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Analysis of Input (Supply) Multipliers for the Maltese Economy on the Basis of the SIOTs for 2010 and 2015

Ian P. Cassar[1], & Adrian Theuma[2]

[1] Senior Lecturer, University of Malta, Malta

[2] Independent Researcher, Attard, Malta

Correspondence: Ian P. Cassar, Univeristy of Malta, Malta. E-mail: ian.p.cassar@um.edu.mt

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Abstract

The goal of this study is to present and assess estimates of input (supply) multipliers within the context of the Maltese economy to identify in which economic sectors it is the most beneficial to allocate primary resources with the aim to support economic growth. Via the application of the Ghoshian Supply-Driven Model, this study presents the first highly disaggregated input (supply) multiplier estimates for the Maltese economy based on the 2010 and 2015 Symmetric Input-Output Tables. This study also includes a comparative analysis between the years 2010 and 2015 to assess changes in the input (supply) multipliers ranking across economic sectors. Based on the 2015 Symmetric Input-Output Table, potential output is mostly increased following the additional allocation of primary inputs to the Manufacturing of other non-metallic mineral products sector following the highest input (supply) multiplier estimate, keeping all else constant. Furthermore, based on the 2010 Symmetric Input-Output Table, the Advertising and market research sector registered the highest input (supply) multiplier. The input (supply) multipliers are subject to the traditional input-output framework and the supply-side modelling assumptions. However, they do provide estimates on the potential change in economy-wide output following exogenous primary input shocks in every sector. In other words, the input (supply) multipliers provide policy makers a guide in which economic sector it is most beneficial to allocate primary inputs, such as labour supply, with the aim of supporting economic growth. The derived input (supply) multipliers may be utilised to aid in the formation of industry specific labour market policies with the aim of supporting overall economic expansion.

Keywords: input-output tables, input (Supply) multipliers, Ghoshian supply-driven model, primary inputs, economic growth, labour market

1. Introduction

The goal of this study is to put forward estimates which can help guide policy makers to identify in which Maltese economic sectors it is the most beneficial to allocate primary resources with the sole objective of supporting economic growth. This shall be achieved via the application of the Ghoshian Supply-Driven Model which will be utilised to estimate the input (supply) multipliers based on the Symmetric Input-Output Tables (SIOTs) for the reference years of 2010 and 2015. This is then followed by a comparative analysis of the estimates obtained from both SIOTs with the aim to identify and analyse any changes in the respective ranks of the sectoral input (supply) multipliers. The estimation of input (supply) multipliers provides policy makers with a measure that, utilised together with the conventional Leontief Demand-Driven measures, allows for a deeper level of understanding of the underlying inter-industry linkages of the Maltese economy to thus aid in the formulation of sector specific policies aimed at promoting and supporting economic growth.

Input (supply) multipliers indicate in which economic sector an additional monetary euro worth of primary inputs is the most beneficial in increasing potential economy-wide output. The factors that make up primary inputs are namely Gross Value Added (GVA), imports and net taxes on products[1]. The sub-components of GVA are namely compensation of employees[2], net operating turnover and net taxes on production[3]. Also, compensation of employees consists of wages

[1] Net taxes on products refers to taxes less subsidies on products.

[2] Compensation of Employees is defined as *"the total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the latter during the accounting period"* (ESA, 2010).

[3] Net taxes on production refers to taxes less subsidies on production.

and salaries, and social contributions by the employers (Eurostat Manual of Supply, Use and Input-Output Table, 2008). Therefore, the input (supply) multipliers can be utilised to assess the impact on economy-wide output following exogenous changes in labour supply for every sector, assuming that the other primary input factors remain fixed. Such multipliers can therefore provide a first cut estimate of the potential impact, on aggregate output production across the production structure of the economy, resulting from an additional input of labour supply within a specific sector. To estimate the input (supply) multipliers, two highly disaggregated Symmetric Input-Output Tables (SIOTs) for the years ending 2010 and 2015 published by the National Statistics Office (NSO) in 2016 and 2021, respectively, shall be utilised. Both SIOTs are disaggregated at 44 sectoral level and abide by the latest 2010 European System of National and Regional Accounting (ESA 2010) methodological framework. The ESA 2010 sets a common methodological framework between Member States (MS) on the construction of national accounts data.

The analysis put forward in this research is based on the Ghoshian Supply-Driven Model which was developed by Ghosh in his seminal study entitled "*Input-Output Approach in an Allocation System" published in* 1958 (Ghosh, 1958). The Ghosh Supply-Driven Model is also referred to as the Ghoshian Allocation System, which utilises as a foundation the input-output framework originally pioneered by Leontief (1951). According to Rose and Miernyk (1989), the Ghoshian Supply-Driven input-output model has two distinguishing features. The primary feature of the supply-side model is that there is the possibility to estimate potential output following exogenous shocks in primary inputs. Therefore, the exogenously determined value-added drives the Ghoshian Allocation Model and hence the term supply-driven model. The second distinguishing feature of the Ghosh supply-side model is that of utilising fixed output allocation coefficients (Rose and Miernyk, 1989). The Ghoshian model was heavily criticised over the years (Oosterhaven, 1989)[4], but was later conceptually justified in its' application if the supply-side model was to be interpreted as a price model (Dietzenbacher, 1997).[5] To this date only a handful of studies which have their methodological foundation in input-output analysis have been applied to the Maltese economy. These studies either focus their analysis on the production structure of the Maltese economy via multiplier analysis (Cassar 2015; Cassar and Rapa 2018) and hypothetical extraction analysis (Cassar 2013, Cassar 2017; Theuma 2020), or to assess the contribution and impact of the tourism sector within the Maltese economy (Briguglio, 1992; Blake et. al., 2003; Sinclair et. al., 2005; Cassar et. al., 2016; Sacco and Cassar 2019).

