added, income and employment, due to a marginal change in final demand. Thus, these multipliers do not account for either the relative size of the industry or for the amount of final demand each industry is driving throughout the economy via its multipliers. For this reason, an analysis based solely on these results may give only a partial over-

view of the importance of each sector. In this light, the analysis can be complemented with accounting multipliers that take into consideration the size of final demand of each industry, together with the magnitude of direct and indirect effects. Secondly, it should be noted that the results obtained from the Leontief demand driven model are based on a number of robust assumptions which have to be taken into account when evaluating the resulting multiplier effects. One key assumption which underpins the Leontief demand driven model is that of fixed prices. The model assumes that an increase in the final demand of one sector (no matter how large) will not be constrained by the supply of labour or by intermediate goods and services (given also the implicit assumption of no resource constraints), nor will it result in a change in relative prices. Furthermore, the assumption of constant returns to scale in the Leontief production function neglects the possibility of substitution of one input for another in the production process. It is assumed the purchases of input requirements by each industry are determined solely by the desired level of output, implying that there has been no consideration into how changes in input prices (which are implicitly assumed to be fixed), changes in technology and efficiency gains through economies of scale, may or may not affect the underlying production processes of sectors in the economy. Therefore, interpreting multiplier estimates in the context of modelling marginal changes in activity (impact analysis), will implicitly invoke various assumptions about how the economy behaves in response to changes in demand, since these measures, would effectively be estimating the resulting impacts in an economic scenario which may differ from that of the given base year of 2010.

The industry specific multipliers derived in this study should be evaluated with caution by policy makers, given the assumptions which are invoked by the Leontief input-output modelling framework. However, they nonetheless still provide an analytically derived first cut estimate of the possible impacts that could be generated throughout the economy, as a result of an exogenous increase in final demand. Oosterhaven, Piek and Stedler (1986) assert that a realistic estimate of the true impact that an increase in final demand would have on the generation of output, value added, income and employment, would be approximately half way between the simple and total multipliers. This statement is based on the observation that simple multipliers probably underestimate economic impacts given that they omit household and factor income activities, whilst total multipliers probably overestimate these impacts due to strict assumptions concerning the behaviour of household income-expenditure patterns.

References

- Baumol, W. J. A. (2000). Leontief's Great Leap Forward: Beyond Quesnay, Marx and Bortkiewicz. *Econ. Syst. Res.* 12(2), 141–152.
- Blake, A., Sinclair, T. M., Sugiyarto, G. & DeHann, C. (2003). *The Economic Impact of Tourism in Malta: Input-Output Modelling*. The University of Nottingham, Report for the Malta Tourism Authority.
- Briguglio, L. (1992). Tourism Multipliers in the Maltese Economy. In P. Johnson & B. Thomas (Eds.), *Perspectives on Tourism Policy* (pp. 76–80). London: Mansell.
- Cassar, I. P. (2015). *Estimates of Output, Income, Value Added and Employment Multipliers for the Maltese Economy* (WP-03-2015), Central Bank of Malta, Valletta.
- Cassar, I. P. (2017). *Assessing Structural Change in the Maltese Economy via the Application of a Hypothetical Extraction Analysis* (WP-01-2017), Central Bank of Malta, Valletta.
- Cassar, I. P., Vella, K. & Buttigieg, S. (2016). Understanding the Economic Contribution of Tourism in Malta. *Mediterr. J. Soc. Sci.* 7(6), 49–60.
- Eurostat. (2013). *European System of Accounts, ESA 2010*. Luxembourg: Publications Office of the European Union.
- Gravino, D. (2012). Economic and Policy Implications of Industry Interdependence: An Input-Output Approach. *Int. J. Econ. Financ.* 4(6), 22–31.
- Hirschman, A. O. (1958). *The Strategy of Economic Development*. Study in Economics. New York: Yale University Press.
- Leontief, W. (1941). *The Structure of American Economy, 1919-1929*. Cambridge: Harvard University Press.
- Miller, R. E. & Blair, P. D. (2009). *Input-Output Analysis: Foundations and Extensions*. New York: Cambridge University Press.
- National Statistics Office of Malta (NSO). (2016). *Supply, Use and Input-Output Tables 2010*. Valletta: National Statistics Office.
- Oosterhaven, J., Piek, G. & Stedler, D. (1986). Theory and Practice of Updating Regional Versus Interregional Interindustry Tables. *Pap. Reg. Sci.* 59(1), 57–72.
- Sinclair, T. M., Blake, A., Gooroochurn, N. & DeHann, C. (2005). *Modelling Tourism Impacts on Small Island Economies: Evidence from Cyprus, Malta and Mauritius*. The University of Nottingham.

