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The London input-output tables

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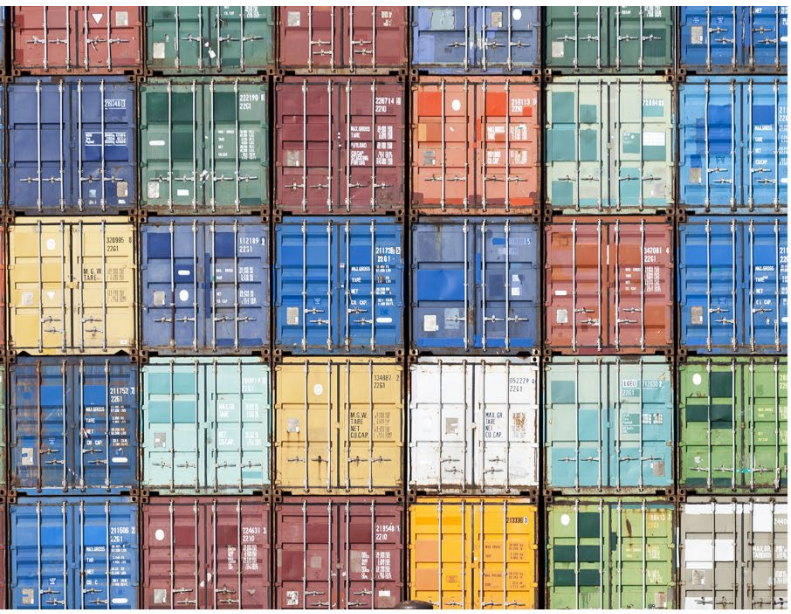

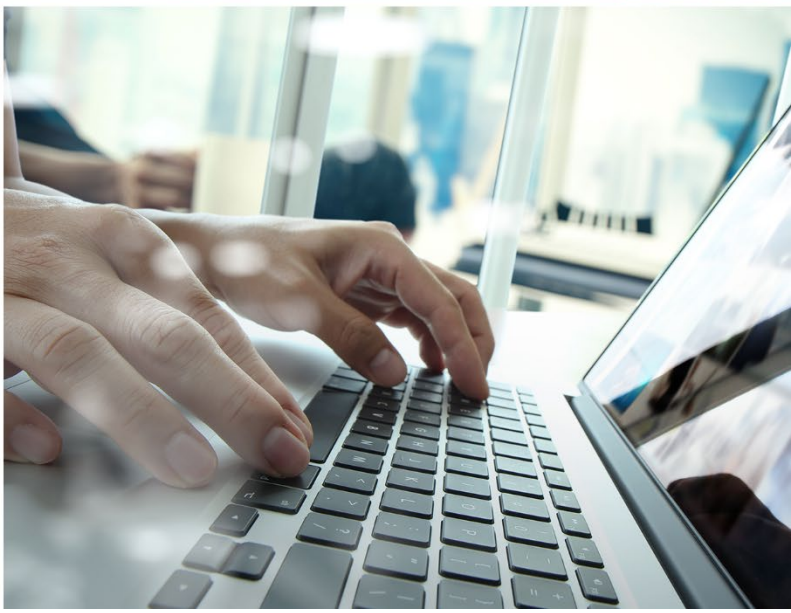

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Executive summary

1. Introduction

GLA Economics has developed for the first time a set of input-output (IO) tables for London in order to provide basic economic accounts for London and insights on the distribution of economic activity in the capital.

Specifically, IO tables provide an overview of activity across sectors and key aggregates (production, consumption and expenditure) as well as the interlinkages between sectors and London's trade (with the rest of the UK, the EU and the rest of the world).

While IO tables are insightful tools in themselves, they can also enable the development of more complex or complementary models. For example, they could be used in developing computable general equilibrium models for economic policy analysis, environmental IO models for environmental policy analysis or more complex/disaggregated models of international trade for trade policy analysis.

This Executive summary provides some essential background on IO analysis and on the critical assumptions required to develop the London tables before setting out the main conclusions of the analysis and some of the key findings in more detail. Finally, it includes a section on next steps. The fuller report provides much more detail on IO background and on the methodology for developing the London IO tables.

As this is the first time that GLA Economics has published IO tables for London, and there is significant uncertainty around the estimates, the results are **experimental**[1]. The tables are available on the London Datastore (all figures are for 2013)[2].

2. Background

IO analysis is the name given to an analytical framework developed by Wassily Leontief in the 1930s. The purpose of the framework is to analyse the interdependencies throughout an economy. It models the activity of a group of sectors in terms of: their production and consumption; what they buy and sell to each other; what they sell to others such as consumers, or government; and, inputs to the production process, namely labour and capital. There are official tables for the UK[3] and Scotland[4].

The development of the London IO tables uses a methodology which primarily translates the UK tables, produced by the Office for National Statistics (ONS) to London. This is complemented by published data for London where available.

IO tables are intensive in the use of data, and their construction relies on a number of methodological choices, and assumptions where data is not available. Specifically, for London, these choices are for the method to estimate interdependencies in production and consumption

[1] ONS describes experimental statistics as in the testing phase, and not yet fully developed, see Guide to Experimental Statistics - Office for National Statistics
[2] See https://data.london.gov.uk/dataset/london-input-output-tables
[3] There are tables for 1984, 1990, 1995, 2000, 2005, 2010, 2013 and 2014. See UK input-output analytical tables - Office for National Statistics. The London tables derive from the UK tables, and use the 2013 UK tables as these were the most recent available at the time work on the London tables began
[4] There are tables for 1998-2015. See Input-Output Tables and Multipliers for Scotland

between sectors, and the modelling of imports, and goods exports. They are presented and discussed more fully in the main paper.

3. Conclusions

London has an economy which is nearly a quarter of the size of the UK economy, with GVA of £355bn in 2013. The development of IO tables provides insight on the structure of the economy. This first iteration provides insight on the structure of economic accounts, interlinkages within the economy, and trade. Key insights are:

- Export-oriented sectors account for much of London's output. These sectors, and others which enable the movement of people and goods, support a trade surplus with the EU and the rest of the world.

- Exports from London to the rest of the UK are a quarter higher than to the rest of the world, and London is in trade balance with the rest of the UK.

- Using accounting identities it is possible for the first time, in the absence of published sources, to estimate, imports to London from within the UK, and elsewhere. It indicates that while London has a trade surplus with the rest of the world outside the UK there is a small deficit with the rest of the UK.

Incomplete imports data means that it is not possible with the approach adopted in this paper to produce IO tables for the rest of the UK to provide a more granular comparison of the economies for London and the rest of the UK. It is also not possible to produce IO tables which might support more advanced analyses of supply chains, or environmental accounts, to estimate, for example, the carbon content of imports.

4. Key findings

London had Gross Value Added (GVA) of £355bn in 2013, 23% of the UK total of £1,552bn[5]. The London economy mirrors the UK in terms of the contribution of components of income, expenditure and production to output, although its share of the supply and use of resources for these purposes is slightly higher.

London has a different sectoral composition of output to the rest of the UK.

Four sectors account for half of London's output:

- Information, communication, arts, entertainment and recreation
- Financial and insurance activities
- Real estate, architecture, engineering and building services
- High value business support.

Manufacturing accounts for 10% of UK GVA, compared with 2% of London GVA.

[5] This uses the balanced measure of GVA, see Regional economic activity by gross value added (balanced), UK - Office for National Statistics

Three of the sectors where London specialises are export-oriented, while trade is also important to sectors associated with the movement of people and goods.

Among London's highest exporting sectors are sectors in which it specialises:

- Financial and insurance activities, £51bn of exports in 2013
- Information, communications, arts, entertainment and recreation, £35bn
- High value business support, £20bn

Other sectors which have significant exports have an association with connections beyond London:

- Wholesale, £30bn of exports in 2013
- Accommodation, food, travel and tourism, £28bn
- Transport and storage, £22bn

These are the sectors which have the strongest export orientation, as measured as a ratio of London GVA, and as a share of UK exports. Additionally, Manufacturing in London also has a significant export orientation, although it is a comparatively small share of total UK exports.

There are clear differences in the sector distribution of exports for London and the rest of the UK.

For the rest of the UK the sectors with the strongest export orientation (as a ratio of GVA) are:

- Manufacturing
- Financial and insurance activities

Interestingly, and unlike London, for the rest of the UK, Finance is more important for intermediate demand than final demand.

Trade is more important to the London economy than the rest of the UK (as a ratio of GVA). While trade within the UK is more important, London's export orientation with the rest of the world is slightly stronger than for the rest of the UK.

London's exports are 81% of its GVA, and the exports from the rest of the UK are 46% of its GVA.

London's exports to the rest of the world are 36% of its GVA, and the rest of the UK's exports to the rest of the world are 33% of its GVA.

London has a small trade deficit with the rest of the UK, and a trade surplus with the rest of the world. This surplus is insufficient to offset the trade deficit of the rest of the UK with the rest of the world.

London trades more with the rest of the UK than it does with the rest of the world. Exports to the rest of the UK were £158bn, compared to £126bn to the rest of the world, of which £67bn is with the EU.

London's trade is slightly in deficit with the rest of the UK by £2bn, but in surplus with the rest of the world to the value of £60bn, of which there is a surplus with the EU of £35bn.

The rest of the UK has a surplus with London of £2bn, and a trade deficit with the rest of the world of £99bn, of which £89bn is with the EU.

The UK as a whole has a trade deficit of £39bn; specifically, it has a trade surplus with the Rest of the world (excluding the EU) of £14bn and a trade deficit with the EU of £54bn.

5. Next steps

The tables are on the London Datastore[6], and so are available for analysis, and development, such as in producing a Computable General Equilibrium model to model the impacts on the London economy of changes.

A significant next step to support the development of sub-national IO tables for the UK would be improved modelling of inter-regional trade flows. Ultimately, it would be positive if the ONS produced sub-national IO tables for the UK as this would allow comparison between the structure of the London economy, and those for other parts of the UK.

If it was possible to link a London IO table into a global database then it would be possible to do more complex analysis, such as to estimate London's role in global value chains, or produce environmental accounts, such as the household carbon consumption of imports.

[6] See https://data.london.gov.uk/dataset/london-input-output-tables

1 Introduction

GLA Economics has developed IO tables to provide basic economic accounts for London, and insight on the distribution of economic activity by production, income, and expenditure. They allow estimation of the size of the interlinkages between sectors in the London economy in the supply and use of resources.

GLA Economics has published a number of studies of the London economy[7]. This has provided basic statistics such as output, as measured by Gross Value Added (GVA), jobs, and productivity. It has reported that there is a concentration of activity in central areas of London, and attributed this to clustering of sectors to achieve agglomeration economies, and that there is specialisation in export-oriented sectors. Less attention has been given to the use of resources in London.

IO tables are a well-established tool to study an economy, and the use of resources within it. The framework incorporates the four basic economic activities of an open economy like London:

- **Production**: which involves sectors producing goods and services
- **Consumption**: which represents purchases of goods and services by both sectors of the economy and domestic final users comprising mainly households and central and local government
- **Accumulation**: which involves all capital transactions including fixed investment expenditure and changes in the stock of assets and goods
- **Trade**: which involves imports from, and exports to, the rest of the UK, the European Union, and the rest of the world

The tables are a highly complex piece of analysis involving multiple data sources and calculations within a single conceptual framework. To ensure the robustness of the analysis ONS-published data for London has been used where available. Further, the calculations have been completed so that the accounting identities around the measures of economic output (GVA), and supply and use of resources hold, as reported in Chapter 3.

The analysis is reasonable as it follows one of the methodologies in the academic literature. This is to translate the UK tables produced by ONS to London – Annex A explains how this is done. One important assumption inherent in the methodology is that technological coefficients of production are the same at a national and regional level. Data limitations mean that GLA Economics has made two key data assumptions:

- London goods exports estimates are the same as published HMRC figures. The allocation by sector takes the distribution in the UK IO tables, and applies the London share of UK GVA. This has been done because there is no published source which converts exports data on the classification which HMRC uses to the classification which ONS uses in its IO tables.
- Imports have been estimated using an accounting identity as there are no published regional imports statistics. This permits an analysis of trade flows, but estimates of imports may suffer from larger measurement error than survey estimates because there is no means of calibration.

[7] See, for example, Economic Evidence Base for London 2016 | London City Hall

In summary, there is inherent uncertainty in all IO tables despite efforts to ensure robustness. This is for similar reasons, if varying degrees for each of the reasons, which for London are:

- The methodology adopted to derive the IO tables
- Some data is available only at the UK level, and has been estimated for London
- Estimates have been derived where there are data gaps, ie, imports and goods exports

As this is the first time that GLA Economics has published IO tables for London, and there is significant uncertainty around the estimates, the results are **experimental**[8]. The tables are available on the London Datastore[9].

The remainder of the main paper has the following structure:

- Chapter 2 provides background explanation on theory and practice of IO tables
- Chapter 3 presents what the tables say on the London economy, and interlinkages within it
- Chapter 4 presents what the tables say on London's trade with the rest of the UK, the EU, and the rest of the world
- Chapter 5 is the conclusion

Annex A explains the methodology adopted to produce the IO tables, and Annex B provides more detailed information on linkages in the London economy than provided in Chapter 3.

[8] ONS describes experimental statistics as in the testing phase, and not yet fully developed, see Guide to Experimental Statistics - Office for National Statistics
[9] See https://data.london.gov.uk/dataset/london-input-output-tables

2 Background to input-output tables

2.1 Use of IO tables

This chapter describes the conceptual framework behind the production of IO tables, and how this supports a range of applications.

IO tables at a sub-national level[10] offer two types of additional insight with respect to national tables:

- they provide a picture of specialisation in economic activities at a regional level;
- they provide a way of understanding trade flows – exports and imports from/to other regions and other countries. The smaller the region of interest, the more these will tend to play a bigger part in the economy.

Previous analysis by GLA Economics has suggested that both of these factors are important to the development of the London economy[11]. Among the devolved authorities in the UK only Scotland has published IO tables[12], although there is an academic literature on sub-national IO tables[13]. The ONS has produced tables for the UK[14].

2.2 Conceptual framework

Figure 2.1 provides the structure of an IO table. The table records the sum of the market value of all physical resources used in an economy, and GVA. The direction of the arrows indicates the process from supply through production to use, and so the value of output in supply equals the value of output in use.

An IO table breaks down economic activities into four components. The left-hand side of the standard IO structure records the supply of resources for production. Specifically:

- Primary inputs to intermediate demand or consumption (matrix **p**) for all sectors of the economy. This includes compensation of employees, the gross operating surplus of companies, and imports.
- The intermediate consumption matrix (matrix **A**) for each sector. It includes all the inputs that each sector purchases from all the other sectors (including itself) in order to produce its outputs[15] – these are the direct consumption effects.