According to official publicly available data published by the NSO, the output of the Maltese economy grew, in level terms, by 93 per cent between the years 2011 and 2019. Furthermore, between the years 2018 and 2019, Malta's GDP grew by 8.2 per cent. During the same period, GVA also increased by around 9 per cent (NSO, 2021). From the 2015 SIOT, the two Maltese economic sectors with the largest output production are the financial services and gaming sectors, accounting to around 21 and 16 per cent of total production, respectively. The financial services sector exports around 90 per cent of its final demand abroad, while importing 97 per cent of its total output. Also, the gaming sector exports around 95 per cent of its final demand abroad, while importing around 76 per cent of its total output. Notwithstanding the considerable economic growth experienced in the Maltese economy, especially the expansion of the labour supply resulting from the increasing importation of foreign workers, greater female participation rates and increasing pension workers, Malta still faces the challenge of labour supply shortage (Malta Employers' Association, 2019). Although the supply shortage is experienced across many economic sectors of the Maltese economy, it is especially evident in the financial services (MFSA, 2015), gaming (MGA, 2018) and hospitality (Cefai, 2021) sectors. This way, the input (supply) multipliers can help researchers and policy makers to identify in which economic sector it is most beneficial to increase labour supply in terms of supporting higher economic growth.[6]

The Ghosh supply-side model within the context for the Maltese economy has been applied by Cassar (2017) to obtain forward linkage measures required for key sectoral analysis. Theuma (2018) presented the first set of input (supply) multiplier estimates based on the Maltese 2010 SIOT, however utilising a highly aggregated SIOT.[7] The application of the Ghosh supply-side model is much less prevalent in the literature than the Leontief model. Indeed, its most common

[4] One of the main criticisms by Oosterhaven (1988) was that an exogenous shock of primary inputs only in one sector would result in output changes across the rest of the economic sectors even if their primary inputs (excluding the sector in which the shock originates) remained unchanged.

[5] In this study, the effects on potential output shall be assessed following a simultaneous one monetary euro exogenous change in primary inputs across every sector rather than in terms of relative price changes following Davis and Salkin (1984) and Chen and Rose (1986).

[6] It is important to note that the input (supply) multipliers estimated are based on the 2010 and 2015 SIOTs. Therefore, results should be interpreted with caution especially after potential changes in the production structure of the Maltese economy, for example, during a pandemic.

[7] It should be noted that the study by Theuma (2018) refers to an unpublished undergraduate dissertation.

application is to be found within the context of linkage analysis (Dietzenbacher and Van der Linden, 1997; Andreosso-O'Callaghan, & Yue 2004; Cardenete Flores and Sancho Pifarré, 2006; Cassar, 2017). Other notable studies which apply this methodology include, for example, Miernyk et al., (1978) in which an assessment of the maximum potential effect for the U.S. economy's output following different primary input constraints, were undertaken. Davis and Salkin (1984) assess the effects on California's economy to identify the importance of water as an input (Davis and Salkin, 1984). A similar study was undertaken by Chen and Rose (1984) to identify the importance of bauxite as an input to the Taiwanese economy (Chen and Rose, 1984). Leung and Pooley (2001) subsequently present an indepth study comparing the input (supply) multipliers to Leontief demand driven based value-added multipliers. It should further be noted that a significant portion of the literature in which the Ghosh supply-side model is put forward focuses primarily on evaluating the model's underlying assumptions and its plausibility when applied to an economic system in the real world. (Oosterhaven 1989, 1996; Gruver 1989).

2. Data, Methodology and Assumptions

The data required to undertake the application of the Ghosh supply-side model may be directly obtained from an industry-by-industry SIOT. The inter-industry flows of an economy, at a point in time, are recorded and put forward, in monetary terms, across the various elements which make up the SIOT. The Ghoshian Supply-Driven Model is applied on two SIOTs for the reference years of 2010 and 2015 within the context of Malta. The two SIOTs for the years 2010 and 2015 are both disaggregated at a 44 sectoral level. The sectoral classification adopted within the SIOT corresponds to the latest revision of the European Activity (NACE Rev.2, 2008). The SIOTs provide a visualisation of the inputs utilised and output produced by each sector within the Maltese economy for the reference periods of 2010 and 2015. Therefore, the two SIOTs are disaggregated into '*n*' number of sectors representing the different economic sectors that undertake production activity within the Maltese economy.

The derivation of the Ghoshian Supply-Driven Model shall be presented next, and it follows the methodological structure presented in Miller and Blair (2009). It will thereafter be followed by a brief description of the assumptions put forward by the model. The first step towards deriving the input (supply) multipliers is to obtain the Ghoshian Allocation Matrix (**B**). Leontief in his dual models derived the technical coefficients matrix (**A**) that is required to derive the Leontief inverse via the division of the intermediate consumption matrix (**Z**) column with the output of every sector. However, Ghosh's method to derive the allocation matrix **B** which is required to derive the Ghoshian Inverse is via the division of every row element within matrix **Z** by the corresponding total output for each sector. Therefore, the computational difference between the two techniques is the "*rotation*" or "*transpose*" within the matrix of domestic inter-industry flows **Z** (Miller and Blair, 2009).

$$\boldsymbol{b_{i,j} = \frac{z_{i,j}}{x_i}} \qquad \boldsymbol{i, j \ = \ 1, \dots, n} \qquad \textbf{(1)}$$