Appendix

A Value Added, Income and Employment Ratios

No.	NACE code	Industry	Value Added		Income Input Coefficient		Employment Output Ratio	
			Value	Rank	Value	Rank	Value	Rank
1	A01-02	Crop and animal production, hunting...	0.51	17	0.15	29	9.02	26
2	A03	Fishing and aquaculture	0.29	34	0.10	35	4.85	34
3	C10T12	Manufacture of food products, beverages...	0.28	35	0.16	24	9.37	24
4	C13T15	Manufacture of textiles, wearing apparel...	0.45	20	0.18	20	10.68	21
5	C16	Manufacture of wood and of products...	0.37	25	0.16	25	11.85	17
6	C17-22	Manufacture of paper and paper products, ...	0.42	22	0.19	18	9.06	25
7	C23	Manufacture of other non-metallic mineral...	0.26	37	0.17	21	11.44	18
8	C24	Manufacture of basic metals	0.79	4	0.15	26	12.30	15
9	C25	Manufacture of fabricated metal products, ...	0.35	28	0.22	15	15.26	13
10	C26-32	Manufacture of computer, electronic...	0.25	38	0.11	34	5.61	32
11	C33	Repair and installation of machinery...	0.30	32	0.28	11	11.04	20
12	D35-E39	Electricity, gas, steam and air conditioning...	0.18	39	0.08	36	3.74	36
13	B+F	Mining and quarrying and construction	0.33	29	0.15	27	9.55	23
14	G45	Wholesale and retail trade and repair...	0.53	15	0.25	13	17.03	11
15	G46	Wholesale trade, except of motor vehicles...	0.59	13	0.28	10	15.37	12
16	G47	Retail trade, except of motor vehicles...	0.61	11	0.29	8	22.47	7
17	H49-53	Land transport and transport via pipelines, ...	0.35	27	0.18	19	7.64	27
18	I	Accommodation and food service activities	0.38	23	0.23	14	18.50	10
19	J58-63	Publishing activities, motion picture, video...	0.43	21	0.17	23	6.66	31
20	K64	Financial service activities, except insurance...	0.07	40	0.04	38	1.38	38
21	K65	Insurance, reinsurance and pension funding...	0.52	16	0.15	28	4.82	35
22	K66	Activities auxiliary to financial services...	0.29	33	0.14	30	6.78	30
23	L68	Real estate activities	0.75	5	0.01	39	0.74	39
24	M69+70	Legal and accounting activities; ...	0.66	9	0.27	12	12.83	14
25	M71+M72	Architectural and engineering activities; ...	0.46	19	0.21	16	11.22	19
26	M73-75	Other professional, scientific and technical...	0.27	36	0.11	33	5.59	33
27	N77	Rental and leasing activities	0.37	24	0.11	32	7.50	29
28	N78	Employment activities	0.79	3	0.73	2	45.74	2
29	N79	Travel agency, tour operator...	0.31	30	0.14	31	7.62	28
30	N80-82	Security and investigation activities; ...	0.67	8	0.53	5	36.58	3
31	O84	Public administration and defence...	0.63	10	0.54	4	21.60	8
32	P85	Education	0.84	2	0.75	1	36.46	4
33	Q86	Human health activities	0.71	7	0.48	6	19.17	9
34	Q87-88	Social work activities	0.72	6	0.65	3	33.70	5
35	R90T92	Creative, arts and entertainment activities; ...	0.30	31	0.05	37	1.80	37
36	R93	Sports activities and amusement...	0.37	26	0.29	9	28.68	6
37	S94	Activities of membership organisations	0.60	12	0.48	7	88.21	1
38	S95	Repair of computers and personal...	0.55	14	0.20	17	10.66	22
39	S96	Other personal service activities	0.50	18	0.17	22	12.00	16
40	TU	Activities of households as employers; ...	0.98	1	0.00	40	0.00	40

Source: NSO.