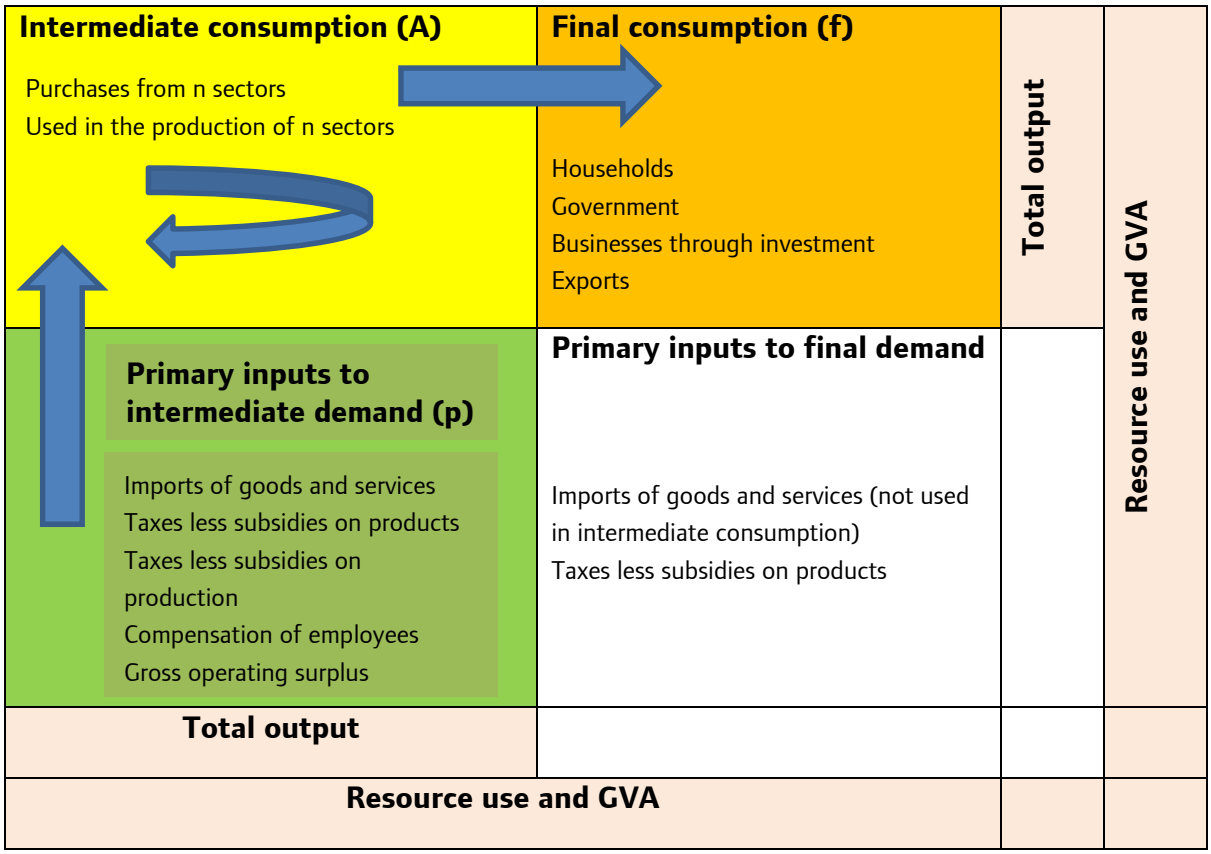
The right section of the framework records the way in which resources are used or consumed. Specifically:

- The final consumption matrix (matrix **f**) records the use of sectoral output for reasons other than production, including consumption by households and government, investment and accumulation, and exports.

[10] See Miller, R & Blair, P (2009). Input-output analysis: foundations and extensions, second edition. Cambridge University Press, Cambridge, ISBN: 978-0-511-65103-8
[11] See, for example, Economic Evidence Base for London 2016 | London City Hall
[12] See Input-Output Tables and Multipliers for Scotland. Northern Ireland has produced IO tables, see NI Economic Accounts Overview | Northern Ireland Statistics and Research Agency, but has only published multipliers, see Multipliers derived from Input-Output tables | Northern Ireland Statistics and Research Agency
[13] See Annex A for some references, and for Wales see Welsh Economy Research Unit - Research - Cardiff University
[14] See UK input-output analytical tables - Office for National Statistics
[15] For this reason this matrix is a square with dimension of the number of sectors under analysis

- The primary inputs to final demand matrix records inputs to final demand that are not produced, and this is primarily imports not used in production.

Figure 2.1: Structure of input-output tables



In practice, it is often the case that the lower sections of the IO framework (matrix **p** and the matrix of primary inputs to final demand) also include adjustments for taxes and subsidies. This is the case when matrix **A** and matrix **f** are expressed in basic or purchaser prices (before taxes and subsidies). The equivalent of the top sections of the ONS tables for the UK, and the London tables, are in basic prices, while the bottom half is in purchaser prices.

IO tables can be presented on an industry by industry, or product by product basis. The differences and respective advantages/disadvantages are:

- industries are closer to standard statistical sources and actual market transactions but may produce more than one product;
- products tend to be more homogenous in terms of cost structures and productive activities, so they can be more meaningful for the purpose of international comparisons.

The London tables are on a product by product basis[16]. In the main paper the term 'sector' is therefore used to mean 'product', rather than in its more common meaning of 'industry'.

There is a close relationship between the national accounting measures of output of Gross Domestic Product (GDP), and GVA, and IO tables. One approach to the production of IO tables is to use national accounts. For example, the UK and Scotland IO tables have been derived from

[16] They derive from ONS tables for the UK, which are on this basis.

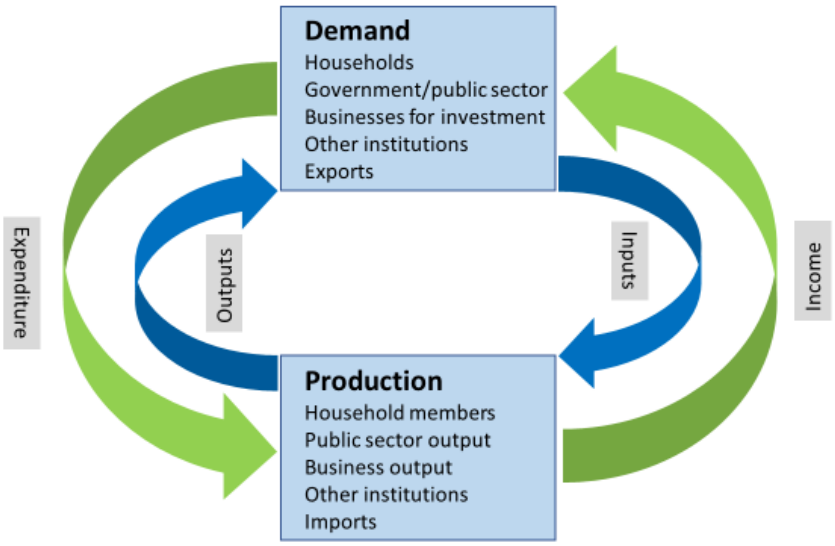
a part of the national accounting framework, specifically the Supply and Use tables[17]. The development of IO tables for London can therefore help achieve a deeper understanding of economic activity in London in the absence of national accounts for the city.

Consequently, the components of the three measures of economic output or value added, from production, income and expenditure, are all part of an IO table. For example, the income measures of GDP and GVA can be estimated from the primary inputs to intermediate demand (matrix **p**):

- GVA is the sum of compensation of employees, gross operating surplus, and taxes less subsidies on production
- GDP is GVA plus taxes less subsidies on products

The three measures of output are equal because the bodies which consume goods and services, such as households, businesses and governments, are also the ones that produce them and pay for them (once we have adjusted demand to include exports and exclude imports). They provide inputs to the production process for which they receive income, and they incur expenditure on the outputs, (Figure 2.2). Demand and production of services reads across to IO tables because of the direct connection to the use and supply of resources.

Figure 2.2: Circular flow diagram for measures of economic output



While Supply and Use tables give a measure of direct demand through inputs, outputs and final consumption or demand, the additional benefit of IO tables is that they also enable measurement of indirect demand, or how different parts of the economy inter-relate. This is derived through the **Leontief inverse matrix**, **L**, which is described below.

[17] Supply and use tables are conceptually very similar to IO tables in terms of structure. The main difference is that both of the supply and use tables have a structure of product by industry, and so it is not possible to combine them directly into a single table. The IO tables require a conversion from product to industry or vice-versa to enable the incorporation of the two tables into a single table.

The first step is to produce the **matrix of coefficients.** In order to do this, it is necessary to normalise the columns for each sector in the economy in matrices **A** (of intermediate consumption) and **p** (of primary inputs to intermediate demand) in Figure 2.1. That is, the vertical sum across the entries is set to be equal to one. The elements of matrix **A** and matrix **p** are the share of each input (whether sectoral or primary input) as a percentage of total sectoral input. A modelled example is the London IO tables on the London Datastore[18].

This normalised form of matrix **A** incorporates the **direct** requirements of other sectors for the produce of each sector. Then, if the value of total output for each sector is x, and for all sectors is summarised by the vector **x**, and similarly there is a vector **f** for final consumption by each sector, the following identity will hold (following the top sections of Figure 2.1):

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{f}$$

Re-writing **x** as **Ix**, where **I** is the identity matrix (ie the matrix which has ones on the diagonal, and zeroes elsewhere) we can re-write the equation as:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}$$

The Leontief inverse, **L**, is then defined as:

$$\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$$

The **Leontief inverse** is also known as the total requirements matrix. It translates final demand changes (from **f**) into total output changes (from **x**), as **x = Lf**. In this way it encompasses both **direct** and **indirect** requirements of sectors to meet final demand, and not just the direct requirements for intermediate consumption[19].

Using the Leontief inverse it is possible to derive the **primary input content of final demand**, calculated as **pLf**. This formula models the intermediate consumption of imports and components of economic output (in **p** through **A**) and attributes them across the households and other institutions responsible for final demand (in **f**) – this is the indirect demand for imports and components of output in final demand. This can be added to the primary inputs to final demand (see Figure 2.1) to estimate the direct and indirect input contributions to final demand. Results for London for imports are at Table 4.7.

Additionally, the use of accounting identities in the construction of IO tables allows the estimation of imports as:

GVA + taxes less subsidies on products = Final demand – imports

For example, for London this allows the estimation of trade flows with the rest of the UK, the EU, and the rest of the world. While GVA figures, and the exports component of final demand come from published ONS data other figures in the equation above have been derived – Annex A explains the methodology that has been adopted. Therefore, estimates of London imports based on the IO tables will reflect measurement errors in the modelling.

[18] See https://data.london.gov.uk/dataset/london-input-output-tables
[19] As captured by the matrix **A**

2.3 Potential applications and development

Some applications flow immediately:

- Linkages between sectors in production within London. It provides a way of considering the interconnectedness of sectors in the London economy. This can be for direct and indirect effects, and can be modelled in a number of ways[20]. There are:
    - Backward linkages, that is the consumption of the output of other sectors in the production of a particular sector, and
    - Forward linkages, that is the use of the production of a particular sector in the consumption of other sectors
- Linkages between London and other economies – for example, the primary input content of final demand matrix indicates the value within exports from London of imports used in production. The IO table also captures direct demand for imports across the London economy

Later chapters draw out results for these themes.

The literature[21] identifies other uses for IO tables, which have not been pursued in this paper. Specifically, it does not consider employment or output multiplier effects[22]. That is estimates of economy-wide impacts of a policy to change demand in one industry. This is because a number of assumptions implicit to the development of IO tables are not likely to hold for the London economy: such as the absence of constraints in supply to production, or purchases in household budgets, and that there will not be relative price changes in allocating resources between activities[23].

The HM Treasury Green Book[24] expresses concerns about the use of multipliers for appraisal and evaluation in central government, "Multiplier effects … are likely to have limited additionality and the effects are generally accounted for at a macro level by aggregate decisions to spend at a particular level. If multiplier effects do occur it is usually not possible to reliably observe or measure differences between individual programmes and options within projects at a UK level. It is therefore recommended that they should not be included in estimates of social value."

Computable general equilibrium models make use of IO tables[25], and, as the name suggests, include the general equilibrium consequences of constraints and price effects which IO tables cannot. The UK Government Brexit analysis[26] models regional effects as does the European Commission (EC) RHOMOLO model[27]. These are both computable general equilibrium models, although the regional IO tables on which they are based are not publicly available.

[20] Annex B provides a fuller discussion of methodological issues
[21] For an academic discussion see Miller, R & Blair, P (2009). Input-output analysis: foundations and extensions, second edition. Cambridge University Press, Cambridge, ISBN: 978-0-511-65103-8
[22] The calculation of multipliers is the same as for linkages. It is the application of the analysis that differs.
[23] See On input-output tables: uses and abuses for a fuller discussion
[24] See The Green Book: appraisal and evaluation in central government - GOV.UK
[25] See, for example, the approach adopted by the Scottish Government Computable General Equilibrium modelling: introduction - gov.scot
[26] See Exiting the European Union: Publications - GOV.UK
[27] See The RHOMOLO model | EU Science Hub

Secondly, more comprehensive IO tables consider imports and exports by country or region to provide more comprehensive analysis of trade flows[28]. The World Input-Output Database[29] holds data on 56 sectors, and the IO data for the EC RHOMOLO connects to this database. The OECD has developed a set of IO tables to estimate global value chains[30]. The Eora global supply chain database[31] has environmental indicators, including greenhouse gas emissions, and can be used, for example, to model carbon consumption through indirect demand effects, such as household carbon consumption of imports.

[28] For an example, see Exposure to Brexit in regions on both sides of the Channel | VOX, CEPR Policy Portal, and a fuller version at The continental divide? Economic exposure to Brexit in regions and countries on both sides of The Channel - Chen - 2018 - Papers in Regional Science - Wiley Online Library
[29] See WIOD Home
[30] See Input-Output Tables (IOTs) - OECD
[31] See Eora Global MRIO

3 The London economy and interlinkages

3.1 Introduction

This section summarises the key insights that the London IO tables provide on the following features of the economy:

- The supply and use of resources by sector in London and how it compares with the UK (Section 3.2);
- The structure of the London economy in terms of income, output, and expenditure and how it compares with the UK (Section 3.3);
- The extent to which agglomeration economies depend on interlinkages in production (as opposed, say, to access to pools of labour or expertise), and if so which interlinkages are important (Section 3.4)

The importance of trade with other parts of the UK, the EU, and the rest of the world – is mostly covered in Chapter 4.

3.2 Use of resources in London and value added in London's economy

It is an accounting identity that resource supply within an economy should equal resource use. Specifically, inputs to consumption should equal consumption[32]. Overall supply and use of resources in London in 2013 added up to £1,004 billion, (Table 3.1). On the supply side, imports (including with the rest of the UK) were £226bn, and accounted for just under a quarter (22%) of the value of supply, while the remainder was output produced in London[33]. On the use side, £619bn (62%) of resources were for final demand, while the remaining £385bn (38%) was an input to the production of other sectors. Exports were £284bn, 46% of final demand or over a quarter of the value of total supply/use (28%).

Table 3.1: Supply and use of resources in London, £bn purchaser prices, 2013

supply		use	
total output at basic prices	£740bn	intermediate input at purchaser prices	£385bn
taxes less subsidies on products	£38bn	final demand at purchaser prices	£619bn
imports at purchaser prices	£226bn		
	£1,004bn		£1,004bn

Source: GLA Economics calculations

As a comparison Table 3.2 replicates Table 3.1 for the UK. In 2013, UK resource use had a value of £3,786bn, and so London used 26% of this total. Imports were £557bn, and accounted for 15% of the value of supply in the UK. As for London, three fifths (61%) of resources are for final demand, or £2,296bn in value. Exports were £518bn, or 14% of the value of supply – while this proportion is lower than for London, there is, of course, no equivalent for the UK of trade with the rest of the UK.

[32] Pictorially supply is the left half of Figure 2.1, that is primary inputs to intermediate demand and intermediate consumption, and use is the top half of Figure 2.1, which is intermediate and final consumption

[33] The value of this output in purchaser prices is the value in basic prices plus taxes less subsidies

Table 3.2: Supply and use of resources in the UK, £bn purchaser prices, 2013

supply		use	
total output at basic prices	£3,041bn	intermediate input at purchaser prices	£1,490bn
taxes less subsidies on products	£188bn	final demand at purchaser prices	£2,296bn
imports at purchaser prices	£557bn		
	£3,786bn		£3,786bn

Source: ONS Input-output analytical tables[34]

3.3 The structure of London's economy

While London uses £1,004bn of resources, the corresponding output (GDP[35]) produced by the city at purchaser prices in 2013 was £393bn. Deducting £38bn of taxes less subsidies on production, this is equivalent to output (GVA) at basic prices of £355bn in 2013, (Table 3.3). Following national accounting conventions, this can be measured in three ways:

- GVA on a production basis: while total output is £740bn (Table 3.1), £385bn is used in intermediate production, and the remainder is value added of £355bn;
- GVA on an income basis: £205bn is compensation for employees, £143bn is gross operating surplus, and £7bn is taxes less subsidies on production, adding up to £355bn;
- GVA on an expenditure basis: final demand at purchaser prices is £619bn (Table 3.1), less £226bn for imports and £38bn for taxes and subsidies on products, giving once again £355 bn.