The supply of sector i's output for every sector j that purchases the intermediate inputs from sector i is represented by $\boldsymbol{b_{i,j}}$. These elements are referred to as the sales or allocation coefficients (Dietzenbacher, 1997), as opposed to the Leontief technical coefficients (Miller and Blair, 2009). Therefore, the allocation matrix B is derived via the pre-multiplication of the output inverse matrix $\boldsymbol{\hat{x}^{-1}}$ with the intermediate consumption matrix **Z**, which is denoted in matrix algebra form as:

$$\boldsymbol{B = \hat{x}^{-1}.Z} \qquad \boldsymbol{B} = \begin{bmatrix} \boldsymbol{b_{1,1}} & \cdots & \boldsymbol{b_{1,n}} \\ \vdots & \ddots & \vdots \\ \boldsymbol{b_{n,1}} & \cdots & \boldsymbol{b_{n,n}} \end{bmatrix} \qquad \textbf{(2)}$$

Where **Z** denotes a square *(n x n)* dimensional matrix illustrating the domestic inter-industry transactions, $\boldsymbol{\hat{x}^{-1}}$ denotes the inverse of the square diagonal *(n x n)* dimensional matrix $\boldsymbol{\hat{x}}$ derived from the total production vector $\boldsymbol{x}$, and **B** denotes a square *(n x n)* dimensional matrix that illustrates the total production value created in a sector for each unit of primary input in the other sector (Augustinovics, 1970).

The following relationship may be established from the observation of a SIOT:

$$\boldsymbol{x_j = \sum_{i=1}^{n} Z_{i,j} + v_j} \qquad \boldsymbol{i, j = 1, \dots, n} \qquad \textbf{(3)}$$

Where output is a function of domestic inter-industry flows and primary inputs for every sector. Equation 3 may be re-written in matrix algebra notation as:

$$\boldsymbol{x' = i'Z + v'} \qquad \textbf{(4)}$$

Where $\boldsymbol{x}'$ denotes a *(1 x n)* dimensional row vector portraying total output as the summation totals of matrix **Z** and a row vector of primary inputs $\boldsymbol{v}'$. The balance equation of the Ghosh supply-side model is obtained by the substitution of equation 2 into equation 4 and solving, denoted as:

$$\boldsymbol{x}' = \boldsymbol{v}'(\boldsymbol{I} - \boldsymbol{B})^{-1} = \boldsymbol{v}'\boldsymbol{G} \qquad (5)$$

Where the solution to the Ghoshian Supply-Driven Model balance equation is denoted via the multiplication of a row vector of primary inputs $\boldsymbol{v}'$ with the output inverse matrix **G**.

$$\boldsymbol{G} = (\boldsymbol{I} - \boldsymbol{B})^{-1} \qquad \boldsymbol{G} = \begin{bmatrix} \boldsymbol{g_{1,1}} & \cdots & \boldsymbol{g_{1,n}} \\ \vdots & \ddots & \vdots \\ \boldsymbol{g_{n,1}} & \cdots & \boldsymbol{g_{n,n}} \end{bmatrix} \qquad (6)$$

The Ghosh output inverse matrix **G** takes the form of a square *(n x n)* dimensional matrix. The summation of the row elements within the **G** matrix provides estimates for the input (supply) multipliers for every economic sector shown in equation 7.

$$\sum_{j=1}^{n} \boldsymbol{g_{i,j}} = \boldsymbol{g_{i,1}} + \cdots + \boldsymbol{g_{i,n}} = {\boldsymbol{\partial x_1}}/{\boldsymbol{\partial v_i}} + \cdots + {\boldsymbol{\partial x_n}}/{\boldsymbol{\partial v_i}} \qquad (7)$$

The row summation operation of the Ghoshian output inverse matrix (**G**) for every economic sector provides the input (supply) multipliers in the form of a column vector of dimensions *(n x 1)*. The input (supply) multipliers provide a guide in which economic sector it is most advantageous for primary input resources to be allocated in terms of supporting the increase of potential output. In other words, the multiplier estimates provide a measure that captures the extent to which economy-wide output would change following an exogenous one monetary euro change in a factor of primary inputs of a specific sector. In this regard, this supply-side model is analogous to the Leontief simple output (production) multipliers where output is determined endogenously (Miller and Blair, 2009).

It should also be noted that the column summations of the Ghoshian inverse matrix **G** provide another interpretation. The column summations may be viewed as reflecting the impact on the output of a sector, following a change in primary inputs of another sector. In other words, the column sums within the output inverse matrix **G** represent the impact on output of sector *j* due to a one monetary euro exogenous change in primary inputs for each sector *i* as depicted in equation 8. Although this type of analysis is not explicitly undertaken in this paper[8] it is interesting to note that although there exists a strict theoretical duality between the Ghosh Supply-Driven model and the Leontief Demand-Driven model, the column sums of matrix **G** are found to essentially mirror the row sums of the Leontief Inverse Matrix (Miller and Blair, 2009).

$$\sum_{i=1}^{n} \boldsymbol{g_{i,j}} = \boldsymbol{g_{1,j}} + \cdots + \boldsymbol{g_{n,j}} = {\boldsymbol{\partial x_j}}/{\boldsymbol{\partial v_1}} + \cdots + {\boldsymbol{\partial x_j}}/{\boldsymbol{\partial v_n}} \qquad (8)$$

The Ghoshian Supply-Driven model follows the assumption that the distribution patterns of output supply is fixed. In contrast to the Leontief Demand-Driven model with fixed input coefficients, the Ghosh Supply-Driven model assumes fixed output coefficients. The proportion of output supplied and sold by sector *i* to each sector *j* is identical. This also invokes the assumption that the Ghoshian Supply-Driven Model follows a production function with perfectly substitutable inputs[9], meaning that no input is essential (Gruver, 1989).

Another assumption invoked by the Ghoshian Supply-Driven model is that resources within an economy are assumed to be infinite. Therefore, any exogenous change in a factor of primary inputs on total output can be estimated as long as the other factors that make up primary inputs remain unchanged. This implies that any level of potential output may be attained from the model since the modelling technique does not take into account the resource limitations of the economy under study. Therefore, the input (supply) multiplier estimates should be utilised with caution. However, they

[8] The column sums of the Ghoshian output inverse matrix are readily available because matrix **G** was required to estimate the input (supply) multiplier estimated. Therefore, the sectoral column sums of the output inverse matrix are available within Appendix C of this paper.