B Output Multipliers

No.	NACE code	Industry	Simple Output Multiplier		Induced Effects		Total Output Multiplier	
			Value	Rank	Value	Rank	Value	Rank
1	A01-02	Crop and animal production, hunting...	1.58	10	0.52	25	2.10	22
2	A03	Fishing and aquaculture	1.30	27	0.32	35	1.62	34
3	C10T12	Manufacture of food products, beverages...	1.53	12	0.53	24	2.07	23
4	C13T15	Manufacture of textiles, wearing apparel...	1.38	21	0.50	26	1.89	29
5	C16	Manufacture of wood and of products...	1.36	24	0.48	29	1.84	30
6	C17-22	Manufacture of paper and paper products, ...	1.24	33	0.49	28	1.73	31
7	C23	Manufacture of other non-metallic mineral...	1.79	5	0.64	16	2.43	10
8	C24	Manufacture of basic metals	1.22	34	0.44	30	1.66	32
9	C25	Manufacture of fabricated metal products, ...	1.35	25	0.61	18	1.96	26
10	C26-32	Manufacture of computer, electronic...	1.21	35	0.30	36	1.51	35
11	C33	Repair and installation of machinery...	1.47	18	0.76	11	2.23	19
12	D35-E39	Electricity, gas, steam and air conditioning...	1.95	2	0.38	33	2.34	15
13	B+F	Mining and quarrying and construction	1.75	6	0.59	19	2.34	14
14	G45	Wholesale and retail trade and repair...	1.52	13	0.70	15	2.22	20
15	G46	Wholesale trade, except of motor vehicles...	1.50	16	0.79	9	2.29	17
16	G47	Retail trade, except of motor vehicles...	1.52	14	0.77	10	2.29	16
17	H49-53	Land transport and transport via pipelines, ...	1.63	9	0.62	17	2.25	18
18	I	Accommodation and food service activities	1.70	8	0.72	14	2.42	11
19	J58-63	Publishing activities, motion picture, video...	1.42	19	0.50	27	1.92	27
20	K64	Financial service activities, except insurance...	1.04	39	0.10	39	1.13	39
21	K65	Insurance, reinsurance and pension funding...	1.14	37	0.35	34	1.50	36
22	K66	Activities auxiliary to financial services...	1.26	31	0.39	32	1.65	33
23	L68	Real estate activities	1.29	29	0.12	38	1.41	37
24	M69+70	Legal and accounting activities; ...	1.38	22	0.75	12	2.14	21
25	M71+M72	Architectural and engineering activities; ...	1.73	7	0.72	13	2.46	9
26	M73-75	Other professional, scientific and technical...	2.09	1	0.56	22	2.65	8
27	N77	Rental and leasing activities	1.54	11	0.43	31	1.98	25
28	N78	Employment activities	1.24	32	1.67	1	2.91	1
29	N79	Travel agency, tour operator...	1.81	3	0.56	21	2.37	13
30	N80-82	Security and investigation activities; ...	1.37	23	1.31	5	2.68	7
31	O84	Public administration and defence...	1.39	20	1.32	4	2.70	6
32	P85	Education	1.18	36	1.67	2	2.85	2
33	Q86	Human health activities	1.27	30	1.14	7	2.40	12
34	Q87-88	Social work activities	1.29	28	1.49	3	2.78	3
35	R90T92	Creative, arts and entertainment activities; ...	1.12	38	0.15	37	1.27	38
36	R93	Sports activities and amusement ...	1.79	4	0.93	8	2.72	5
37	S94	Activities of membership organisations	1.49	17	1.27	6	2.76	4
38	S95	Repair of computers and personal ...	1.34	26	0.56	20	1.90	28
39	S96	Other personal service activities	1.51	15	0.55	23	2.06	24
40	TU	Activities of households as employers; ...	1.02	40	0.00	40	1.02	40

Source: Authors' own calculations.