Table 3.3: London's Gross Value Added, £bn basic prices, 2013, production, income and expenditure approaches

	Production	
	Total output at basic prices	£740bn
-	Total intermediate inputs at basic prices	£385bn
=	GVA at basic prices	£355bn

	Income	
	Compensation of employees	£205bn
+	Taxes less subsidies on production	£7bn
+	Gross operating surplus	£143bn
=	GVA at basic prices	£355bn

	Expenditure	
	Household final consumption (including NPISH)	£209bn
+	General government final consumption	£64bn
+	Gross capital formation	£62bn
+	Exports	£284bn
=	Total final demand	£619bn
-	Total imports	£226bn
=	GDP at purchaser prices	£393bn
-	Taxes less subsidies on products	£38bn
=	GVA at basic prices	£355bn

Source: GLA Economics calculations
Note: NPISH is Non-Profit Institutions Serving Households, eg charities or universities

[34] See UK input-output analytical tables - Office for National Statistics
[35] The ONS publishes GDP numbers for the UK, but not for sub-national areas. As a matter of course, GLA Economics follows ONS conventions and reports GVA as its lead measure of output for London. It is possible, as has been done here, to estimate GDP for London from published ONS sources.

London contributed 23% in 2013 of UK GVA of £1,552bn, which is in line with its share of use of resources (27%). Table 3.4 provides the components of UK GVA, and is a counterpart to Table 3.3 for London. This provides a more detailed basis for comparing the London and UK economies, and suggests that the main differences are in the structure of production:

- Production:
    - London had output that was 24% of UK output of £3,041bn
    - London had intermediate inputs that was 26% of the UK total of £1,490bn
    - 52% of total London output was on intermediate inputs, while the comparable figure for the UK was 49%
- Income:
    - the shares of GVA distributed between labour, through compensation of employees, and capital, through gross operating surplus are the same for London and the UK – in other words, the London share of UK compensation of employees, and gross operating surplus was the same as the London share of UK GVA at 23%
- Expenditure:
    - London's household final consumption, and general government final consumption were both 18% of UK consumption
    - London's gross capital formation was 21% of UK investment spending

It should be noted that the trade figures in Tables 3.3 and 3.4 are not comparable. In the UK table the trade figure represents trade with the rest of the world, while in the London table it also includes trade with the rest of the UK. Statistically it is to be expected that imports and exports would be comparatively more important to London than to the UK as London trades with a larger geographic area. The next chapter considers in more detail the origin and destination of trade.

Table 3.4: UK's Gross Value Added, £bn basic prices, 2013, production, income and expenditure approaches

	Production	
	Total output at basic prices	£3,041bn
-	Total intermediate inputs at basic prices	£1,490bn
=	GVA at basic prices	£1,552bn

	Income	
	Compensation of employees	£879bn
+	Taxes less subsidies on production	£24bn
+	Gross operating surplus	£649bn
=	GVA at basic prices	£1,552bn

	Expenditure	
	Household final consumption (including NPISH)	£1,139bn
+	General government final consumption	£350bn
+	Gross capital formation	£291bn
+	Exports	£518bn
=	Total final demand	£2,296bn
-	Total imports	£557bn
=	GDP at purchaser prices	£1,740bn
-	Taxes less subsidies on products	£188bn
=	GVA at basic prices	£1,552bn

Source: GLA Economics calculations
Notes: NPISH is Non-Profit Institutions Serving Households, eg charities or universities
Gross capital formation includes Gross fixed capital formation, valuables, and changes in inventories

Table 3.5 considers the supply and use of resources in London at a sector level. This follows the classification of the economy used in the London Business Survey[36]. Sector GVA is presented on a products basis and it is therefore different from the headline GVA estimates in ONS publications, which are on an industries basis[37]. London GVA in aggregate is the same for both approaches. Four product sectors account for over half of supply, as measured by GVA, and nearly as much when measured by total output:

- Information, communication, arts, entertainment, and recreation;
- Financial and insurance activities;
- Real estate, architecture, engineering and building services;
- High value business support.

In terms of the use of resources these product sectors accounted for 39% of intermediate (*direct*) demand and 39% of total (*direct* and *indirect or final*) demand in 2013. In contrast, Manufacturing accounted for 2% of GVA, 12% of intermediate demand, and 9% of total demand.

For Financial and insurance activities, and Real estate the share of total demand was higher than for intermediate demand. This indicates the relatively lower importance of other London producers to these sectors. Other London producers are relatively more important for High value business support.

[36] See London Business Survey 2014 – London Datastore. It is the source of trade data for the IO table.
[37] See Regional gross value added (income approach) - Office for National Statistics

Table 3.5: GVA and Distribution of supply and use of resources in London by sector, 2013

Product classification			Supply		Use	
Code	Description	GVA	GVA	total output	intermediate demand	total demand
A, B, D & E	Primary & Utilities	£4bn	1%	1%	5%	3%
C	Manufacturing	£8bn	2%	3%	12%	9%
F	Construction	£18bn	5%	8%	11%	7%
45+46	Wholesale (inc. motor trades)	£11bn	3%	6%	4%	6%
47	Retail (exc. motor trades)	£15bn	4%	3%	0%	3%
H	Transport and storage	£16bn	5%	6%	11%	7%
I + 79	Accommodation, food, travel and tourism	£17bn	5%	5%	2%	7%
J+R	Information, communications, arts, entertainment and recreation	£42bn	12%	11%	12%	11%
K	Financial and insurance activities	£52bn	15%	16%	8%	10%
L+71+81	Real estate, architecture, engineering and building services	£57bn	16%	12%	8%	12%
M-71-72-75	High value business support	£39bn	11%	10%	11%	6%
N+S-79-81	Administrative and support services	£25bn	7%	6%	11%	5%
Q+72+75	Health, social work, scientific R&D and veterinary services	£19bn	5%	4%	1%	7%
O+P	Public administration & education	£30bn	8%	9%	4%	7%
T	Households as employers	£1bn	0%	0%	0%	0%
	Total	£355bn	100%	100%	100%	100%

Source: GLA Economics calculations

Table 3.6 replicates Table 3.5 for the UK. Economic activity in the UK is more balanced, and less specialised than London:

- Supply and use of resources in Information and communication, Finance, Real estate, and High value business support was between 30 and 35% of resources for all measures
- Manufacturing accounts for 10% of GVA, and 15% of total output

Table 3.6: GVA and Distribution of supply and use of resources in the UK by sector, 2013

Product classification			Supply		Use	
Code	Description	GVA	GVA	total output	intermediate demand	total demand
A, B, D & E	Primary & Utilities	£75bn	5%	7%	11%	7%
C	Manufacturing	£149bn	10%	15%	17%	15%
F	Construction	£97bn	6%	8%	10%	8%
45+46	Wholesale (inc. motor trades)	£81bn	5%	5%	6%	5%
47	Retail (exc. motor trades)	£77bn	5%	4%	0%	4%
H	Transport and storage	£66bn	4%	5%	8%	5%
I + 79	Accommodation, food, travel and tourism	£64bn	4%	4%	2%	4%
J+R	Information, communications, arts, entertainment and recreation	£116bn	7%	7%	8%	7%
K	Financial and insurance activities	£110bn	7%	8%	10%	8%
L+71+81	Real estate, architecture, engineering and building services	£227bn	15%	11%	7%	11%
M-71-72-75	High value business support	£82bn	5%	4%	10%	4%
N+S-79-81	Administrative and support services	£94bn	6%	5%	8%	5%
Q+72+75	Health, social work, scientific R&D and veterinary services	£135bn	9%	8%	2%	8%
O+P	Public administration & education	£172bn	11%	9%	3%	9%
T	Households as employers	£6bn	0%	0%	0%	0%
	Total	£1,552bn	100%	100%	100%	100%

Source: GLA Economics calculations

While GLA Economics has derived London estimates of some elements of the IO tables from the UK tables, as set out in Annex A, there are other elements for which the ONS has published London data by sector. These are compensation of employees, reported in Table 3.7, and gross capital formation. While both have been used in the derivation of the London IO tables as the best available information, the estimates on gross capital formation are not reported in this chapter because of the reservations that the ONS express about data quality.

Broadly speaking, employees in London take a higher proportion of GVA across sectors as compensation than employees in the UK, (Table 3.7). There are a few sectors where the share was similar, the notable exception being Manufacturing, while for the two economies as a whole the share was almost identical, in the case of London being 58%.

Table 3.7: Compensation of employees by sector, London and UK, total (£bn) and share of GVA, 2013

Product classification		London Compensation of Employees		UK Compensation of Employees	
Code	Description	Total	share of London GVA	Total	share of UK GVA
A, B, D & E	Primary & Utilities	£1bn	30%	£24bn	33%
C	Manufacturing	£5bn	62%	£101bn	68%
F	Construction	£12bn	67%	£53bn	55%
45+46	Wholesale (inc. motor trades)	£9bn	77%	£57bn	70%
47	Retail (exc. motor trades)	£10bn	65%	£46bn	60%
H	Transport and storage	£12bn	72%	£44bn	67%
I + 79	Accommodation, food, travel and tourism	£12bn	68%	£42bn	65%
J+R	Information, communications, arts, entertainment and recreation	£25bn	59%	£68bn	59%
K	Financial and insurance activities	£27bn	52%	£58bn	53%
L+71+81	Real estate, architecture, engineering and building services	£8bn	14%	£35bn	15%
M-71-72-75	High value business support	£25bn	65%	£47bn	57%
N+S-79-81	Administrative and support services	£17bn	68%	£55bn	59%
Q+72+75	Health, social work, scientific R&D and veterinary services	£16bn	83%	£102bn	76%
O+P	Public administration & education	£25bn	84%	£139bn	81%
T	Households as employers	£1bn	100%	£6bn	93%
	Total	£205bn	58%	£879bn	57%

Source: GLA Economics calculations

3.4 Interlinkages in the London economy

It is possible with IO tables to measure interlinkages in the production and consumption of sectors across the London economy. This can be for:

- Direct and indirect effects:
  - Direct effects, that is the direct increase of intermediate demand or consumption across all sectors of the economy associated with an increase in a unit of final demand of a particular sector.
  - Indirect effects, which are the additional increase in requirements of production sectors associated to an increase in a unit of final demand of a particular sector.
- Backward and forward linkages:
  - Backward linkages, that is the consumption of the output of other sectors in the production of a particular sector, and
  - Forward linkages, that is the use of the production of a particular sector in the consumption of other sectors

Linkages can be estimated for both direct and indirect effects, as shown in the figures below.

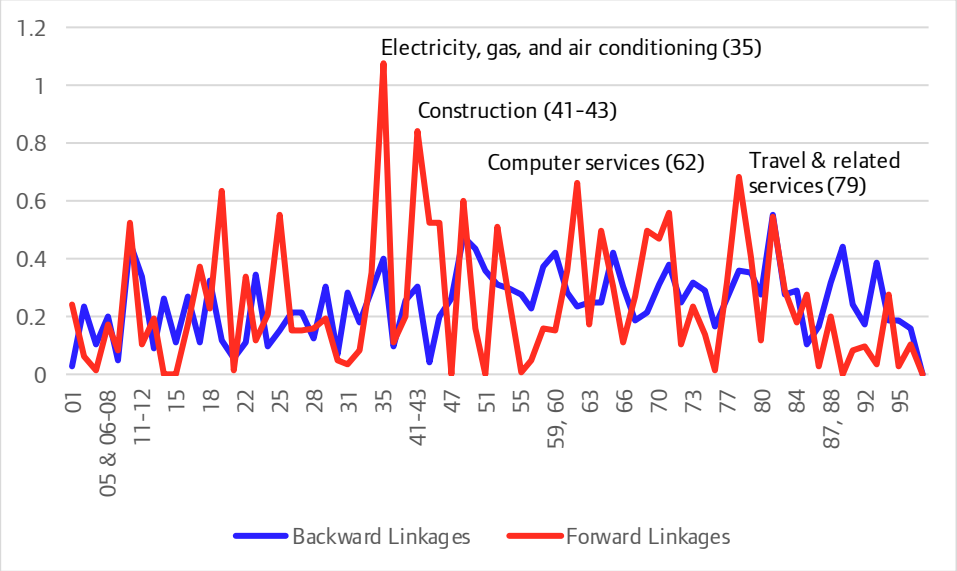
This analysis has been conducted for 75 London sectors as opposed to the 15 sectors in the main IO tables[38] published on the London Datastore[39]. This provides more insight as the larger

[38] The main analysis is for 15 sectors as this is what is possible with data from the London Business Survey. This analysis assumes that export and import shares of sales are the same across sub-products as they are for the sector category. This assumption is not robust to estimate trade flows for 75 sectors, but is less material to an analysis of output.
[39] See https://data.london.gov.uk/dataset/london-input-output-tables

the number of sectors the smaller are the sector groupings and the less likely statistically that there will be linkages with each individual sector[40]. Annex B provides the methodology supporting this analysis, and tables of the data behind the figures in this section. The reported linkages there are for both within sector effects, and without sector effects – there are within sector linkages when one firm in a sector purchases from another firm in the same sector. The main paper presents sector effects which includes within sector effects.

Direct linkages, whether forward or backward, are relatively small for all sectors, except one[41], (Figure 3.1). That is, an increase by £1 in the value of production of any sector would lead to an increase in the sectors used in its production of less than £1 (backward linkages), and consumption of it in the production of other sectors of less than £1 (forward linkages). For most sectors forward linkages are larger than backward linkages, and these are largest for Electricity, gas, and air conditioning (35)[42], Construction (41-43), Computer services (62)[43], and Travel & related services (79)[44].

Figure 3.1: Direct unweighted linkages for sectors, backward and forward, in the London economy, 2013

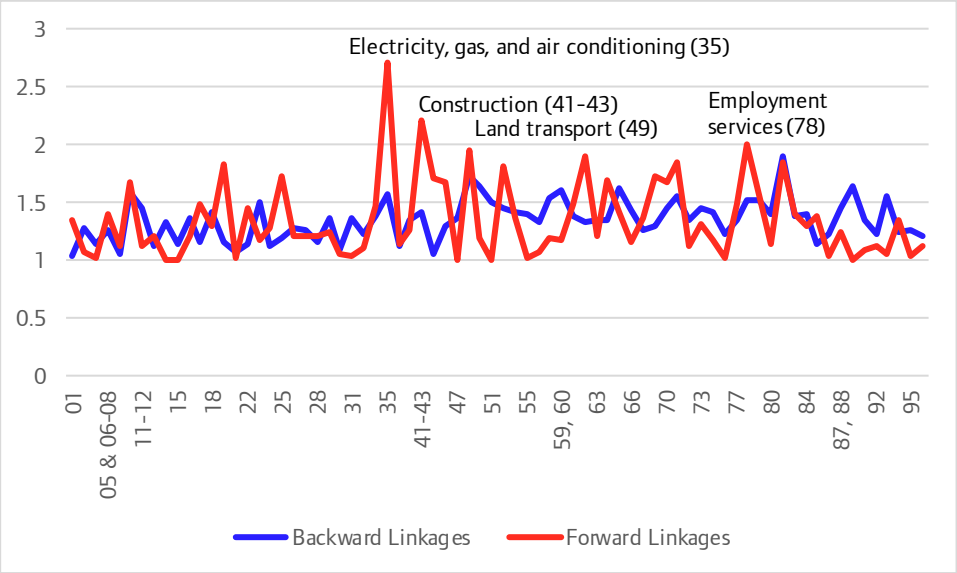


Source: GLA Economics calculations

The effects of all linkages, direct and indirect, are larger as a matter of arithmetic, (Figure 3.2). In practice, for London, they are all greater than one, for both forward and backward linkages. Again, for most sectors forward linkages are larger than backward linkages, and these are largest for Electricity, gas, and air conditioning (35), Construction (41-43), Employment services (78)[45], and Land transport (49)[46].