[9] This is an extreme case opposite to the Leontief production function, which implies perfect complementary inputs. With perfectly substitutable inputs, goods and services are perfectly interchangeable. On the other hand, with perfectly complementary inputs, goods and services and consumed together.

do provide first cut estimates to assess the change in the potential economy-wide output following exogenous primary input shocks in every economic sector.

3. Results

The input (supply) multipliers capture the resultant impact on economy-wide output following a one monetary euro exogenous shock in primary inputs for every economic sector. Therefore, the input (supply) multiplier estimates are of great importance for policy makers because they indicate in which economic sectors it is most beneficial for primary inputs to be allocated in terms of supporting economic growth. Similarly, the input (supply) multipliers can also be utilised to assess the consequent effects on total output following adverse shocks on primary inputs.

Table 1 provides the ranking of the input (supply) multiplier estimates for the years ending 2010 and 2015. In Table 1, the top ten sectors are ranked based on the highest input (supply) multipliers for the year ending 2015. The description of each economic sector is found within Appendix A, which follows the NACE Rev.2 (2008) classification. The input (supply) multipliers and their rankings have been estimated for all economic sectors within the context of the Maltese economy, which are collectively found within Appendix B. The estimates from Table 1 were calculated following equation 7 in the methodology chapter via the row summation of the Ghoshian output inverse matrix $(\mathbf{G})$ for every sector. Furthermore, the derivation of the Ghoshian output inverse matrix $(\mathbf{G})$ was possible following the solution of the Ghoshian Supply-Driven Model balance equation in equation 5 that is presented within the methodology chapter.

From Table 1, for the year ending 2015, the top-ranking sector with the highest input (supply) multiplier of 2.62 euro is the Manufacture of other non-metallic mineral products (8) sector, followed by the Electricity (13) sector amounting to 2.61 euro. Therefore, based on the 2015 SIOT, a one monetary euro increase in the availability of primary inputs towards the Manufacture of other non-metallic mineral products (8) and the Electricity (13) sectors would lead to an increase in economy-wide output of 2.62 and 2.61 euro respectively. Similarly, from Appendix B and for the year ending 2010, the top-ranking sector with the highest input (supply) multiplier of 2.56 euro is the Advertising and market research (28) sector, followed by the Electricity (13) sector amounting to 2.52 euro. Therefore, based on the 2010 SIOT, a one monetary euro increase in the availability of primary inputs towards the Advertising and market research (28) and Electricity (13) sectors would lead to an increase in economy-wide output of 2.56 and 2.52 euro respectively.

Table 1. Top 10 Ranking Input (Supply) Multipliers

Sector Number	Sector Name	2010 Input (Supply) Multipliers	Rank	2015 Input (Supply) Multipliers	Rank
8	Manufacture of other non-metallic mineral products	2.23	4	2.62	1
13	Electricity, gas, steam and air conditioning supply, water collection, treatment and supply, sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	2.52	2	2.61	2
10	Manufacture of fabricated metal products, except machinery and equipment	2.08	6	2.43	3
31	Employment activities	2.10	5	2.39	4
6	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1.82	9	2.11	5
27	Architectural and engineering activities; technical testing and analysis	1.69	12	2.10	6
33	Security and Investigation Activities	1.94	7	1.92	7
16	Wholesale trade, except of motor vehicles and motorcycles	1.71	11	1.89	8
32	Travel agency, tour operator reservation service and related activities	1.33	23	1.89	9
26	Legal and accounting activities; activities of head offices; management consultancy activities	1.34	22	1.79	10

Source: Author's own calculations

The input (supply) multipliers are also justified to assess the impact on economy-wide output following adverse exogenous shocks in a factor of primary inputs. From Table 1 and for the year ending 2015, one monetary euro less availability of primary inputs to the Manufacture of other non-metallic mineral products (8) sector would result in economy-wide output to decline by 2.62 euro. Similarly, for the year ending 2010, one monetary euro less availability of primary inputs to the Advertising and market research (28) sector would result in economy-wide output to decline by 2.23 euro. The reduction in the total output originates from the fewer primary inputs available for output production in the sector in which the shock originates, which in turn supplies its output to other economic sectors in the form of inputs required for their production processes to produce output. In this case, based on the 2015 SIOT, the less availability of primary inputs, for example labour, in the production process of the Manufacture of other non-metallic mineral products (8) sector would lead to a reduction in the output of the sector itself and in turn the output of the other economic sectors that depend on Manufacture of other non-metallic mineral products (8) sector.