C Value Added Multipliers

No.	NACE code	Industry	Simple Value Added Multiplier		Induced Effects		Total Value Added Multiplier	
			Value	Rank	Value	Rank	Value	Rank
1	A01-02	Crop and animal production, hunting...	0.70	16	0.22	25	0.92	18
2	A03	Fishing and aquaculture	0.39	35	0.13	35	0.53	36
3	C10T12	Manufacture of food products, beverages...	0.49	33	0.23	24	0.71	31
4	C13T15	Manufacture of textiles, wearing apparel...	0.56	26	0.21	26	0.77	28
5	C16	Manufacture of wood and of products...	0.51	30	0.20	29	0.71	30
6	C17-22	Manufacture of paper and paper products, ...	0.50	31	0.21	28	0.71	33
7	C23	Manufacture of other non-metallic mineral...	0.53	28	0.27	16	0.81	25
8	C24	Manufacture of basic metals	0.87	4	0.18	30	1.05	11
9	C25	Manufacture of fabricated metal products, ...	0.50	32	0.26	18	0.76	29
10	C26-32	Manufacture of computer, electronic...	0.32	39	0.13	36	0.45	38
11	C33	Repair and installation of machinery...	0.46	34	0.32	11	0.78	27
12	D35-E39	Electricity, gas, steam and air conditioning...	0.39	36	0.16	33	0.55	35
13	B+F	Mining and quarrying and construction	0.59	22	0.25	19	0.84	21
14	G45	Wholesale and retail trade and repair...	0.72	15	0.30	15	1.02	14
15	G46	Wholesale trade, except of motor vehicles...	0.77	13	0.33	9	1.10	10
16	G47	Retail trade, except of motor vehicles...	0.78	12	0.33	10	1.10	9
17	H49-53	Land transport and transport via pipelines, ...	0.56	25	0.26	17	0.83	23
18	I	Accommodation and food service activities	0.63	20	0.30	14	0.94	16
19	J58-63	Publishing activities, motion picture, video...	0.58	23	0.21	27	0.79	26
20	K64	Financial service activities, except insurance...	0.08	40	0.04	39	0.12	40
21	K65	Insurance, reinsurance and pension funding...	0.55	27	0.15	34	0.70	34
22	K66	Activities auxiliary to financial services...	0.36	37	0.16	32	0.53	37
23	L68	Real estate activities	0.86	5	0.05	38	0.90	20
24	M69+70	Legal and accounting activities; ...	0.81	8	0.32	12	1.13	8
25	M71+M72	Architectural and engineering activities; ...	0.73	14	0.31	13	1.03	13
26	M73-75	Other professional, scientific and technical...	0.60	21	0.23	22	0.83	22
27	N77	Rental and leasing activities	0.53	29	0.18	31	0.71	32
28	N78	Employment activities	0.88	3	0.71	1	1.59	2
29	N79	Travel agency, tour operator...	0.57	24	0.23	21	0.81	24
30	N80-82	Security and investigation activities; ...	0.82	7	0.55	5	1.38	4
31	O84	Public administration and defence...	0.78	11	0.56	4	1.34	5
32	P85	Education	0.91	2	0.71	2	1.61	1
33	Q86	Human health activities	0.81	9	0.48	7	1.29	7
34	Q87_88	Social work activities	0.82	6	0.63	3	1.45	3
35	R90T92	Creative, arts and entertainment activities; ...	0.34	38	0.06	37	0.40	39
36	R93	Sports activities and amusement...	0.65	19	0.39	8	1.04	12
37	S94	Activities of membership organisations	0.80	10	0.54	6	1.34	6
38	S95	Repair of computers and personal...	0.68	18	0.24	20	0.91	19
39	S96	Other personal service activities	0.69	17	0.23	23	0.93	17
40	TU	Activities of households as employers; ...	0.99	1	0.00	40	0.99	15

Source: Authors' own calculations.