[40] To see this point graphically this section provides linkages for 75 products for the UK, and Annex B provides the corresponding analysis for 127 products.
[41] Electricity, gas and air conditioning for forward linkages
[42] Of the more aggregated 15 sectors part of Primary & utilities
[43] Of the more aggregated 15 sectors part of Information, communication, arts, entertainment, and recreation
[44] Of the more aggregated 15 sectors part of Accommodation, food, travel and tourism
[45] Of the more aggregated 15 sectors part of Administrative and support services
[46] Of the more aggregated 15 sectors part of Transport and storage

Figure 3.2: Direct and indirect unweighted linkages for sectors, forward and backward, in the London economy, 2013



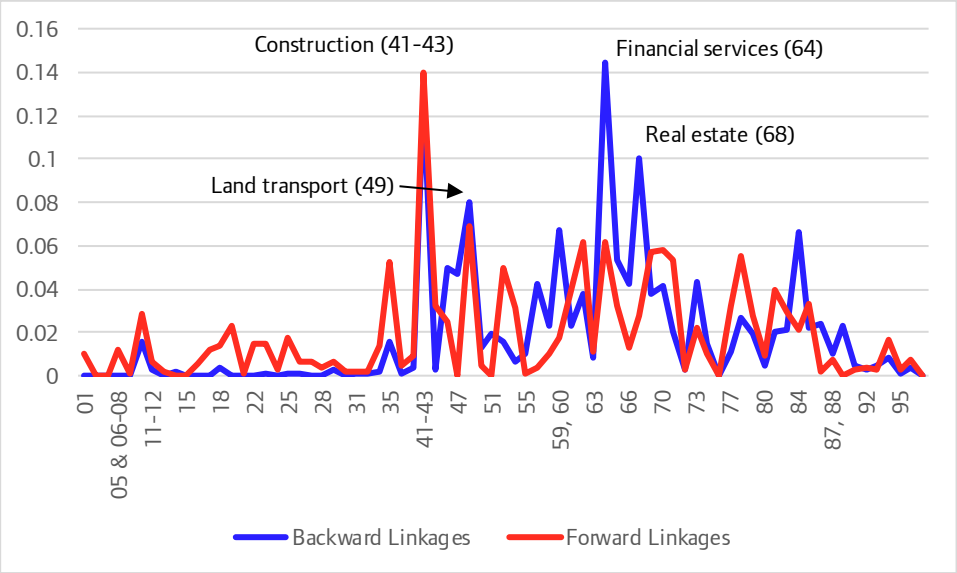
Source: GLA Economics calculations

An inference is that at the level of disaggregation of this analysis to 75 sectors there is little evidence of association between supply chain effects and sector specialisation. As a general proposition, linkages are not noticeably stronger for the sectors in which London specialises, which suggests they are of limited importance in explaining agglomeration effects. It should be noted, though, that one of the assumptions of the analysis is that technological coefficients are the same at a national and regional level. There is a possibility that the modelling approach adopted does not reflect well the effects of specialisation in London.

One limitation of the linkages analysis presented so far is that it has not taken into account the relative value of the production of sectors. Effectively it has treated each sector as of equal importance, and has not allowed that output is higher for some sectors. Weighting each component of direct sector consumption by its overall contribution to direct consumption provides a remedy[47], and gives a different perspective on the London economy (Figure 3.3). Backward linkages are now more prominent in the results. Again Construction (41-43), and Land transport (49) have significant linkages, now both forward and backward linkages. For the first time, and reflecting the size of the sectors Financial services (64)[48], and Real estate (68)[49] are important, in both cases as backward linkages. That is, the success of these sectors in the London economy is dependent on, and activates, the contribution of other sectors.

[47] Annex B provides a more detailed explanation
[48] Of the more aggregated 15 sectors part of Financial and insurance activities
[49] Of the more aggregated 15 sectors part of Real estate, architecture, engineering and building services

Figure 3.3: Direct and indirect weighted linkages for sectors, forward and backward, in the London economy, 2013



Source: GLA Economics calculations

It is not possible with the available data to produce the counterpart of these charts for the rest of the UK. There is no survey corresponding to the London Business Survey which provides insight on the relative importance of imports within the UK and elsewhere by sector[50]. The UK is a poor comparator because there is no equivalent of imports within the national boundary.

[50] This is part of the matrix of coefficients, which is the starting point for the calculations in this section.

4 Interlinkages between London, the rest of the UK, Europe, and the rest of the world

4.1 Introduction

In addition to providing insights on the structure of an economy, IO tables can also provide valuable insight into its trade linkages. In the case of the London IO tables, this means not just international imports and exports flows (whether from/to Europe or the rest of the world) but also imports and exports flows with the rest of the UK.

GLA Economics has previously estimated regional trade balances within the UK[51], but IO tables provide a framework for an integrated assessment of trade flows and is a more robust modelling approach. Nevertheless, there are still data gaps in the modelling of trade flows – Section 4.2 explains what they are, and the assumptions used to address them.

Section 4.3 considers the inter-connectedness of the London economy with the rest of the UK, the EU, and the rest of the world in terms of:

- An aggregate level comparison of imports and exports
- A sector-level analysis of imports which contribute to production and to exports
- A sector-level analysis of the consumption of imports for both intermediate and final demand

4.2 Estimating London's imports and exports: data issues and key assumptions

There is a range of published data for exports and imports, and which can support the development of London IO tables. Specifically:

- GLA Economics[52], HM Revenue and Customs (HMRC)[53], and the ONS[54] have published figures for the exports of goods and services from London and the UK to other countries.
- The ONS also publishes statistics on imports to the UK as part of the balance of payments statistics[55].
- HMRC has published statistics on goods imports to regions[56], although as the London economy is predominantly service-oriented this is of limited value[57].

However, there are no official statistics on service imports to UK regions, or trade flows between UK regions.

In the absence of official statistics in the required format GLA Economics has had to make two significant modelling assumptions:

[51] See Growing Together II: London and the UK economy | London City Hall
[52] See An analysis of London's exports | London City Hall and London's Economy Today - Issue 198 - February 2019 | London City Hall
[53] See HM Revenue & Customs uktradeinfo - Regional Trade Statistics
[54] See Regionalised estimates of UK service exports - Office for National Statistics
[55] See UK Balance of Payments, The Pink Book: 2018 - Office for National Statistics
[56] See UK regional trade in goods statistics disaggregated by smaller geographical areas - GOV.UK
[57] Even for Manufacturing London exports tend to be in services

- Goods exports to the EU and the rest of the world for sectors which have UK goods exports have been estimated in proportion to the London share of UK GVA[58], and calibrated to the HMRC estimate for London goods exports. This is because GLA Economics has no means to convert HMRC goods exports figures to the classification the ONS uses for IO tables
- As there are no official statistics for imports these have been estimated using national accounting identities[59]. In consequence, measurement errors in other components of the IO tables will be reflected directly in estimates of imports as there is no other means to calibrate the figures.

4.3 Trade flows from production and total output

Exports can be part of London output, but not production, where they are imports which are re-exported without any production activity in London. As well as imports that support production, there are other imports which are part of London's overall output but that are not part of London's production. This applies to those imports that are components of final demand, but are not part of production in some way, and so are mostly purchases by households.

London has a stronger trade position than the rest of the UK. It has trade surpluses with the EU of £35bn, and the rest of the world of £25bn, and a small deficit with the rest of the UK of £2bn, (Table 4.1). In terms of trade associated with production there are surpluses for each geography, of £37bn with the EU, £28bn with the rest of the world, and £15bn with the rest of the UK. The differences are a consequence that there are imports to London for final demand, and for which there is no production in London.

While the rest of the UK has a small trade surplus with London of £2bn, it has a deficit of £89bn with the EU, and a deficit of £10bn with the rest of the world. In terms of production the trade deficit with the EU falls to £14bn, and there is a surplus of £83bn with the rest of the world.

Overall, the UK as a whole has a trade deficit with the EU of £54bn, and a surplus with the rest of the world of £14bn. In terms of production there is a surplus with the EU of £23bn, and with the rest of the world of £111bn.

[58] In 2013 London's service exports had a value of £93bn, and goods exports had a value of £33bn.
[59] The identity is, GVA + taxes less subsidies on products = Final demand – imports, and is explored more fully in Annex A

Table 4.1: Trade flows for London, the rest of the UK, and the UK from production and total output, £bn, 2013

		London		Rest of the UK		UK	
		Production	Output	Production	Output	Production	Output
Rest of the UK	Exports	£139bn	£158bn	£125bn	£160bn		
	Imports	£125bn	£160bn	£139bn	£158bn		
	Net exports	£15bn	-£2bn	-£15bn	£2bn		
EU	Exports	£60bn	£67bn	£150bn	£161bn	£210bn	£229bn
	Imports	£23bn	£32bn	£164bn	£250bn	£186bn	£282bn
	Net exports	£37bn	£35bn	-£14bn	-£89bn	£23bn	-£54bn
Rest of the world	Exports	£53bn	£59bn	£208bn	£231bn	£262bn	£289bn
	Imports	£25bn	£34bn	£126bn	£241bn	£151bn	£275bn
	Net exports	£28bn	£25bn	£83bn	-£10bn	£111bn	£14bn
Total outside UK	**Exports**	**£113bn**	**£126bn**	**£358bn**	**£392bn**	**£471bn**	**£518bn**
	Imports	**£48bn**	**£66bn**	**£289bn**	**£491bn**	**£337bn**	**£557bn**
	Net exports	**£66bn**	**£60bn**	**£69bn**	**-£99bn**	**£134bn**	**-£39bn**
Total	**Exports**	**£253bn**	**£284bn**	**£483bn**	**£552bn**		
	Imports	**£173bn**	**£226bn**	**£429bn**	**£649bn**		
	Net exports	**£80bn**	**£58bn**	**£54bn**	**-£97bn**		

Source: GLA Economics calculations

For London trade within the UK is more important than trade beyond the UK. While for the rest of the UK trade beyond the UK is more important. For London exports and imports within the UK are around 45% of GVA, while the corresponding figures for the rest of the UK are 13%, (Table 4.2).

In contrast, exports outside the UK for London represent 36% of GVA, and for the UK represent 33%. The importance of imports from outside the UK is lower for London at 19% of GVA, and higher for the rest of the UK at 41%.

Table 4.2: Trade flows weighted by GVA for London, the rest of the UK, and the UK, 2013

	London	rest of the UK	UK
exports/GVA	81%	46%	
exports (within UK)/GVA	45%	13%	
exports (outside UK)/GVA	36%	33%	33%
imports/GVA	64%	54%	
imports (within UK)/GVA	45%	13%	
imports (outside UK)/GVA	19%	41%	36%

Source: GLA Economics calculations

Table 4.3 provides aggregate trade balances for London by sector for all exports to any of the rest of the UK, the EU, and the rest of the world. These are for the supply and use of resources in the production process. Exports represent exports of a particular sector while imports represent the imports used in the production of that sector in London.

It should be noted that the figures for imports in Table 4.3 are not imports of that product into London**.** The primary inputs to intermediate demand (matrix **p**) in IO tables, including the UK

table, records imports for the production of a product, which may be of a range of products. As noted earlier, there is no data on regional imports of services[60].

So, for example, Table 4.3 reports that the value of imports to the Primary & utilities sector is £2bn – this is not an estimate of the use of the product of this sector in London. There might be Primary & utilities imports for the production of all sectors, and there will be imports for Primary & utilities production from other sectors.

London's highest exporting sectors are:

- Financial and insurance activities, £51bn of exports in 2013;
- Information, communications, arts, entertainment and recreation, £35bn;
- Manufacturing, £33bn;
- Wholesale, £30bn;
- Accommodation, food, travel and tourism, £28bn;
- Transport and storage, £22bn;
- High value business support, £20bn

London's largest trade surpluses in production are in:

- Manufacturing, £27bn;
- Information, communications, arts, entertainment and recreation, £21bn;
- Financial and insurance activities, £20bn;
- Accommodation, food, travel and tourism, £18bn;
- Transport and storage, £13bn;
- High value business support, £8bn

There is a relationship between the sector in which London specialises and export activity, but there is not a perfect match. Further, sectors associated with the movement of people and goods also have surpluses, as does Manufacturing. The results for Manufacturing are particularly dependent on the fact that there is an assumption for the sector distribution of goods exports, and so may not be robust.

In contrast, London relies on imports in support of the Construction sector. It is also estimated that London relies on imports for Public administration and education – this data has been imputed as the data source for this analysis, the London Business Survey, did not survey this sector. These imports come primarily from the rest of the UK (Table 4.4).

[60] The London Business Survey estimates purchases from outside London of sectors, which has the same limitation as IO tables.

Table 4.3: Aggregate sector-level trade balances from production for London, £bn, 2013

Product classification				
Code	**Description**	**Exports**	**Imports**	**Net exports**
A, B, D & E	Primary & Utilities	£2bn	£2bn	-£1bn
C	Manufacturing	£33bn	£6bn	£27bn
F	Construction	£8bn	£22bn	-£14bn
45+46	Wholesale (inc. motor trades)	£30bn	£25bn	£5bn
47	Retail (exc. motor trades)	£1bn	£4bn	-£4bn
H	Transport and storage	£22bn	£9bn	£13bn
I + 79	Accommodation, food, travel and tourism	£28bn	£10bn	£18bn
J+R	Information, communications, arts, entertainment and recreation	£35bn	£14bn	£21bn
K	Financial and insurance activities	£51bn	£31bn	£20bn
L+71+81	Real estate, architecture, engineering and building services	£8bn	£10bn	-£2bn
M-71-72-75	High value business support	£20bn	£12bn	£8bn
N+S-79-81	Administrative and support services	£6bn	£5bn	£1bn
Q+72+75	Health, social work, scientific R&D and veterinary services	£9bn	£2bn	£7bn
O+P	Public administration & education	£1bn	£20bn	-£19bn
T	Households as employers	£0bn	£0bn	£0bn
	Total	**£253bn**	**£173bn**	**£80bn**

Source: GLA Economics calculations

A breakdown of London's trade balances with its trading partners for production activities by sector is available by sector. For the six sectors with the largest trade balances identified above all have surpluses with each of the rest of the UK, the EU, and the rest of the world (except for Financial and insurance activities which is in balance with the rest of the UK).

Table 4.4: Sector-level trade from production for London, the rest of the UK, and the UK, £bn, 2013

Product classification		Rest of the UK			EU			Rest of the world		
Code	Description	Exports	Imports	Net exports	Exports	Imports	Net exports	Exports	Imports	Net exports
A, B, D & E	Primary & Utilities	£1bn	£2bn	-£1bn	£0bn	£0bn	£0bn	£1bn	£0bn	£0bn
C	Manufacturing	£20bn	£4bn	£16bn	£7bn	£1bn	£6bn	£7bn	£1bn	£6bn
F	Construction	£7bn	£18bn	-£11bn	£0bn	£3bn	-£2bn	£0bn	£1bn	-£1bn
45+46	Wholesale (inc. motor trades)	£17bn	£13bn	£5bn	£7bn	£6bn	£1bn	£6bn	£7bn	-£1bn
47	Retail (exc. motor trades)	£0bn	£2bn	-£2bn	£0bn	£1bn	-£1bn	£0bn	£1bn	-£1bn
H	Transport and storage	£14bn	£7bn	£6bn	£5bn	£1bn	£4bn	£4bn	£1bn	£3bn
I + 79	Accommodation, food, travel and tourism	£15bn	£9bn	£7bn	£7bn	£1bn	£6bn	£6bn	£1bn	£5bn
J+R	Information, communications, arts, entertainment and recreation	£17bn	£9bn	£7bn	£8bn	£2bn	£6bn	£10bn	£3bn	£7bn
K	Financial and insurance activities	£22bn	£23bn	£0bn	£16bn	£2bn	£14bn	£13bn	£6bn	£6bn
L+71+81	Real estate, architecture, engineering and building services	£5bn	£8bn	-£4bn	£2bn	£1bn	£1bn	£1bn	£0bn	£1bn
M-71-72-75	High value business support	£11bn	£8bn	£3bn	£5bn	£2bn	£3bn	£4bn	£2bn	£2bn
N+S-79-81	Administrative and support services	£2bn	£4bn	-£2bn	£2bn	£0bn	£2bn	£2bn	£0bn	£1bn
Q+72+75	Health, social work, scientific R&D and veterinary services	£7bn	£2bn	£5bn	£0bn	£0bn	£0bn	£1bn	£0bn	£1bn
O+P	Public administration & education	£1bn	£15bn	-£15bn	£0bn	£3bn	-£2bn	£0bn	£2bn	-£2bn
T	Households as employers	£0bn	£0bn	£0bn	£0bn	£0bn	£0bn	£0bn	£0bn	£0bn
	Total	**£139bn**	**£125bn**	**£15bn**	**£60bn**	**£23bn**	**£37bn**	**£53bn**	**£25bn**	**£28bn**

Source: GLA Economics calculations

It is not possible to produce the counterpart of Tables 4.3 and 4.4 for the rest of the UK because there is no equivalent of the London Business Survey to record imports in the form of purchases by each sector, or exports to London.