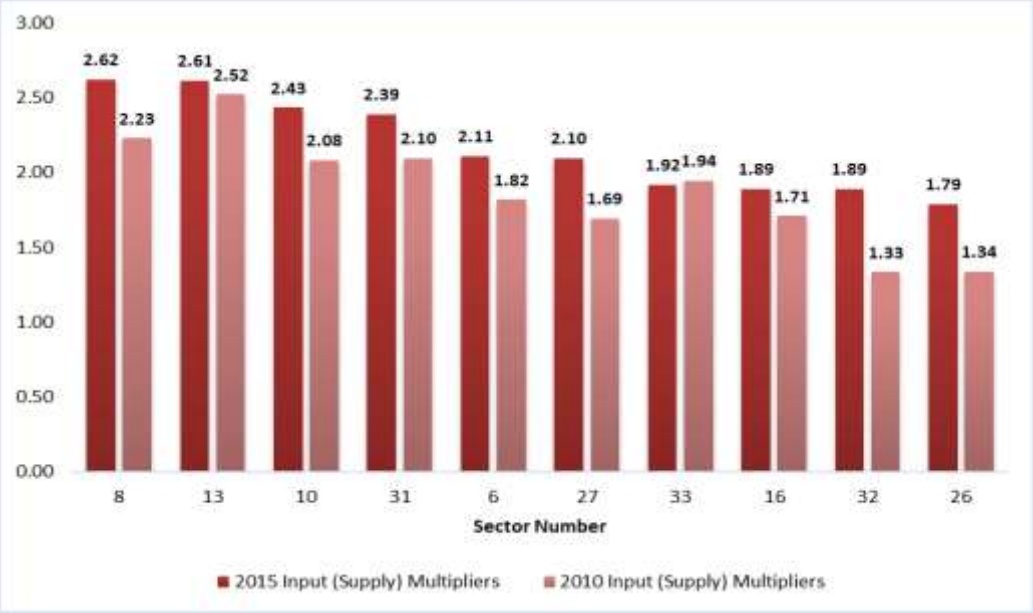

Figure 1. Top 10 Input (Supply) Multipliers for the year ending 2010 and 2015

Source: Author's own calculations.

From Appendix B, for the years ending 2010 and 2015, the three domestic economic sectors with the least input (supply) multipliers are the (i) Households activities as employers (43), (ii) Imputed rents of owner-occupied dwellings (25) and (iii) Activities of extra-territorial organisations and bodies (44), respectively. For the year ending 2010, had the availability of primary inputs of any of these sectors increased by one monetary euro, total output would only increase by a unitary amount since their input (supply) multiplier estimates amount to one euro, respectively. However, for the year ending 2015, the input (supply) multiplier for the Households activities as employers (43) sector slightly increased to 1.01 euro. Therefore, although the same unitary effect on total output occurs following a one monetary euro increase in primary inputs of sectors 25 and 44, sector 43 slightly increases the overall economy-wide output. However, the increase is negligible and would not maximise the increase in potential output had the same primary inputs been allocated to the top-ranking sectors, keeping all else constant.

From Appendix B, noticeable differences in the ranking of the input (supply) multipliers for the years ending 2010 and 2015 were observed across all Maltese economic sectors. From Table 1, when focusing the comparison of the input (supply) multipliers for the top ten highest ranking sectors based on the 2010 and 2015 SIOTs, the Electricity (13) sector was the only domestic sector that managed to maintain the same ranking. The highest input (supply) multiplier for the year ending 2010 is attributed to the Advertising and market research (28) sector, which according to the 2010 SIOT, only 4 per cent of its output takes the form of imports. However, from Appendix B and for the year ending 2015, in terms of input (supply) multiplier, the same sector ranked 26, with 46 per cent of its total output attributed to imports.

In the SIOTs for the years 2010 and 2015, the sector with the highest share of imports is the financial services (21) sector. Based on the 2010 SIOT, the financial services (21) sector accounted to around 90 per cent of its total output as imports. Similarly, based on the 2015 SIOT, the financial services (21) sector accounts to around 87 per cent of its total output as imports. The high import content stems from the inclusion of Special Purpose Entities (SPEs) within the NACE sectoral classification as directed under the latest NACE REV.2 (2008) during the construction of the SIOTs. From Appendix B, it can also be observed that the input (supply) multipliers of the financial services (21) sector for the years ending 2010 and 2015 exhibit low multiplier magnitudes relative to the other domestic economic sectors, amounting to 1.18 and 1.13 euro respectively.

4. Conclusion and Discussion

The input (supply) multiplier estimates capture the extent to which the allocation of an extra monetary euro worth of primary inputs to an economic sector would increase overall potential output throughout the entire economy in terms of supporting economic growth. Therefore, this measure can be utilised to assess the potential increase on economy-wide output following one monetary euro exogenous shock in a factor of primary inputs. In the context of a the domestic

SIOTs employed for this study, primary inputs pertain to all the components of GVA together with the imports of goods and services component.

The multipliers derived in this paper can be of use for policymakers for the formulation of sector specific labour market policy formation as they illustrate how a potential change in sectoral labour supply, which is captured via compensation of employees (a sub-component of GVA) could influence production activities not only in that sector, but across all sectors in the economy. In other words, the input (supply) multipliers may indicate in which economic sector, operating within the Maltese economy, it would be most advantageous to increase the labour supply with the aim of supporting higher economic growth. The relevance of the results presented in this paper for policy makers should be evaluated within the context of the significant labour supply shortage present within various sectors of the Maltese economy. This notwithstanding the negative impact that the COVID-19 pandemic has had on the economy (NPB, 2020). The Malta Employers' Association wage inflation survey carried out in 2019 concluded that more than half of the Maltese companies surveyed employ foreign workers. Increasing female participation rates and pension workers also contributed to the rise in the labour force. Maltese-based companies face strong competition to meet their required personnel demand (Vistage, 2021). Amongst others, the Malta Financial Services Authority (MFSA, 2015) and the Malta Gaming Authority (MGA, 2018) had already presented publications on the challenges faced by the skills gap to meet labour demand. Therefore, Maltese-based companies recruit foreign workers to fill in the excess labour demand, leading to the influx of foreign nationals (The Malta Chamber, 2018). The hospitality sector also faces the challenge of skills shortage, reinforced with the lack of foreign workers available locally due to the pandemic (Cefai, 2021). The influx of foreign workers and increased female participation in the labour force drives upwards the supply of labour which in turn positively shocks total output. The input (supply) multipliers could thus be utilised by policy makers to indicate in which sector it is most beneficial to allocate primary resources, such as labour supply, with the aim of supporting economic expansion. Furthermore, it should be noted that, all else equal, in a situation where labour supply does not keep up with increased labour demand, market pressures would also lead to an upward pressure on wage inflation. The resulting effects of excess labour demand could be assessed via the Leontief Cost-Push Price Model, where the consequence of increasing wage costs reflect in higher prices across all Maltese economic sectors because of their interlinkages (Theuma, 2018).