D Income Multipliers

No.	NACE code	Industry	Simple Income Multiplier		Induced Effects		Total Income Multiplier	
			Value	Rank	Value	Rank	Value	Rank
1	A01-02	Crop and animal production, hunting...	0.24	25	0.09	25	0.34	25
2	A03	Fishing and aquaculture	0.15	35	0.06	35	0.21	35
3	C10T12	Manufacture of food products, beverages...	0.25	24	0.10	24	0.35	24
4	C13T15	Manufacture of textiles, wearing apparel...	0.24	26	0.09	26	0.33	26
5	C16	Manufacture of wood and of products...	0.23	29	0.09	29	0.31	29
6	C17-22	Manufacture of paper and paper products, ...	0.23	28	0.09	28	0.32	28
7	C23	Manufacture of other non-metallic mineral...	0.30	16	0.12	16	0.42	16
8	C24	Manufacture of basic metals	0.21	30	0.08	30	0.28	30
9	C25	Manufacture of fabricated metal products, ...	0.29	18	0.11	18	0.40	18
10	C26-32	Manufacture of computer, electronic...	0.14	36	0.05	36	0.19	36
11	C33	Repair and installation of machinery...	0.36	11	0.14	11	0.49	11
12	D35-E39	Electricity, gas, steam and air conditioning...	0.18	33	0.07	33	0.25	33
13	B+F	Mining and quarrying and construction	0.28	19	0.11	19	0.39	19
14	G45	Wholesale and retail trade and repair...	0.33	15	0.13	15	0.46	15
15	G46	Wholesale trade, except of motor vehicles...	0.37	9	0.14	9	0.51	9
16	G47	Retail trade, except of motor vehicles...	0.36	10	0.14	10	0.50	10
17	H49-53	Land transport and transport via pipelines, ...	0.29	17	0.11	17	0.40	17
18	I	Accommodation and food service activities	0.34	14	0.13	14	0.47	14
19	J58-63	Publishing activities, motion picture, video...	0.23	27	0.09	27	0.32	27
20	K64	Financial service activities, except insurance...	0.04	39	0.02	39	0.06	39
21	K65	Insurance, reinsurance and pension funding...	0.17	34	0.06	34	0.23	34
22	K66	Activities auxiliary to financial services...	0.18	32	0.07	32	0.25	32
23	L68	Real estate activities	0.05	38	0.02	38	0.08	38
24	M69+70	Legal and accounting activities; ...	0.35	12	0.14	12	0.49	12
25	M71+M72	Architectural and engineering activities; ...	0.34	13	0.13	13	0.47	13
26	M73-75	Other professional, scientific and technical...	0.26	22	0.10	22	0.36	22
27	N77	Rental and leasing activities	0.20	31	0.08	31	0.28	31
28	N78	Employment activities	0.79	1	0.30	1	1.09	1
29	N79	Travel agency, tour operator...	0.26	21	0.10	21	0.36	21
30	N80-82	Security and investigation activities; ...	0.62	5	0.24	5	0.85	5
31	O84	Public administration and defence...	0.62	4	0.24	4	0.86	4
32	P85	Education	0.79	2	0.30	2	1.09	2
33	Q86	Human health activities	0.53	7	0.21	7	0.74	7
34	Q87-88	Social work activities	0.70	3	0.27	3	0.97	3
35	R90T92	Creative, arts and entertainment activities; ...	0.07	37	0.03	37	0.10	37
36	R93	Sports activities and amusement...	0.44	8	0.17	8	0.60	8
37	S94	Activities of membership organisations	0.60	6	0.23	6	0.83	6
38	S95	Repair of computers and personal...	0.26	20	0.10	20	0.37	20
39	S96	Other personal service activities	0.26	23	0.10	23	0.36	23
40	TU	Activities of households as employers; ...	0.00	40	0.00	40	0.00	40

Source: Authors' own calculations.