An alternative presentation of exports data is to consider sector exports from production weighted by GVA, (Table 4.5). It does this for all exports, and exports outside the UK. London has four sectors where the value of exports exceeds GVA, which suggests an outward looking orientation to the activities of the city. These are:

- Manufacturing
- Wholesale
- Accommodation, food, travel and tourism
- Transport and storage

Indeed, exports for Financial and insurance activities are 97% of GVA.

The rest of the UK has a strong export orientation in Manufacturing, and Financial and insurance activities.

Arithmetically, exports outside the UK as a share of GVA will be lower than all exports as a share of GVA. The pattern of exports by this measure is similar to that for all London exports.

Table 4.5: Sector exports from production, total and outside the UK, weighted by GVA for London, and the rest of the UK, 2013

Product classification		London	Rest of the UK	London	Rest of the UK
Code	Description	Exports/GVA	Exports/GVA	Exports (outside UK)/GVA	Exports (outside UK)/GVA
A, B, D & E	Primary & Utilities	41%	47%	27%	45%
C	Manufacturing	416%	130%	164%	127%
F	Construction	44%	25%	4%	2%
45+46	Wholesale (inc. motor trades)	265%	58%	113%	40%
47	Retail (exc. motor trades)	4%	9%	3%	5%
H	Transport and storage	133%	34%	50%	20%
I + 79	Accommodation, food, travel and tourism	167%	17%	78%	5%
J+R	Information, communications, arts, entertainment and recreation	83%	24%	43%	11%
K	Financial and insurance activities	97%	108%	54%	69%
L+71+81	Real estate, architecture, engineering and building services	13%	8%	5%	3%
M-71-72-75	High value business support	53%	58%	23%	39%
N+S-79-81	Administrative and support services	23%	45%	14%	39%
Q+72+75	Health, social work, scientific R&D and veterinary services	46%	5%	8%	4%
O+P	Public administration & education	3%	14%	2%	3%
T	Households as employers	1%	0%	1%	0%
	Total	**81%**	**46%**	**36%**	**33%**

Source: GLA Economics calculations

Table 4.6 provides some comparisons of shares of London exports from production, and of UK exports, and in relation to GVA. For example, Financial and insurance activities account for 15% of London's GVA, and 20% of its exports, representing London's most important export sector. At the same time, it only accounts for 42% of all UK exports in this sector. Of the other sectors in which London specialises Information, communication, arts, entertainment, and recreation, and High value business support are also important in terms of London's exports, and make a significant contribution to UK exports in the sector. In contrast, Accommodation, food, travel and tourism, Transport and storage, and Wholesale sectors are relatively less important in London in terms of GVA, but more important in terms of exports both as a share of London exports, and in contribution to UK exports. While, Manufacturing makes a valuable contribution to London exports, but a comparatively small contribution to all UK exports.

Table 4.6: London sector share of: London GVA; exports from production, total and outside UK; UK GVA; and, exports from production from UK, 2013

Product classification		London				
Code	Description	% GVA	% exports	% exports (outside UK)	% UK sector GVA	% UK sector exports
A, B, D & E	Primary & Utilities	1%	1%	1%	5%	3%
C	Manufacturing	2%	13%	11%	5%	7%
F	Construction	5%	3%	1%	19%	33%
45+46	Wholesale (inc. motor trades)	3%	12%	11%	14%	32%
47	Retail (exc. motor trades)	4%	0%	0%	19%	11%
H	Transport and storage	5%	9%	7%	25%	45%
I + 79	Accommodation, food, travel and tourism	5%	11%	12%	26%	98%
J+R	Information, communications, arts, entertainment and recreation	12%	14%	16%	36%	68%
K	Financial and insurance activities	15%	20%	25%	48%	42%
L+71+81	Real estate, architecture, engineering and building services	16%	3%	3%	25%	36%
M-71-72-75	High value business support	11%	8%	8%	47%	35%
N+S-79-81	Administrative and support services	7%	2%	3%	27%	12%
Q+72+75	Health, social work, scientific R&D and veterinary services	5%	3%	1%	14%	28%
O+P	Public administration & education	8%	0%	0%	17%	9%
T	Households as employers	0%	0%	0%	21%	45%
	Total	**100%**	**100%**	**100%**	**23%**	**24%**

Source: GLA Economics calculations

The final table in this chapter, Table 4.7, considers the use of imports in final demand, whether indirectly after intermediate consumption for production, or directly for final demand[61]. £113bn of imports, or half (50%) of all imports, are for exports, again emphasising the outward-looking orientation of London's economy. £90bn of imports used for exports, or four fifths (80%) are used in intermediate consumption. The next largest demand for imports is for household and government consumption, of which £85bn are imports, or 38%. £65bn, or three quarters (76%), is through intermediate demand or consumption.

Looking across categories of imports, £27bn, or 12% of all imports, are for exports to the EU and £22bn, or 10% of all imports, are for exports to the rest of the world. More significantly, imports to support exports to the rest of the UK are £64bn, or 28%, of all imports. Imports are a significant component of exports irrespective of the source of imports, or the destination for exports.

[61] Chapter 2 explains how this is derived from IO tables.

Table 4.7: The contribution of imports to the components of final demand through intermediate and final demand, £bn, 2013

		household and government consumption	investment	exports to the rest of the UK	exports to the EU	exports to the rest of the world	total
intermediate demand	imports from the rest of the UK	£48bn	£14bn	£35bn	£15bn	£13bn	£125bn
	imports from the EU	£9bn	£2bn	£7bn	£3bn	£2bn	£23bn
	imports from the rest of the world	£8bn	£2bn	£8bn	£4bn	£3bn	£25bn
	all imports	*£65bn*	*£18bn*	*£50bn*	*£21bn*	*£18bn*	*£173bn*
final demand	imports from the rest of the UK	£13bn	£7bn	£9bn	£4bn	£3bn	£35bn
	imports from the EU	£4bn	£2bn	£2bn	£1bn	£1bn	£9bn
	imports from the rest of the world	£3bn	£2bn	£2bn	£1bn	£1bn	£9bn
	all imports	*£20bn*	*£10bn*	*£14bn*	*£5bn*	*£4bn*	*£53bn*
all demand	imports from the rest of the UK	£61bn	£20bn	£44bn	£18bn	£16bn	£160bn
	imports from the EU	£12bn	£4bn	£9bn	£4bn	£3bn	£32bn
	imports from the rest of the world	£12bn	£3bn	£10bn	£5bn	£4bn	£34bn
	all imports	*£85bn*	*£28bn*	*£64bn*	*£27bn*	*£22bn*	*£226bn*

Source: GLA Economics calculations

5 Conclusion

This is the first set of IO tables for London. They provide new insights on the structure of London's economy, and the city's trade with the rest of the UK, and the world.

The tables have been made available on the London Datastore[62], and so are available for analysis, and development, such as in producing a Computable General Equilibrium model to model the impacts on the London economy of changes.

In the absence of IO tables for other areas of the UK produced on a consistent basis it is only possible to produce limited comparisons of the London economy with other parts of the UK, or of trade flows within the UK. Improved modelling of inter-regional trade flows would be a benefit of itself, and its availability would be a significant next step to support the development of sub-national IO tables for the UK. The Economic Statistics Centre of Excellence (ESCoE)[63] advises that the next step would be to develop an inter-regional trade matrix for the four nations of the UK[64]. Ultimately, it would be positive if the ONS produced sub-national IO tables for the UK.

If it was possible to link a London IO table into a global database then it would be possible to do more complex analysis, such as to estimate London's role in global value chains, or produce environmental accounts, such as the household carbon consumption of imports.

[62] See https://data.london.gov.uk/dataset/london-input-output-tables
[63] ESCoE is an independent research centre sponsored by the ONS. It provides research that addresses the challenges of measuring the modern economy.
[64] See A Data Map of Existing UK Data Sources, ESCoE DP-2018-03 at Discussion Papers - ESCoE

Annex A Methodology for London input-output tables

A.1 Coverage

This annex outlines the approach taken in developing London's IO table. To do so, it first sets out the different types of IO tables and identifies which one has been used for the capital. It then sets out the specific methodology used to construct the London IO table setting out the data sources, and the modelling approach. The final section reviews how the modelling might need to be extended to provide a broader range of outputs.

A.2 Types of input-output tables

There are many different forms of IO tables. While they all effectively lead to the same output, the purpose of the IO table and the means for constructing it can vary greatly. For example, IO tables can vary from simply looking at one geographic area on its own to looking at several areas at the same time and illustrating the detailed trade links between them. Regional IO tables can also vary in terms of being constructed entirely using regional data to being based on the national IO tables.

Consequently, in this section, some of the main differing factors between IO tables are discussed. It also highlights the approach taken for the London IO table.

A.2.1 Geographic coverage – single area, intraregional or interregional

A key differing factor between IO tables is the scope and purpose of the analysis. IO tables can be produced to look at a single region and shows the intraregional links within that economy, or it can look at several regions and show the interregional links between them. It can also be something that lies between these two alternatives. A region might be a NUTS1[65] region like London, a NUTS2 region like an area of inner or outer London, a combination of regions like the Greater South East, or even whole countries.

Simply put, a single regional IO table only looks at the economy of one region in isolation (Case I in Figure A.1). Whereas an interregional IO table looks at several regional economies together (Case II in Figure A.1)[66]. For example, if a single regional IO table is a matrix with *x* columns and *y* rows, then an interregional IO table can be made up of one or more matrices also with *x* columns and *y* rows. From this simple explanation, the benefit of interregional IO tables can clearly be seen – that they are able to show the trade linkages between regions at a more granular level. This can be useful when showing the impact of interregional feedbacks. This is when, for instance, higher demand for a product in Region A can lead to higher demand along the supply chain in Region B which can then lead to a further increase in demand among B's supply chain in Region A. However, the negative can also be seen – that interregional IO tables require a lot of information about regional economies and trade flows (which could be estimated using survey or non-survey techniques like a gravity trade model).

There is potentially a third type of regional IO tables which sits between a single region and an interregional IO table (Case III in Figure A.1)[67]. This is where a model can show the impact on other regions but not capture the impact of interregional feedbacks. Using the example above,

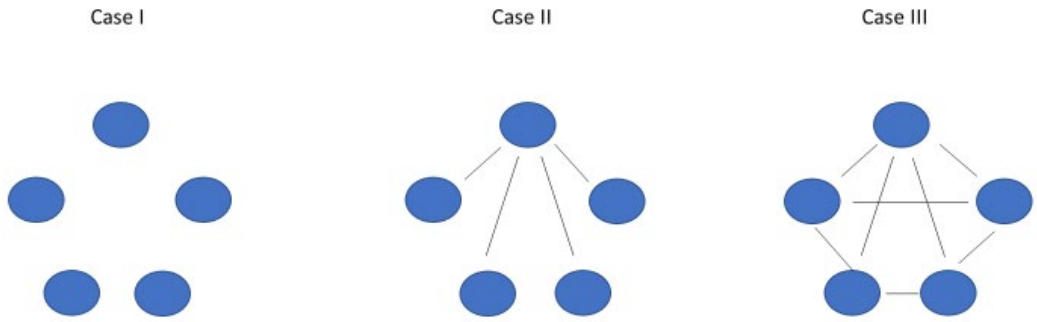
[65] See Eurostat - Office for National Statistics for the NUTS classification

[66] Miller, R & Blair, P (2009). Input-output analysis: foundations and extensions, second edition. Cambridge University Press, Cambridge, ISBN: 978-0-511-65103-8.

[67] See: Lenzen, et al (2004). CO2 multipliers in multi-regional input-output models, *Economic Systems Research*, 16, 4, pg.391-412; and Safr, K and Vltavska, K (2017). Illustration of single-regional and inter-regional approach in regional input-output analysis, *Statistika*, 97, 1, pg.17-31.

it can therefore capture the impact of higher demand in Region A along the supply chain in Region B but it does not capture the supply chain feedback from Region B to Region A. Figure A.1 shows a summary of the different types of regional IO tables.

Figure A.1: Different types of regional IO tables



Source: GLA Economics, from Safr, K and Vltavska, K (2017)

For the London IO table, the best description is the model that lies between a single and interregional IO table. This is because it has one-round export and import effects to other regions. In terms of the scope of the London IO table, the regions of focus are defined as London NUTS1 region, the rest of the UK comprised of all other UK NUTS1 regions, the EU, and the rest of world.

A.2.2 Economy characterisation – product or industry

ONS statistics for output and jobs tend, as a matter of course, to be for industries[68], such as Finance, and Professional services. The current UK Standard Industrial Classification of Economic Activities 2007 (SIC2007)[69] follows the Eurostat NACE classification[70].

A second approach is to classify the production of goods and services by products, rather than activities. Again, there is a Eurostat classification, known as the Classification of Products by Activity (CPA)[71], which ONS adopts. This categorises products which have common characteristics.

As Eurostat is responsible for both the NACE and CPA classifications it has developed them as an integrated system. Each CPA product, whether a transportable or non-transportable good or

[68] See, for example, for output All data related to gross value added (gva) - Office for National Statistics, and for jobs UK labour market Statistical bulletins - Office for National Statistics
[69] See UK SIC 2007 - Office for National Statistics
[70] See Glossary:Statistical classification of economic activities in the European Community (NACE) - Statistics Explained. The term NACE derives from the French **N**omenclature statistique des **a**ctivités économiques dans la **C**ommunauté **e**uropéenee.
[71] See Standard and other national and international classifications - Office for National Statistics and Glossary:Statistical classification of products by activity (CPA) - Statistics Explained

service, is assigned to one single NACE activity. The linkage to NACE activities gives the CPA a structure parallel to that of NACE at all levels.

As a consequence, while an industry may produce more than one product, the linkage between industry and product in the NACE and CPA classifications is for the primary product. For example, while butter is the primary product of the activities of the dairy industry, other products include processed liquid or solid milk, cream, yoghurt, and cheese. These other products are secondary products of the dairy industry, while butter would be a secondary product if it were produced by another industry. For this reason, there are separate, but interconnected, activity and product classifications.

As IO tables record the supply and use of resources in a single table they have the form of product by product or industry by industry. Eurostat has a preference for product by product IO tables, and this is what the ONS provides to them[72]. ONS does not produce industry by industry IO tables, and so as the London tables flow from the UK tables they are product by product.

As IO tables bring together the supply and use of resources in one table this has either to be in terms of industries or products:

- Industry by industry IO tables are closer to statistical sources, and actual market transactions
- Product by product IO tables are believed to be more homogenous in terms of cost structures and productive activities.

A.2.3 Modelling approach - survey, non-survey or hybrid

There are a range of possible approaches to the construction of IO tables. These can largely be grouped into three main types of methodologies[73] which are:

A.2.3.1 Survey methods

The survey approach utilises surveys or any other sort of reliable regional data to create IO tables. This is in a similar vein to the method used to create the national IO tables. Generally, survey-based IO tables are superior in terms of relevance, accuracy and robustness as they directly relate to information about the region. However, a lack of regional data and the high cost associated with collecting this information otherwise often makes this approach implausible.

Scotland has adopted this approach, and developed its own Supply and Use Tables[74] which it calibrates to the UK tables. These have a similar form to IO tables except they have a product by industry structure, and so cannot be combined into a single table. Assumptions need to be made to derive industry by industry or product by product supply and use tables, so that they can be combined to produce IO tables[75].

[72] See Eurostat Manual of Supply, Use and Input-Output Tables - Product - Eurostat
[73] Greenstreet, D (1989). A conceptual framework for constructing of hybrid regional input-output models, *Socio-Economic Planning Sciences*, 23, 5, pg.283-289.
[74] See Supply and use tables - Office for National Statistics
[75] See IO Methodology Guide for more information

A.2.3.2 Non-survey methods

These methods are also known as 'reduction methods'. This is because they often involve taking national data and reducing or scaling down to a sub-national level. Given this, this approach does not require lots of regional information as it uses national data and assumptions.