From Table 1 and based on the 2015 SIOT, the increase in potential output is maximised following the allocation of primary inputs to the Manufacture of other non-metallic mineral products (8) sector. The moment that labour supply lags behind labour demand, market pressures would drive wages upwards that in turns leads to price increases across all Maltese economic sectors, keeping all else constant.

From Table 1 in the results chapter, for the year ending 2015, the highest input (supply) multiplier was attributed to the Manufacture of other non-metallic mineral products (8) sector. In other words, every additional one monetary euro worth of primary inputs allocated to the Manufacture of other non-metallic mineral products (8) sector would significantly increase potential output based on the 2015 SIOT. Similarly, from Appendix B and for the year ending 2010, the highest input (supply) multiplier was attributed to the Advertising and market research (28) sector. Therefore, every additional one monetary euro worth of primary inputs allocated to the Advertising and market research (28) sector would significantly increase potential output based on the 2010 SIOT. These results are based on the reference year in which the SIOTs were constructed, including the assumptions imposed by the standard input-output framework and the supply-side model, keeping all other things constant.

From Appendix B, findings present that the overall ranking of the input (supply) multipliers between the reference years of 2010 and 2015 changed. In fact, Figure 1 shows different rankings of the top ten sectors with the highest input (supply) multiplier estimates, excluding the Electricity (13) sector, which ranked second across both SIOTs for the year ending 2010 and 2015. Following the analogous feature between the input (supply) multipliers and Leontief output (production) multipliers, the magnitude of the input (supply) multipliers also depend on the share of leakages in relation to the amount of inputs utilised during the production of output by every sector. From Appendix B, sectors with high import content such as the Financial services (21) sector experienced low multiplier effects on potential output.

The application of the Ghosh Supply-Driven Model to estimate the input (supply) multipliers is subject to several robust assumptions, presented in detail within the methodology chapter. The input (supply) multiplier estimates should be interpreted with caution following the robust assumptions implied by the input-output modelling framework and the supply-side model. However, the input (supply) multipliers estimated in this study provide a first cut estimate in which economic sector it is most optimal to make primary resources available to support economic growth in the Maltese economy.

A research avenue which would enable significantly further insights on the impact of a further availability of primary inputs on the production process is the formulation of a computable generable equilibrium (CGE) model (Sue Wing, 2004; Boeters and Savard, 2011) within the context of the Maltese economy which could for example be utilised to

assess the effects on the labour market following different scenarios of policy implementation. For instance, this would potentially allow for a more in-depth study on the effects on wages and unemployment. Furthermore, depending on the specification of the CGE model, assuming it allows for the disaggregation of the households institution, it could be possible to study the effects on the labour market of different policy scenarios across the different household groups and thus assess also the sector specific impact of such policies on household income distribution.

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Appendix A

44-Industry Classification According to NACE Rev.2.

Sector Number	Sector Name	Nace Rev.2
1	Crop and animal production, hunting and related service activities	A01
2	Forestry and logging	A02
3	Fishing and aquaculture	A03
4	Manufacture of food products, beverages and tobacco products	C10T12
5	Manufacture of textiles, wearing apparel and leather products	C13T15
6	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	C16
7	Manufacture of paper and paper products, printing and reproduction of recorded media, manufacture of coke and refined petroleum products, chemical products, basic pharmaceutical products and pharmaceutical preparations and rubber and plastic products	C17-22
8	Manufacture of other non-metallic mineral products	C23
9	Manufacture of basic metals	C24
10	Manufacture of fabricated metal products, except machinery and equipment	C25
11	Manufacture of computer, electronic and optical products, electrical equipment, machinery and equipment n.e.c., motor vehicles, trailers and semi-trailers, Other transport equipment and of furniture; other manufacturing	C26-32
12	Repair and installation of machinery and equipment	C33
13	Electricity, gas, steam and air conditioning supply, water collection, treatment and supply, sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	D35-E39
14	Mining and quarrying and construction	B+F
15	Wholesale and retail trade and repair of motor vehicles and motorcycles	G45
16	Wholesale trade, except of motor vehicles and motorcycles	G46
17	Retail trade, except of motor vehicles and motorcycles	G47
18	Land transport and transport via pipelines, water transport, air transport, warehousing and support activities for transportation and postal and courier activities	H49-53
19	Accommodation and food service activities	I
20	Publishing activities, motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activitiesTelecommunications, computer programming, consultancy and related activities; and information service activities	J58-63
21	Financial service activities, except insurance and pension funding	K64
22	Insurance, reinsurance and pension funding, except compulsory social security	K65
23	Activities auxiliary to financial services and insurance activities	K66
24	Real estate activities excluding imputed rents	L68B
25	Imputed rents of owner-occupied dwellings	L68A
26	Legal and accounting activities; activities of head offices; management consultancy activities	M69+70
27	Architectural and engineering activities; technical testing and analysis	M71+M72
28	Advertising and market research	M73
29	Other professional, scientific and technical activities; veterinary activities	M74_75
30	Rental and leasing activities	N77
31	Employment activities	N78
32	Travel agency, tour operator reservation service and related activities	N79
33	Security and Investigation Activities	N80-82
34	Public administration and defence; compulsory social security	O84
35	Education	P85
36	Human health activities	Q86
37	Social work activities	Q87_88
38	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	R90T92
39	Sports activities and amusement and recreation activities	R93
40	Activities of membership organisations	S94
41	Repair of computers and personal and household goods	S95
42	Other personal service activities	S96
43	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	T
44	Activities of extra-territorial organisations and bodies	U