E Employment Multipliers

No.	NACE code	Industry	Simple Employment Multiplier		Induced Effects		Total Employment Multiplier	
			Value	Rank	Value	Rank	Value	Rank
1	A01-02	Crop and animal production, hunting...	14.34	24	5.68	25	20.02	24
2	A03	Fishing and aquaculture	7.74	34	3.50	35	11.24	34
3	C10T12	Manufacture of food products, beverages...	14.60	23	5.84	24	20.43	22
4	C13T15	Manufacture of textiles, wearing apparel...	13.35	26	5.51	26	18.86	28
5	C16	Manufacture of wood and of products...	15.97	19	5.25	29	21.21	20
6	C17-22	Manufacture of paper and paper products, ...	11.06	30	5.38	28	16.44	30
7	C23	Manufacture of other non-metallic mineral ...	19.37	13	7.04	16	26.41	13
8	C24	Manufacture of basic metals	14.98	21	4.79	30	19.77	25
9	C25	Manufacture of fabricated metal products, ...	19.30	14	6.71	18	26.01	15
10	C26-32	Manufacture of computer, electronic...	7.45	35	3.25	36	10.70	35
11	C33	Repair and installation of machinery...	15.13	20	8.29	11	23.42	18
12	D35-E39	Electricity, gas, steam and air conditioning ...	8.51	33	4.20	33	12.71	33
13	B+F	Mining and quarrying and construction	17.28	17	6.50	19	23.78	17
14	G45	Wholesale and retail trade and repair ...	21.27	11	7.67	15	28.93	11
15	G46	Wholesale trade, except of motor vehicles...	20.10	12	8.62	9	28.72	12
16	G47	Retail trade, except of motor vehicles...	26.04	8	8.44	10	34.48	9
17	H49-53	Land transport and transport via pipelines, ...	12.81	28	6.78	17	19.59	26
18	I	Accommodation and food service activities	24.75	9	7.87	14	32.62	10
19	J58-63	Publishing activities, motion picture, video...	9.97	31	5.45	27	15.42	31
20	K64	Financial service activities, except insurance...	1.73	39	1.04	39	2.77	39
21	K65	Insurance, reinsurance and pension funding...	5.79	36	3.88	34	9.67	36
22	K66	Activities auxiliary to financial services...	8.82	32	4.24	32	13.05	32
23	L68	Real estate activities	3.13	37	1.27	38	4.39	37
24	M69+70	Legal and accounting activities; ...	17.43	16	8.25	12	25.68	16
25	M71+M72	Architectural and engineering activities; ...	18.11	15	7.92	13	26.03	14
26	M73-75	Other professional, scientific and technical...	13.03	27	6.08	22	19.11	27
27	N77	Rental and leasing activities	12.35	29	4.72	31	17.07	29
28	N78	Employment activities	48.87	2	18.28	1	67.16	2
29	N79	Travel agency, tour operator...	14.66	22	6.08	21	20.74	21
30	N80-82	Security and investigation activities; ...	42.09	3	14.37	5	56.46	4
31	O84	Public administration and defence...	26.42	7	14.44	4	40.85	7
32	P85	Education	38.24	4	18.28	2	56.52	3
33	Q86	Human health activities	22.09	10	12.43	7	34.52	8
34	Q87-88	Social work activities	36.36	6	16.29	3	52.65	5
35	R90T92	Creative, arts and entertainment activities; ...	2.60	38	1.65	37	4.26	38
36	R93	Sports activities and amusement...	36.93	5	10.14	8	47.07	6
37	S94	Activities of membership organisations	95.69	1	13.94	6	109.63	1
38	S95	Repair of computers and personal...	14.00	25	6.17	20	20.17	23
39	S96	Other personal service activities	17.13	18	6.06	23	23.18	19
40	TU	Activities of households as employers; ...	0.03	40	0.02	40	0.04	40

Source: Authors' own calculations.