The London tables draw on the UK product by product IO tables, and makes use of Location Quotients (LQs) to provide the translation. They show the extent of which regional industries can satisfy regional demand[76]. These provide an estimate of the ratio between a region and a nation of which can then be applied to national tables, typically the national input coefficients (or matrix of coefficients) contained within the national IO table[77]. For example, if the LQs suggest that the regional industry is relatively smaller than the national industry, the national coefficients are reduced accordingly to produce regional coefficients. As will be apparent in the next sections, there are many different methods to create LQs and can include the use of regional output or employment data.

Other non-survey techniques include supply-demand pool approaches, fabrication effects, regional purchase coefficients and community IO models but these have not been considered here[78].

A.2.3.2.1 Simple location quotients

LQs can be viewed as a measure of the ability of a regional industry to supply goods and services to satisfy demand from other industries and by final demand in that region. In its simplest form, the simple LQs (or SLQs) measure the ratios between the regional and national proportions of an industry. This can be in terms of output, but other variables include employment[79] (usually the most popular), income or value added[80]. It is calculated by taking the ratio of a regional industry and the regional total and dividing it with the ratio of the national industry and the national total. Therefore, the definition of SLQs can be summarised as:

$$SLQ = \left(\frac{regional\ industry\ /\ regional\ total}{national\ industry\ /\ national\ total}\right)$$

These SLQs can then be multiplied to the national input coefficients (i.e. the matrix of coefficients) to create regional input coefficients. Sometimes the SLQs can be greater than one meaning that the industry is more highly concentrated in the region than in the nation. This implies that the regional industry is producing more supply than is regionally demanded. In these cases, it is assumed that this surplus production would be exported to the rest of the nation and the SLQ is assumed to be equal to one, i.e. the regional input coefficient is the same as the national coefficient. However, an issue with this assumption is that the strength of this export relationship when SLQs are greater than one are not accounted (1 x coefficient) unlike for the strength of the import relationship when SLQs are less than one (SLQ x coefficient).

[76] Boero, R, Edwards, B & Rivera, M (2017). Regional input-output tables and trade flows: an integrated and interregional non-survey approach, *Regional Studies*, 52, 2, pg.225-238.
[77] Round, J (1983). Non-survey techniques: a critical review of the theory and the evidence, *International Regional Science Review*, 8, 3, pg.182-212.
[78] For a broad overview of the different approaches, see: Miller, R & Blair, P (2009). Input-output analysis: foundations and extensions, second edition. Cambridge University Press, Cambridge, ISBN: 978-0-511-65103-8.
[79] An issue with using employment is that it does not consider differences in productivity across regions.
[80] Ibid.

An issue specific with SLQs relates to it looking at one industry in isolation. It does not consider the relative size of a regional industry providing inputs and the relative size of a regional industry buying those inputs[81]. So, while a SLQ less than one implies regional industry *i* would need imports to satisfy demand, the part that it could supply on its own could be sufficient to satisfy demand from regional industry *j* if not the entire region. For example, this could be the case when a supplier has specialised in meeting demand from a specific sector but not demand in aggregate. Another complaint is that it could underestimate regional trade (and inversely overestimate intraregional economic activity). It potentially ignores 'cross-hauling' which is the situation in which a region can have both export and imports in individual goods and services as, using the SLQ methodology, a sector can only be an exporter or an importer at any time[82].

A.2.3.2.2 Cross-industry location quotients

These issues can be addressed to some extent by using cross-industry location quotients (CILQs). This looks at the relative regional share of industry *i* as a ratio against the relative regional share of industry *j*[83]. This means that when the supplying industry is relatively smaller than the purchasing industry (CILQ is less than one), then some of the inputs would need to be met by imports. Overall, the formula for calculating CILQs can be summarised as:

$$CILQ = \frac{regional\ /\ national\ for\ industry\ i}{regional\ /\ national\ for\ industry\ j}$$

As with SLQs, when CILQs are greater than one, the regional coefficient is assumed to be the same as the national coefficient (i.e. CILQs = 1). And in instances when industry *i* is the same as industry *j* (i.e. the diagonal elements on a matrix), the convention is to use SLQs instead[84].

A.2.3.3 Hybrid methods

A hybrid method lies between both the survey and non-survey approaches, though the process is more aligned with the latter. There are many different types of hybrid techniques used to create regional IO tables. A common approach, adopted for the London IO table, is the Generation of Regional Input-Output Tables (GRIT) technique. It usually involves five steps which are[85]:

1) Identify a national IO table
2) Use an allocation or location quotient technique to reduce national coefficients to regional coefficients
3) Add superior data and opinion
4) Define appropriate regional sectors by aggregating national sectors adding more superior data (if available) about these regional sectors
5) Using superior data and opinion to refine regional IO table

[81] Flegg, A et al (1995). On the appropriate use of location quotients in generating regional input-output tables, *Regional Studies*, 29, 6, pg.547-561.
[82] Miller, R & Blair, P (2009). Input-output analysis: foundations and extensions, second edition. Cambridge University Press, Cambridge, ISBN: 978-0-511-65103-8.
[83] Flegg, A et al (1995). On the appropriate use of location quotients in generating regional input-output tables, *Regional Studies*, 29, 6, pg.547-561.
[84] Ibid.
[85] Miller, R & Blair, P (2009). Input-output analysis: foundations and extensions, second edition. Cambridge University Press, Cambridge, ISBN: 978-0-511-65103-8. Based on a description by Hewings, G & Jensen, R (1986). Regional, interregional and multiregional input-output analysis, *Handbook of Regional and Urban Economics*, 1, pg. 295-355.

The London tables involve using LQs to reduce the national IO table down to a regional level, and supplements this process with regional survey data and expert opinion to improve reliability and robustness. The London Business Survey[86] has been used to incorporate import and export data specific to London.

A hybrid approach does involve some caveats and assumptions which would need testing to ensure they are valid in a London context at a later stage. Specifically, regarding the non-survey aspect of the methodology, there are two key assumptions which are[87]:

- **Technological coefficients are the same at a national and regional level**
  As noted earlier, LQs are used to show whether a local industry can satisfy local demand. If there is too much supply, this can result in exports to other regions or countries. Similarly, if there is too little supply, this can result in imports from other regions or countries. Consequently, LQs can be considered to reflect the trade coefficients aspect within a regional IO table (i.e. the extent of which a region exports or imports). However, academic literature also points to technological coefficients[88,89] which can reflect the product mix in producing output, the relative productivity of firms and factors that can influence this such as age and size of businesses, and the quality of labour and capital among other factors[90]. LQs do not alter the technological coefficients aspect of the national IO table meaning there is an implicit assumption that the technological aspect is the same at both a regional and national level which may or may not be an accurate reflection.

- **Consumption preferences are the same at a national and regional level**
  The second assumption is that the consumers of output – whether this is private like households and businesses or public like the government – are assumed to have the same preferences at both the national and regional levels. That is, the decision to consume a basket of goods and services over another basket is assumed to be the same in London and across the UK. This, again, is because LQs cannot adjust when reducing the national table to the regional level. This assumption is less relevant to the London IO table. As the next section sets out there are a number of elements of final consumption for which there is data for London, and where this is available this has been used. Other elements have been estimated using a different methodology.

A.3 The London IO table

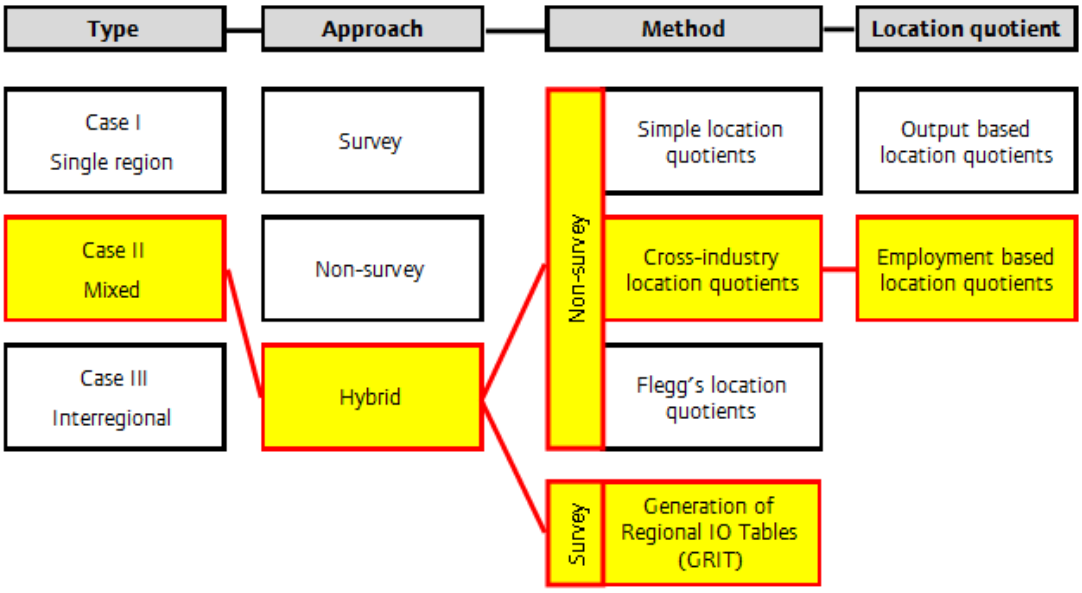
While the previous section set out the type of regional IO table used for the capital, this section discusses the actual methodology and data used to construct the London IO table.

To summarise so far, the London IO table is a 'mixed' regional IO table in that it is primarily focussed on a single region – London – but also looks at the one-round trade effects with other regions. Here, the other regions are defined as the rest of the UK, the EU, and the rest of the

[86] See London Business Survey 2014 – London Datastore
[87] Boero, R, Edwards, B & Rivera, M (2017). Regional input-output tables and trade flows: an integrated and interregional non-survey approach, *Regional Studies*, 52, 2, pg.225-238.
[88] This is sometimes referred to as technical coefficients in the literature. However, in line with the research by Lindberg (2011), technological coefficients is used here to avoid confusion with the trade coefficients at a national level that is sometimes referred to a technical coefficients.
[89] See: Round, J (1983). Non-survey techniques: a critical review of the theory and evidence, *International Regional Science Review*, 8, 3, pg.182-212; and Lindberg, G (2011). On the appropriate use of (input-output) coefficients to generate non-survey regional input-output tables: implications for the determination of output multipliers.
[90] Miller, R & Blair, P (2009). Input-output analysis: foundations and extensions, second edition. Cambridge University Press, Cambridge, ISBN: 978-0-511-65103-8.

world. The methodology itself is a hybrid approach. This involves using a non-survey method – namely LQs which are based on regional employment data – to reduce the national IO table to a regional level. This is then supplemented with regional data and information like those described as part of the Generation of Regional IO Tables (GRIT) technique to make the regional IO table more relevant to the capital. This overall approach is summarised in Figure A.2.

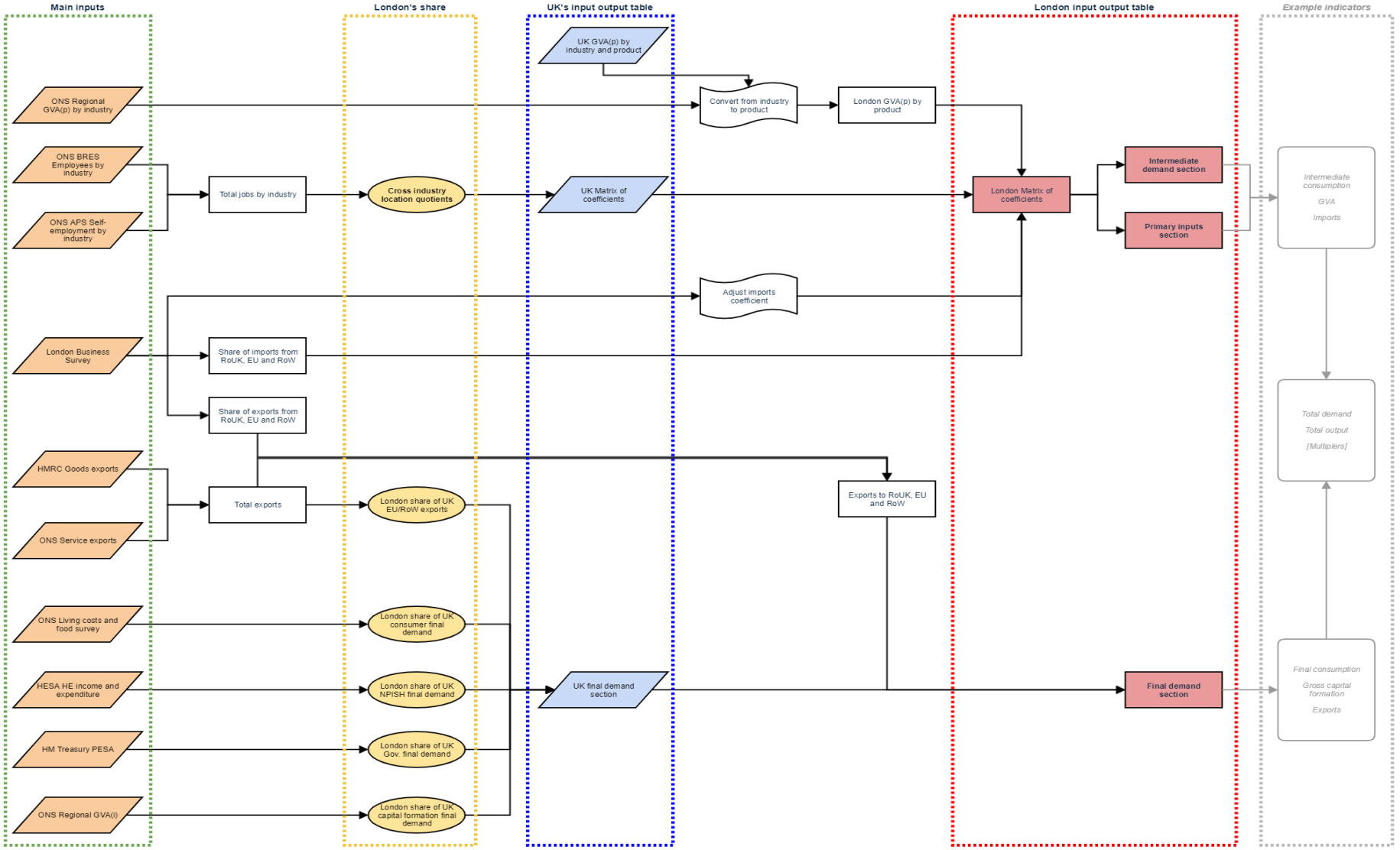
Figure A.2: Overview of the London input-output table approach



Source: GLA Economics

The rest of this section describes the data sources, modelling approach and outputs when creating the London IO table. Figure A.3 provides a flowchart of how this has been operationalised.

Figure A.3: Modelling approach for the London IO table



Source: GLA Economics

A.3.1 Data inputs

Table A.1 lists the data sources that have been used in the derivation of the London IO table.

Given that the London IO table uses a non-survey approach to reduce the national IO table to a regional level, the first data source is the national IO table itself. This is produced by the ONS. While the ONS produces IO supply and use tables annually, the analytical IO table which is of interest here is produced on a more ad-hoc basis. The latest national IO table available at the time of analysis for this paper was for 2013 and is consequently the same base year for the London IO table[91].

Overall, a summary of the main data sources used in the London IO table is shown in Table A.1.