Appendix B

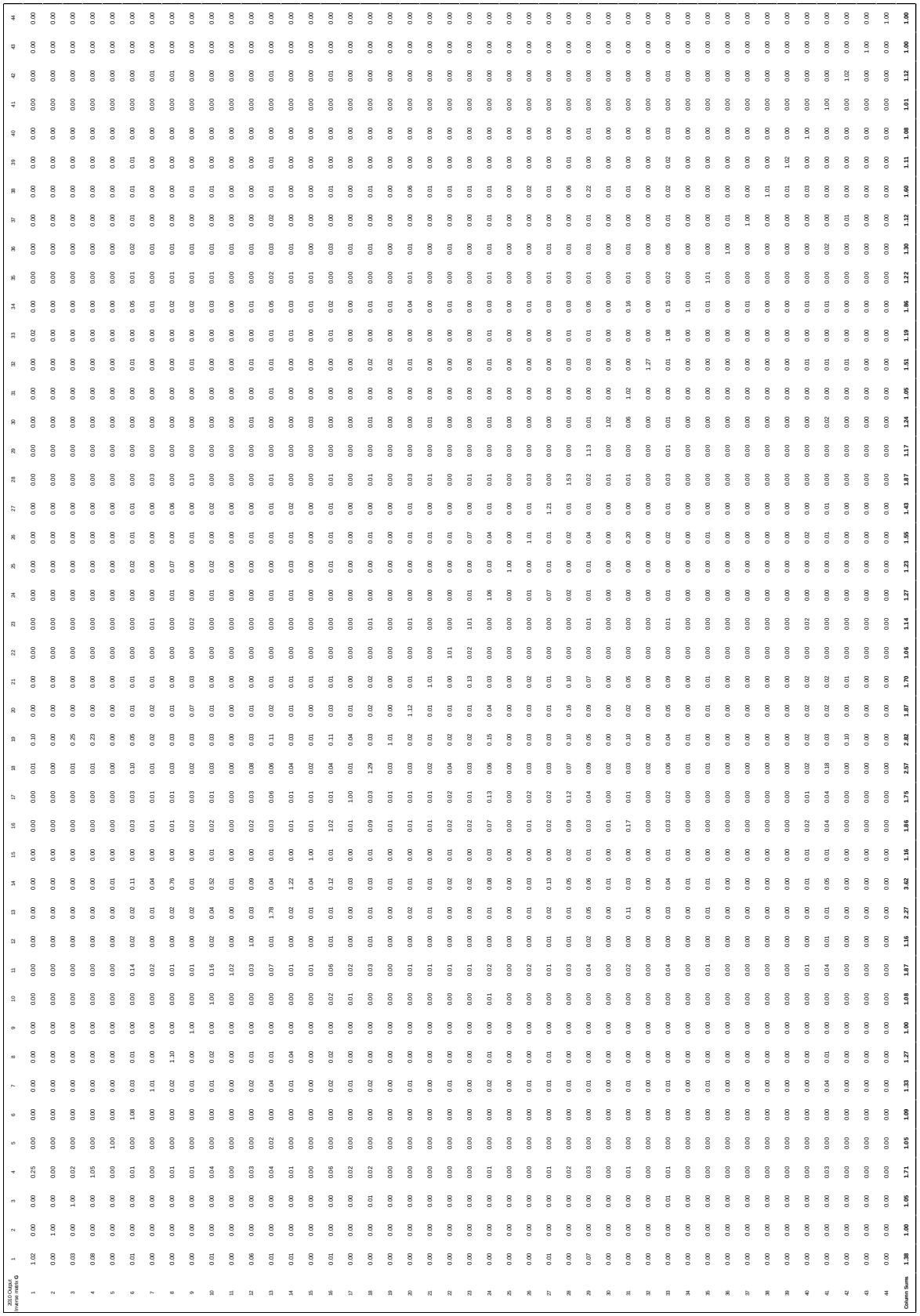
Input (Supply) Multiplier Rankings for the reference years of 2010 and 2015

Sector Number	Sector Name	2010 Input (Supply) Multipliers	Rank	2015 Input (Supply) Multipliers	Rank
1	Crop and animal production, hunting and related service activities	1.42	18	1.70	16
2	Forestry and logging	1.00	41	1.62	19
3	Fishing and aquaculture	1.34	21	1.09	36
4	Manufacture of food products, beverages and tobacco products	1.42	19	1.53	22
5	Manufacture of textiles, wearing apparel and leather products	1.05	36	1.28	28
6	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1.82	9	2.11	5
7	Manufacture of paper and paper products, printing and reproduction of recorded media, manufacture of coke and refined petroleum products, chemical products, basic pharmaceutical products and pharmaceutical preparations and rubber and plastic products	1.28	24	1.46	23
8	Manufacture of other non-metallic mineral products	2.23	4	2.62	1
9	Manufacture of basic metals	1.47	17	1.72	15
10	Manufacture of fabricated metal products, except machinery and equipment	2.08	6	2.43	3
11	Manufacture of computer, electronic and optical products, electrical equipment, machinery and equipment n.e.c., motor vehicles, trailers and semi-trailers, Other transport equipment and of furniture; other manufacturing	1.06	35	1.10	34
12	Repair and installation of machinery and equipment	1.52	15	1.67	17
13	Electricity, gas, steam and air conditioning supply, water collection, treatment and supply, sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	2.52	2	2.61	2
14	Mining and quarrying and construction	1.56	14	1.76	13
15	Wholesale and retail trade and repair of motor vehicles and motorcycles	1.21	28	1.22	30
16	Wholesale trade, except of motor vehicles and motorcycles	1.71	11	1.89	8
17	Retail trade, except of motor vehicles and motorcycles	1.21	27	1.02	39
18	Land transport and transport via pipelines, water transport, air transport, warehousing and support activities for transportation and postal and courier activities	1.73	10	1.60	21
19	Accommodation and food service activities	1.13	33	1.16	31
20	Publishing activities, motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activitiesTelecommunications, computer programming, consultancy and related activities; and information service activities	1.47	16	1.78	11
21	Financial service activities, except insurance and pension funding	1.18	29	1.13	33
22	Insurance, reinsurance and pension funding, except compulsory social security	1.25	26	1.14	32
23	Activities auxiliary to financial services and insurance activities	1.42	20	1.61	20
24	Real estate activities excluding imputed rents	1.92	8	1.78	12
25	Imputed rents of owner-occupied dwellings	1.00	41	1.00	43
26	Legal and accounting activities; activities of head offices; management consultancy activities	1.34	22	1.79	10
27	Architectural and engineering activities; technical testing and analysis	1.69	12	2.10	6
28	Advertising and market research	2.56	1	1.29	26
29	Other professional, scientific and technical activities; veterinary activities	2.27	3	1.72	14
30	Rental and leasing activities	1.13	31	1.36	25
31	Employment activities	2.10	5	2.39	4
32	Travel agency, tour operator reservation service and related activities	1.33	23	1.89	9
33	Security and Investigation Activities	1.94	7	1.92	7
34	Public administration and defence; compulsory social security	1.07	34	1.10	35
35	Education	1.13	32	1.06	37
36	Human health activities	1.02	38	1.02	41
37	Social work activities	1.02	39	1.03	38
38	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	1.01	40	1.02	40
39	Sports activities and amusement and recreation activities	1.03	37	1.28	27
40	Activities of membership organisations	1.26	25	1.37	24
41	Repair of computers and personal and household goods	1.63	13	1.65	18
42	Other personal service activities	1.18	30	1.23	29
43	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	1.00	41	1.01	42
44	Activities of extra-territorial organisations and bodies	1.00	41	1.00	43

Source: Author's own calculations

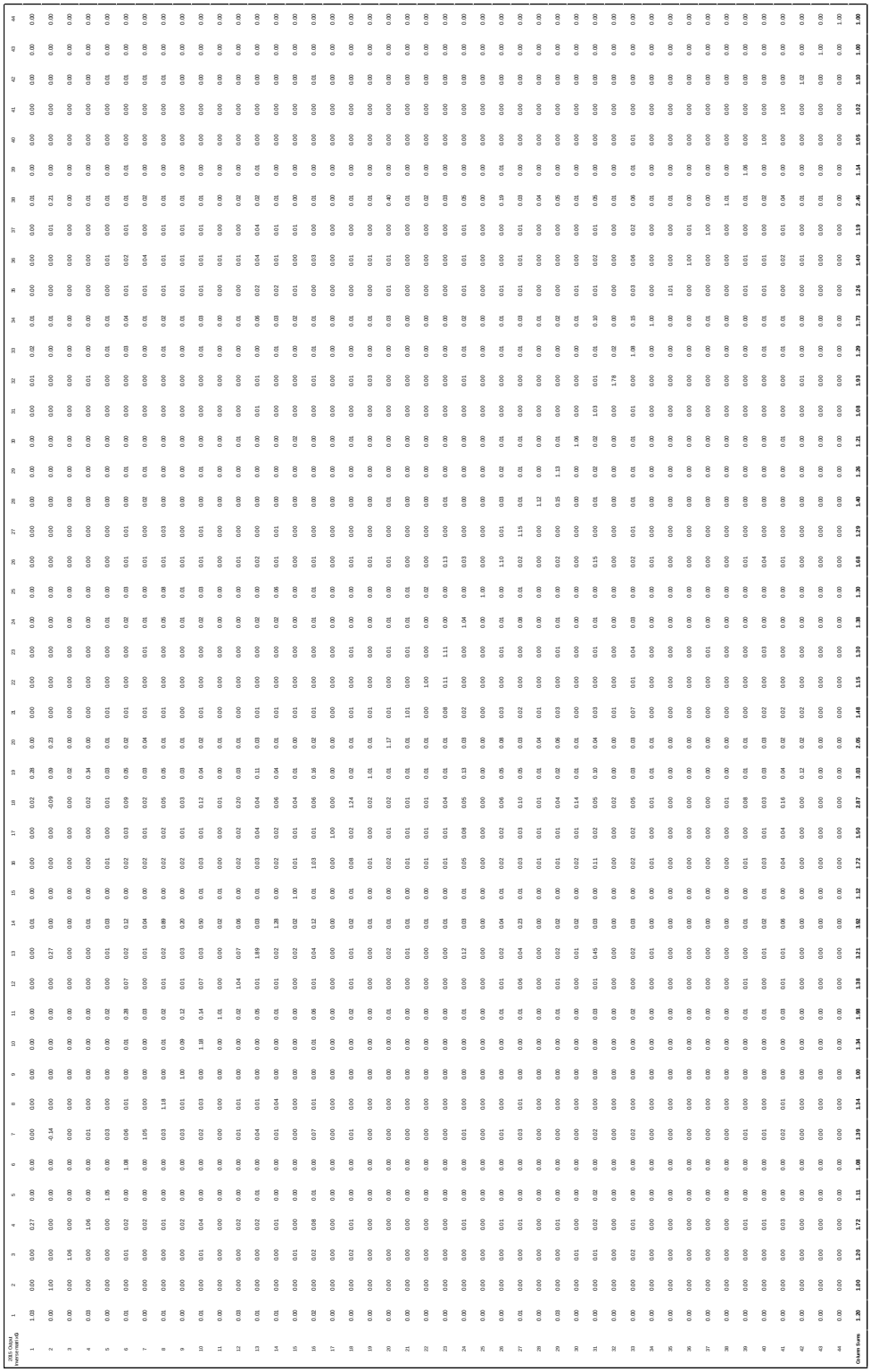
Appendix C

Column Summations of the Ghoshian Output Inverse Matrix for 2010



Source: Author's own calculations**Appendix D**

Column Summations of the Ghoshian Output Inverse Matrix for 2015



Source: Author's own calculationsCopyrights

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