Table A.1: Main data sources used in the London input-output table

Variable	Data	Source
National IO table	UK IO analytical tables	ONS Supply and Use Tables
	UK IO supply and use tables	ONS Supply and Use Tables
Jobs by industry	Workforce jobs (1-digit SIC)	ONS Workforce Jobs
	Employee jobs (2-digit SIC)	ONS Business Register and Employment Survey
	Self-employment jobs (2-digit SIC)	ONS Annual Population Survey
GVA, and income components, by industry	Regional GVA (balanced estimate)	ONS Regional GVA
Supplementary data on imports	London Business Survey 2014	GLA London Business Survey
Share of sales from London to rest of UK	London Business Survey 2014	GLA London Business Survey
London share of UK exports to rest of world	Goods exports	HMRC Regional Goods Exports
	Services exports	ONS Regionalised Estimates of UK Service Exports
Split of London rest of world exports to EU	London Business Survey 2014	GLA London Business Survey
Share of household final expenditure	Weekly household expenditure	ONS Living Costs and Food Survey
Share of NPISH final expenditure	Expenditure by higher education provider	HESA Higher Education Income and Expenditure
Share of government final expenditure	Identifiable and non-identifiable public sector expenditure	HM Treasury Public Sector Expenditure Analysis
Share of gross fixed capital formation	Regional gross fixed capital formation	ONS Regional Accounts

Source: GLA Economics

A.3.2 The calculations for the London IO table

The UK IO table has 127 products. While most products are available at market prices, there are two other categories for which there are not market prices, and for some products there are additional categories to capture this:

- Output for own final use, which includes farmers who consume a proportion of their own produce, and companies who produce and invest in tools or other machines for their own purposes

[91] ONS has subsequently published a 2014 table, see UK input-output analytical tables - Office for National Statistics

- Non-market output, which includes military defence, and the NHS

As the translation from the UK to the London table uses jobs data, which has no breakdown on the activities of companies it has not been possible to maintain this distinction. There are also a few products for which sample sizes of jobs data are not sufficient to provide robust London estimates, and which have been combined with other products.

As a result, the base analysis for the London IO table has 75 products.

This has been further reduced to 15 products for the principal analysis. This is because the London Business Survey, which is one source for import and export data has thirteen sectors. It did not survey Primary & utilities businesses, or businesses in Public administration or Education. These have been added as two products in this modelling, and it has been assumed that the propensity to import and export is in line with the London average[92].

The general ethos for constructing the London IO table is applying London's share to the UK IO tables (i.e. a non-survey approach). This is 'constrained' by known data points for the capital (i.e. a survey hybrid approach).

The first step is the estimation of the CILQs used to reduce the national IO table to London. As noted in the previous section, the London CILQs are based on employment/jobs which is usually the preferred basis given it being readily available and having a higher degree of accuracy. The preferred measure of jobs is the number of workforce jobs, but this is only available by broad industry group (1-digit SIC) while the national IO table is based on detailed sectors[93] (2-digit SIC). To get around this, a proxy of workforce jobs is estimated for the detailed sectors using employee jobs from the ONS Business Register and Employment Survey and self-employment jobs from the ONS Annual Population Survey. This is a standard approach used by GLA Economics in other publications like work looking at GVA per job[94]. This proxy is scaled to the workforce job estimates by broad industry for consistency.

As noted above, the CILQs are adjusted somewhat. For example, the simple location quotients (SLQs) are used on diagonals and CILQs that are greater than one are imposed to equal one.

The CILQs are then multiplied with the UK IO table, specifically the matrix of coefficients (also known as input coefficients). CILQs less than one suggest that the industry is relatively smaller in London than the UK and the input coefficients are reduced. Overall, this produces a **London matrix of coefficients**.

There is more accurate published information on GVA and exports, so this is incorporated into the IO table. The implied GVA estimates are replaced with ONS published regional GVA (balanced estimated) data for the capital[95]. This is equal to the sum of compensation of employees, gross operating surplus and taxes less subsidies on production lines in the IO table[96].

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[92] There are also imports and exports which are not part of business consumption or production, and so would not be captured in London Business Survey measures of purchases and sales. This might, for example, be imports by households, or imports would go for exports without further economic activity. Where splits use the London Business Survey the value used is the London average.

[93] The IO table is based on products rather than industries, but these use similar coding systems and consequently the terms are used interchangeably here.

[94] For example, see: GVA per workforce job estimates for London and the UK, 1997 - 2015 | London City Hall

[95] This uses GVA(B) estimates for 2013 from the 2018 ONS GVA release.

[96] For which there is also London sector level data at Nominal regional gross value added (balanced) per head and income components - Office for National Statistics

However, ONS published GVA statistics are on an industry basis, while the IO tables are on a product basis. Consequently, to convert the GVA by industry data into GVA by product estimates, the ratio between GVA by industry (from the ONS Regional GVA data) and by product (from the UK IO table) at the UK level is applied to the London GVA by industry estimates, and calibrated to the value of London GVA. This is then inserted into the London IO table as supplementary information. The distribution of the components of GVA for each product across taxes less subsidies on production, compensation of employees and gross operating surplus is left unchanged in the absence of better published information.

The next step is to estimate the components of the **final demand section of the London IO table**.

The exports component requires figures for goods and services by sector, for the rest of the UK, the EU, and the rest of the world. The first step is to align to published figures. The value of service exports outside the UK is aligned to published ONS regional statistics on UK service exports, and the distribution of exports between the rest of the UK, the EU[97], and the rest of the world follows the results of the London Business Survey[98]. The London Business Survey collected information about where London firms buy and sell goods and services (within London, rest of UK and rest of world) which can be used as proxies for imports and exports.

HMRC regional goods exports data is recorded by the UN Standard International Trade Classification (SITC)[99]. This does not align with the Eurostat CPA classification, which has been used as the sector definition in the London IO table. Eurostat publishes correspondence tables[100], which in principle permit a readacross of categories between the two classifications. Unfortunately, the mapping for the CPA classification does not include the Wholesale sector, and for this sector the ONS reports goods exports from the UK. Further, application of the mapping implied by the correspondence table suggests that around 90% of London's goods exports are in Manufacturing, which would be over 350% of that sector's GVA, which is implausible.

The ONS also faces this issue of mapping exports data between classifications. The Pink Book[101], on the balance of payments, provides goods exports estimates on the SITC classification, while, as noted the UK IO tables follow the CPA classification. The ONS has the capability to combine administrative datasets to derive a mapping between classifications[102].

This analysis is not available to GLA Economics which has had to make an assumption instead. about the allocation of goods exports across products. Clearly, this can only be for products for which there are UK exports, and the total should be calibrated to the HMRC figure for total London goods exports. Three options have been considered, and the results reported in Table A.2:

[97] Formally the survey was of European Economic Area members, but as this is the same as the EU plus Iceland, Liechenstein, and Norway in this paper this is annotated as the EU
[98] GLA (2015). London Business Survey 2014, July 2015.
[99] See United Nations Statistics Division - Trade Statistics
[100] See Europa - RAMON - Correspondence Tables List, where there are tables for SITC and Combined Nomenclature (CN), and CPA and CN
[101] See UK Balance of Payments, The Pink Book: 2018 - Office for National Statistics
[102] See UK trade in goods by industry, country and commodity - Office for National Statistics

- Allocation between products in proportion to London GVA – exports for Information, communications, arts, entertainment and recreation are higher than UK exports, and for this reason this option has not been chosen
- Allocation between products in proportion to UK exports. Manufacturing exports for London as a share of GVA at 294% appears very high, and this option does not reflect that the structure of London's economy is different to that for the UK. This option has not been chosen
- London exports estimated as the proportion to the London share of UK GVA applied to UK exports. This is the preferred option.

Table A.2: Sector distribution of London goods exports for various allocation methods

Product classification		method of allocating goods exports across sector production					
Code	Description	in proportion to London GVA		in proportion to UK exports distribution		London share of UK GVA	
		value of exports	% sector GVA	value of exports	% sector GVA	value of exports	% sector GVA
A, B, D & E	Primary & Utilities	£1bn	34%	£4bn	98%	£1bn	29%
C	Manufacturing	£5bn	68%	£23bn	294%	£14bn	172%
F	Construction	£0bn	0%	£0bn	0%	£0bn	0%
45+46	Wholesale (inc. motor trades)	£8bn	72%	£5bn	41%	£11bn	98%
47	Retail (exc. motor trades)	£0bn	0%	£0bn	0%	£0bn	0%
H	Transport and storage	£0bn	0%	£0bn	0%	£0bn	0%
I + 79	Accommodation, food, travel and tourism	£0bn	0%	£0bn	0%	£0bn	0%
J+R	Information, communications, arts, entertainment and recreation	£12bn	29%	£1bn	2%	£7bn	16%
K	Financial and insurance activities	£0bn	0%	£0bn	0%	£0bn	0%
L+71+81	Real estate, architecture, engineering and building services	£3bn	5%	£0bn	0%	£0bn	0%
M-71-72-75	High value business support	£3bn	7%	£0bn	0%	£0bn	0%
N+S-79-81	Administrative and support services	£0bn	0%	£0bn	0%	£0bn	0%
Q+72+75	Health, social work, scientific R&D and veterinary services	£0bn	0%	£0bn	0%	£0bn	0%
O+P	Public administration & education	£0bn	0%	£0bn	0%	£0bn	0%
T	Households as employers	£0bn	0%	£0bn	0%	£0bn	0%
	Total	**£33bn**	**9%**	**£33bn**	**9%**	**£33bn**	**9%**

Source: GLA Economics

The final consumption section of the IO table includes final household, NPISH and government expenditure. For the London IO table, the values from the national IO table are taken and London's share of the UK total is applied. The 'share' varies depending on the final expenditure category:

- For households, London's share is based on weekly household expenditure by commodity/service consumed from the ONS Living Costs and Food Survey. Total weekly household expenditure is estimated by multiplying the average expenditure with the weighted number of households. This is calculated for London and the UK; thus, London's share by commodity/service consumed can then be estimated.

These shares are applied to the household final consumption expenditure figures by commodity/service consumed included in the UK supply and use tables. As the UK figures in the supply and use tables and the IO table are slightly different due to various accounting concepts and prices, the supply and use figures are scaled to the IO numbers. This scaling factor is also applied to the London estimates.

- For NPISH, London's share is based on the expenditure by higher education institutions. This is broadly in line with the approach taken by the Scottish Government of which they state that "NPISH includes most universities, charities (including most private schools), religious societies, trade unions and member's clubs…Data specifically relating to the NPISH

sector for Scotland are very limited, however [since] universities represent the main part of the NPISH sector, final demand for the education product will be the same as output from Higher Education institutions and private schools. The remainder of NPISH final demand is estimated in line with ONS classifications and using the UK tables"[103]. Consequently, data relating to higher education expenditure is from HESA and is used to estimate London's share. This share is then applied to the NPISH expenditure figures within the UK IO table.

- For government, London's share is based on central and local government expenditure by government function reported within the HM Treasury PESA database. This is in line with previous work by GLA Economics[104]. Expenditure is either identifiable (i.e. relates to a specific region) or non-identifiable (i.e. relates to more than one region), though non-identifiable spending has been apportioned to regions on a per capita basis. Subsequently, this creates estimates of London's share by government function.

The government expenditure data is broken down by government function and do not align fully with the breakdowns included in the IO. However, this has been matched on a like-for-like basis as much as possible. For example, the education function is assumed to be approximate to SIC 85: Education. For functions that do not align well, the average of all functions is alternatively used. Overall, the London's shares are applied to the government expenditure figures included in the UK IO table.

The remaining parts of final demand is gross capital formation. The ONS publishes London level data at a broad industry level[105], and converted to a product level using the methodology adopted for GVA described above. Allocations across components of gross capital formation, and to individual products are in the proportions of the UK IO table. This updates previous GLA Economics work[106]. Overall, this completes the **final demand section of the London IO table**.

There is no published data on imports of services by region[107], and so no data on imports by region. This is a recognised limitation of UK official statistics[108]. Total imports to London have been estimated using an accounting identity:

GVA + taxes less subsidies on products = Final demand – imports

The London Business Survey has been used to estimate the distribution of imports between the rest of the UK, the EU, and the rest of the world, and across products. **As there is no published data source to calibrate estimates of imports measurement error in the derivation of components of final demand will be reflected in the estimates of imports.**

The incorporation of supplementary information on GVA, exports, and imports in the London matrix of coefficients, means that the column totals will no longer sum to one. Consequently, the entire matrix of coefficients table is re-estimated based on the coefficients relative to the

[103] Scottish Government (2017). Input-output methodology guide, version 3, July 2017, pg. 11.
[104] For example, see: GLA Economics (2014). Growing Together II: London and the UK economy, September 2014.
[105] See Regional Gross Fixed Capital Formation, NUTS1 and NUTS2, 2000 to 2016 - Office for National Statistics
[106] GLA Economics (2014). Growing Together II: London and the UK economy, September 2014.
[107] HMRC published statistics on imports to the UK by region of goods, see UK regional trade in goods statistics disaggregated by smaller geographical areas - GOV.UK
[108] See A Data Map of Existing UK Data Sources, ESCoE DP-2018-03 at Discussion Papers - ESCoE

column total. This process means that the column totals should again equal one and results in an **adjusted London matrix of coefficients**.

From the adjusted matrix of coefficients, the coefficient (or the share) associated with GVA is known. Therefore, the total output can easily be calculated by applying this ratio. For example, say GVA is estimated at £100m and the coefficient is 0.4, total output (which would have a coefficient of 1) can be calculated as £250m (£100m / 0.4). Now that the value of total output is known, the rest of the matrix of coefficients can be easily applied by multiplying this total value with the coefficients. Overall, this completes the **intermediate consumption and primary input sections of the London IO table**.

A.3.2 Model outputs

The data tables for 15 products are available for download from the London Datastore[109]:

- IO table
- Matrix of coefficients
- Leontief inverse
- Primary input content of final demand

Chapter 2 explains the calculations underpinning the tables, and the main results are in Chapters 3 and 4.

A.4 Model developments

The London IO table is a self-contained model which provides evidence on the structure of the London economy, and its exports to, and imports from, the rest of the UK, the EU, and the rest of the world. There are two ways in which the model might develop.

A.4.1 Computable General Equilibrium models

While IO tables can be used to estimate multiplier effects of policies across an economy there are theoretical concerns that these estimates may not be robust because of a lack of supply or budget constraints, and because the table cannot accommodate relative price changes.

Computable General Equilibrium (CGE) models address this. They combine data on the structure and linkages within an economy from an IO table with a set of equations grounded in economic theory of general equilibrium and empirical evidence to estimate the direct and indirect effects of a policy change. The models ensure supply and demand for goods, services and the factors of production, that is labour and capital, in the economy are balanced. They also determine how firms and households respond to changes in incentives. By this means they address the limitations of IO tables.

Model estimates are for the medium to long-term as they are intended to pick up a full range of impacts, and the UK Government has used this approach to estimate the effects of various Brexit scenarios at a national and regional level[110]. The EC RHOMOLO model[111] is a dynamic spatial general equilibrium model used for ex-ante impact assessment of policy instruments such as the EU Cohesion Policy at a regional level, including the UK.

[109] See https://data.london.gov.uk/dataset/london-input-output-tables
[110] See Exiting the European Union: Publications - GOV.UK
[111] See The RHOMOLO model | EU Science Hub

A.4.2 Multi-region input-output models

It has been noted that a limitation of the London IO table is the limited scope to model trade effects – this requires models of the form of Case III in Figure A.1. This restricts understanding of the interaction of the London economy with those elsewhere in the UK and beyond. One consequence is that the environmental impacts of trade with the London economy are not known.

IO tables which consider imports and exports by country or region to provide more comprehensive analysis of trade flows are available. The World Input-Output Database (WIOD)[112] holds data on 56 sectors, and the OECD has developed a set of IO tables to estimate global value chains[113]. The Eora global supply chain database[114] has environmental indicators, including greenhouse gas emissions, and can be used, for example, to model carbon consumption through indirect demand effects.

There is one set of international IO tables which includes the UK at a sub-national level. The key input is the development of regional trade data for NUTS2 European regions. The methodology adopted is[115]:

- take the WIOD national supply and use tables
- develop regional supply and use tables using Eurostat regional data on sector production, investment and income
- calibrate to national supply and use tables

The sub-national IO tables have not been published. Academic publications are analyses of trade flows[116], and the tables also support the EC RHOMOLO model.

[112] See WIOD Home
[113] See Input-Output Tables (IOTs) - OECD
[114] See Eora Global MRIO
[115] For a fuller explanation see Multi-regional trade data on Europe in 2010 - PBL Netherlands Environmental Assessment Agency
[116] For an example, see Exposure to Brexit in regions on both sides of the Channel | VOX, CEPR Policy Portal, and a fuller version at The continental divide? Economic exposure to Brexit in regions and countries on both sides of The Channel - Chen - 2018 - Papers in Regional Science - Wiley Online Library

Annex B Interlinkages in the London economy – methodology and detailed tables

Chapter 2 provides the background to IO tables, and the formulae behind the main calculations. Chapter 3 provides results for interlinkages in the production and consumption of products across the London economy. It did this for:

- Direct and indirect effects
  - Direct, that is products used for intermediate demand
  - Indirect effects, which also includes estimates of the use of products for final demand
- Backward and forward linkages
  - Backward linkages, that is the consumption of the output of other sectors in the production of a particular sector, and
  - Forward linkages, that is the use of the production of a particular sector in the consumption of other sectors

Chapter 2 defined **x** as the value of products, and **A** as the matrix of intermediate consumption of products, then from which we can define **Z,** which is intermediate demand, as:

$$\mathbf{Z} = \mathbf{Ax}$$

The matrix of intermediate consumption derives from the matrix of coefficients[117]. This includes other inputs to production, as well as other products, such as labour, capital and imports, and the sum of the elements of each row is one. This corresponds to direct requirements.

Direct and indirect requirements can be estimated from the Leontief inverse, **L**:

$$\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is the inverse of $(\mathbf{I} - \mathbf{A})$, and **I** is the identity matrix, which has ones on the diagonal, and zeroes elsewhere.

The main Leontief inverse, **L**, weights all products equally. The third form of modelling of linkages in Chapter 3 uses an adapted Leontief inverse, $\mathbf{L^w}$, which weights products according to their value in the economy.

Define **W** as

$$w_{ij} = \frac{z_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} z_{ij}}$$

Then:

$$\mathbf{L^w} = \mathbf{L^{-1}W}$$

Where $\mathbf{L^{-1}}$ is the inverse of the Leontief inverse, **L**

[117] This combines matrices **A** and **p** as defined in Chapter 2

Table B.1 provides the results in Figures 3.1-3.3 corresponding to the calculation of backward and forward linkages for unweighted direct effects (**A**), unweighted direct and indirect effects (**L**), and weighted direct and indirect effects ($\mathbf{L}^{w}$). In accordance with their definitions backward linkages are column sums of the respective matrices, and forward linkages are row sums for individual products.

Table B.1: Backward and forward linkages for London economy, direct and indirect requirements, weighted and unweighted, 2013

product		unweighted				weighted	
code	description	direct		direct & indirect		direct & indirect	
		backward	forward	backward	forward	backward	forward
01	Agriculture	0.03	0.24	1.04	1.35	0.00	0.01
02	Forestry and logging	0.23	0.06	1.29	1.07	0.00	0.00
03	Fishing	0.11	0.01	1.14	1.02	0.00	0.00
05 & 06-08	Coal & lignite, and Oil & gas extraction, metal ores & other	0.20	0.17	1.25	1.40	0.00	0.01
09	Mining Support	0.05	0.08	1.06	1.12	0.00	0.00
10	Food products	0.46	0.52	1.59	1.67	0.02	0.03
11-12	Beverages and tobacco	0.34	0.10	1.45	1.12	0.00	0.01
13	Textiles	0.09	0.20	1.12	1.21	0.00	0.00
14	Wearing apparel	0.26	0.00	1.33	1.00	0.00	0.00
15	Leather goods	0.11	0.00	1.14	1.00	0.00	0.00
16	Wood and wood products	0.27	0.17	1.36	1.21	0.00	0.01
17	Paper & paper products	0.12	0.37	1.16	1.48	0.00	0.01
18	Printing and recording	0.32	0.23	1.42	1.29	0.00	0.01
19-20	Coke, petroleum and chemicals	0.12	0.64	1.16	1.83	0.00	0.02
21	Pharma-ceuticals	0.06	0.02	1.08	1.02	0.00	0.00
22	Rubber & Plastic	0.11	0.34	1.14	1.45	0.00	0.02
23	Other non-metallic mineral products	0.35	0.12	1.50	1.17	0.00	0.01
24	Basic metals	0.10	0.21	1.13	1.27	0.00	0.00
25	Fabricated metal	0.15	0.56	1.19	1.73	0.00	0.02
26	Computers, electronics & opticals	0.22	0.16	1.28	1.20	0.00	0.01
27	Electrical equipment	0.21	0.15	1.27	1.21	0.00	0.01
28	Machinery & equipment	0.13	0.16	1.15	1.21	0.00	0.00
29	Motor Vehicles	0.30	0.19	1.36	1.25	0.00	0.01
30	Other transport equipment	0.07	0.05	1.09	1.06	0.00	0.00
31	Furniture	0.28	0.04	1.36	1.04	0.00	0.00
32	Other manu-facturing	0.18	0.08	1.23	1.11	0.00	0.00
33	Repair & maintenance	0.29	0.35	1.38	1.48	0.00	0.01
35	Electricity, gas and air conditioning	0.40	1.08	1.57	2.70	0.02	0.05
36, 37	Water and sewerage	0.10	0.11	1.13	1.15	0.00	0.00
38, 39	Waste, remediation & management	0.26	0.20	1.36	1.25	0.00	0.01
41-43	Construction	0.31	0.84	1.42	2.21	0.13	0.14
45	Wholesale & Retail - vehicles	0.04	0.52	1.06	1.71	0.00	0.03
46	Wholesale - excl vehicles	0.20	0.53	1.30	1.68	0.05	0.03
47	Retail - excl vehicles	0.26	0.00	1.37	1.00	0.05	0.00
49	Land transport	0.47	0.60	1.74	1.95	0.08	0.07
50	Water transport	0.44	0.16	1.65	1.19	0.01	0.00
51	Air transport	0.36	0.00	1.50	1.00	0.02	0.00
52	Support services for transport	0.31	0.51	1.44	1.81	0.02	0.05
53	Post & courier	0.30	0.26	1.41	1.36	0.01	0.03
55	Accomm-odation	0.28	0.01	1.39	1.01	0.01	0.00
56	Food & beverage services	0.23	0.05	1.33	1.06	0.04	0.00
58	Publishing services	0.38	0.16	1.53	1.19	0.02	0.01
59, 60	Film video & TV etc.; broadcasting	0.42	0.15	1.61	1.18	0.07	0.02
61	Telecommunications	0.29	0.36	1.39	1.49	0.02	0.04
62	Computer services	0.23	0.67	1.33	1.89	0.04	0.06
63	Information services	0.25	0.17	1.35	1.21	0.01	0.01
64	Financial services	0.25	0.50	1.35	1.69	0.14	0.06
65	Insurance & pensions	0.42	0.30	1.62	1.41	0.05	0.03
66	Auxiliary financial services	0.31	0.11	1.43	1.15	0.04	0.01
68	Real estate	0.19	0.27	1.27	1.36	0.10	0.03
69	Legal and accounting	0.21	0.50	1.29	1.72	0.04	0.06
70	Head office & consulting services	0.31	0.47	1.45	1.68	0.04	0.06
71	Architectural services etc.	0.38	0.56	1.55	1.85	0.02	0.05
72	Research & development	0.25	0.11	1.34	1.12	0.00	0.00
73	Advertising & market research	0.32	0.24	1.45	1.32	0.04	0.02
74	Other professional services	0.29	0.14	1.42	1.18	0.02	0.01
75	Veterinary services	0.16	0.01	1.22	1.01	0.00	0.00
77	Rental and leasing services	0.26	0.32	1.36	1.49	0.01	0.03
78	Employment services	0.36	0.68	1.52	2.01	0.03	0.06
79	Travel & related services	0.35	0.41	1.52	1.58	0.02	0.03
80	Security & investigation	0.28	0.12	1.40	1.15	0.00	0.01
81	Building & landscape services	0.56	0.55	1.90	1.85	0.02	0.04
82	Business support services	0.27	0.29	1.39	1.39	0.02	0.03
84	Public administration & defence	0.29	0.18	1.39	1.29	0.07	0.02
85	Education	0.11	0.28	1.14	1.39	0.02	0.03
86	Health	0.17	0.03	1.23	1.03	0.02	0.00
87, 88	Residential care and social work	0.32	0.20	1.45	1.24	0.01	0.01
90	Creative services	0.44	0.00	1.63	1.01	0.02	0.00
91	Cultural services	0.24	0.08	1.35	1.09	0.00	0.00
92	Gambling	0.18	0.10	1.24	1.12	0.00	0.00
93	Sports & recreation	0.38	0.04	1.55	1.05	0.00	0.00
94	Membership organisations	0.19	0.28	1.25	1.34	0.01	0.02
95	Repairs - personal and household	0.19	0.03	1.26	1.03	0.00	0.00
96	Other personal services	0.16	0.10	1.21	1.13	0.00	0.01
97	Households as employers	0.00	0.00	1.00	1.00	0.00	0.00

Source: GLA Economics calculations

An alternative presentation is to consider backward and forward linkages for each product excluding links within that product, and so to gain a sense of the impacts of linkages between products. Table B.2 provides the corresponding results in Figures 3.1-3.3 for the calculation of backward and forward linkages for unweighted direct effects (**A**), unweighted direct and indirect effects (**L**), and weighted direct and indirect effects ($\mathbf{L}^{w}$). In accordance with their definitions backward linkages for each product are column sums of the respective matrices less linkages for that product, and forward linkages for each product are row sums for individual products less linkages for that product.

Table B.2: Backward and forward linkages for London economy, excluding linkages within each product, direct and indirect requirements, weighted and unweighted, 2013

product		unweighted				weighted	
code	description	direct		direct & indirect		direct & indirect	
		backward	forward	backward	forward	backward	forward
01	Agriculture	0.02	0.24	0.03	0.35	0.00	0.01
02	Forestry and logging	0.18	0.01	0.23	0.01	0.00	0.00
03	Fishing	0.10	0.01	0.13	0.01	0.00	0.00
05 & 06-08	Coal & lignite, and Oil & gas extraction, metal ores & other	0.19	0.16	0.23	0.38	0.00	0.01
09	Mining Support	0.04	0.08	0.06	0.11	0.00	0.00
10	Food products	0.35	0.42	0.47	0.55	0.02	0.03
11-12	Beverages and tobacco	0.34	0.10	0.45	0.12	0.00	0.01
13	Textiles	0.08	0.18	0.11	0.19	0.00	0.00
14	Wearing apparel	0.26	0.00	0.33	0.00	0.00	0.00
15	Leather goods	0.11	0.00	0.14	0.00	0.00	0.00
16	Wood and wood products	0.19	0.09	0.27	0.12	0.00	0.01
17	Paper & paper products	0.10	0.36	0.14	0.47	0.00	0.01
18	Printing and recording	0.27	0.18	0.37	0.24	0.00	0.01
19-20	Coke, petroleum and chemicals	0.11	0.63	0.15	0.82	0.00	0.02
21	Pharma-ceuticals	0.05	0.01	0.07	0.01	0.00	0.00
22	Rubber & Plastic	0.11	0.34	0.13	0.45	0.00	0.02
23	Other non-metallic mineral products	0.33	0.10	0.47	0.15	0.00	0.01
24	Basic metals	0.09	0.20	0.12	0.26	0.00	0.00
25	Fabricated metal	0.12	0.52	0.15	0.69	0.00	0.02
26	Computers, electronics & opticals	0.18	0.12	0.24	0.16	0.00	0.01
27	Electrical equipment	0.21	0.14	0.26	0.20	0.00	0.01
28	Machinery & equipment	0.12	0.16	0.15	0.20	0.00	0.00
29	Motor Vehicles	0.29	0.18	0.35	0.23	0.00	0.01
30	Other transport equipment	0.07	0.04	0.09	0.05	0.00	0.00
31	Furniture	0.27	0.02	0.35	0.03	0.00	0.00
32	Other manu-facturing	0.18	0.08	0.23	0.10	0.00	0.00
33	Repair & maintenance	0.23	0.29	0.31	0.41	0.00	0.01
35	Electricity, gas and air conditioning	0.19	0.87	0.30	1.43	0.02	0.05
36, 37	Water and sewerage	0.08	0.10	0.11	0.13	0.00	0.00
38, 39	Waste, remediation & management	0.18	0.13	0.27	0.17	0.00	0.01
41-43	Construction	0.18	0.72	0.28	1.07	0.13	0.14
45	Wholesale & Retail - vehicles	0.04	0.52	0.05	0.70	0.00	0.03
46	Wholesale - excl vehicles	0.20	0.52	0.29	0.67	0.05	0.03
47	Retail - excl vehicles	0.26	0.00	0.37	0.00	0.05	0.00
49	Land transport	0.25	0.37	0.44	0.65	0.08	0.07
50	Water transport	0.30	0.02	0.49	0.03	0.01	0.00
51	Air transport	0.36	0.00	0.50	0.00	0.02	0.00
52	Support services for transport	0.16	0.36	0.27	0.64	0.02	0.05
53	Post & courier	0.28	0.24	0.39	0.34	0.01	0.03
55	Accomm-odation	0.28	0.01	0.39	0.01	0.01	0.00
56	Food & beverage services	0.23	0.05	0.33	0.06	0.04	0.00
58	Publishing services	0.27	0.05	0.42	0.08	0.02	0.01
59, 60	Film video & TV etc.; broadcasting	0.29	0.02	0.47	0.03	0.07	0.02
61	Telecommunications	0.26	0.33	0.36	0.46	0.02	0.04
62	Computer services	0.21	0.64	0.31	0.87	0.04	0.06
63	Information services	0.24	0.17	0.34	0.20	0.01	0.01
64	Financial services	0.24	0.49	0.33	0.68	0.14	0.06
65	Insurance & pensions	0.28	0.16	0.45	0.25	0.05	0.03
66	Auxiliary financial services	0.27	0.07	0.39	0.11	0.04	0.01
68	Real estate	0.19	0.27	0.27	0.36	0.10	0.03
69	Legal and accounting	0.17	0.46	0.25	0.68	0.04	0.06
70	Head office & consulting services	0.23	0.39	0.36	0.59	0.04	0.06
71	Architectural services etc.	0.29	0.47	0.44	0.74	0.02	0.05
72	Research & development	0.16	0.02	0.24	0.02	0.00	0.00
73	Advertising & market research	0.31	0.22	0.44	0.30	0.04	0.02
74	Other professional services	0.26	0.10	0.38	0.15	0.02	0.01
75	Veterinary services	0.16	0.01	0.22	0.01	0.00	0.00
77	Rental and leasing services	0.24	0.30	0.33	0.46	0.01	0.03
78	Employment services	0.21	0.54	0.35	0.83	0.03	0.06
79	Travel & related services	0.14	0.20	0.25	0.31	0.02	0.03
80	Security & investigation	0.25	0.09	0.37	0.12	0.00	0.01
81	Building & landscape services	0.29	0.28	0.54	0.49	0.02	0.04
82	Business support services	0.19	0.20	0.29	0.30	0.02	0.03
84	Public administration & defence	0.29	0.18	0.39	0.29	0.07	0.02
85	Education	0.07	0.24	0.10	0.34	0.02	0.03
86	Health	0.16	0.02	0.22	0.03	0.02	0.00
87, 88	Residential care and social work	0.21	0.09	0.32	0.12	0.01	0.01
90	Creative services	0.44	0.00	0.63	0.00	0.02	0.00
91	Cultural services	0.21	0.05	0.31	0.05	0.00	0.00
92	Gambling	0.14	0.06	0.19	0.08	0.00	0.00
93	Sports & recreation	0.38	0.03	0.54	0.05	0.00	0.00
94	Membership organisations	0.13	0.22	0.18	0.28	0.01	0.02
95	Repairs - personal and household	0.19	0.02	0.26	0.03	0.00	0.00
96	Other personal services	0.14	0.09	0.19	0.12	0.00	0.01
97	Households as employers	0.00	0.00	0.00	0.00	0.00	0.00

Source: GLA Economics calculations

A third presentation of linkages is to normalise estimates, so for each product they are a proportion of the total for the economy. The interpretation of this approach is that estimates greater than one are relatively more important for the economy. As this approach does not change the relative ranking of products, and can be derived from the data provided in Tables B.1 and B.2 the calculations are not provided here.

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