Value Chains, GDP and the Size of Manufacturing *

Jonathan Haskel†

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Abstract

How do we measure the manufacturing share of GDP and does a smaller share mean a lesser economy in any sense? This note shows how the UK statistical authorities measure the size of manufacturing and, in the context, whether manufacturing matters.

*Written for the Manufacturing Metrics Working group.

†(corresponding) Imperial College, CEPR and IZA; Address: Imperial College Business School, South Kensington Campus, London SW7 2AZ, United Kingdom; j.haskel@imperial.ac.uk

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1 Introduction

We need a framework that can answer the following questions.

1. Economy 1 consists of one company, Company A, who employs 100 staff making computers from raw materials, 30 doing R&D, 20 serving lunch and 10 drivers delivering computers to consumers. Is manufacturing employment in this economy 100, 130, 150 or 160?

2. Economy 2 consists of two companies. Company B employs 100 staff making computers from raw materials and buys in all other services from company C i.e. R&D, lunch services and delivery services. Is manufacturing employment in this economy 100, 130, 150 or 160?

3. Economy 3 consists of one company. Company D employs no staff at all making computers. Rather, it buys in all computers from abroad. Instead it has 100 staff coordinating the manufacturing abroad (visiting the overseas companies, providing production line advice in the event of disruption to production and re-engineering the supply chain). At home it also has 30 staff doing R&D, 20 lunch staff and 10 delivery staff. Is manufacturing employment in this economy zero, 100, 130, 150 or 160?

More questions arise when thinking beyond mere matters of classification. Such as: in which of these above economies is GDP or its growth potential maximized? Is there any difference between GDP in economy 1 where manufacturing is entirely at home and economy 3 where it is entirely abroad? Still another is: what are the value chains in these economies and in which part of the value chain is the most value created?

Finally, a question based upon a story. Once upon a time there was an entrepreneur who announced that he had invented a secret manufacturing process that transformed Scottish stream water into computers. He was lauded with awards, technology prizes and everyone declared that this was the hi-technology manufacturing technology economy that the all countries should aspire to. A team of specialist scientists were dispatched to inspect the process and made a startling discovery. In fact he was turning the water into whisky, exporting the whisky and importing computers. He was roundly condemned and it was agreed this economy was nowhere near as desirable as the earlier one. Is the condemnation justified?

To understand the answers to these questions we need a framework. It needs to (a) describe economies with all the features of the above (b) illustrate current measurement conventions and (c) if it is to be used to analyses "value", be amenable to measurement. In particular, it needs to be a framework where National Accounts value added is clearly defined or else it will be unaligned with international measurement conventions.

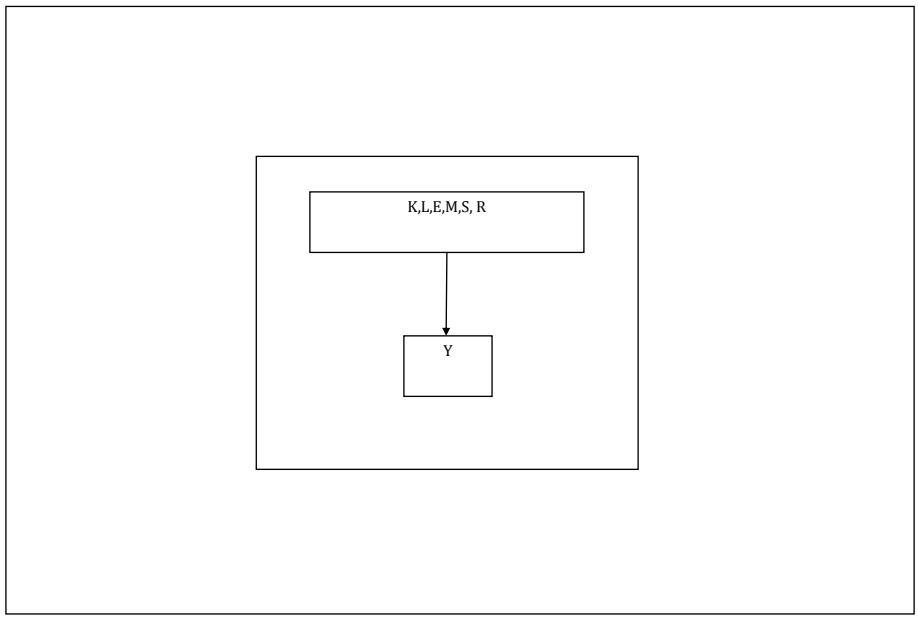
2 Input/output or transformation relations

The first part of the framework is an input/output relation. The second is a group of input/output relations. We use the phrase "transformation" to describe how inputs physically become outputs (as opposed to trade which does this but via exchange of goods and not transformation). We do not use the work "production" since that means something specific in national accounts. Nor do we distinguish between manufacturing services. We use "output" to mean any output, product or services.

The transformation relation is shown in Figure 1.

This relation simply describes how output Y is obtained from inputs. The inputs are flows of services from:

Figure 1: transformation relation



1. 1. K = capital (tangible capital, machines)
2. 2. L = labour
3. 3. E = energy
4. 4. M= raw materials used up in production
5. 5. S purchased = services (e.g. cleaning or legal services)
6. 6. R = ideas/knowledge/intangible capital

The KLEMS framework is due to Jorgenson, et al. the additional of intangibles, follows Corrado et al, who build on Griliches.

To make matters concrete, suppose the firm concerned produces whisky Y. It uses water (M), mixed with alcohol (M) according to a secret recipe/knowledge (R) and puts the whisky into glass bottles (M). It employs L workers, and uses vats to store the whisky in (K). It buys in cleaning services (S) to keep the plant clean.

The following points are worth making. First, the transformation here refers to any form of activity: manufacturing or services. So the firm might be a security van company who employs security guards (L), a truck (K) and produces security services (Y). Second, the model is static: over time, the inputs for example or the state of knowledge with which they are combined might change. Third, knowledge is broadly defined: it might be the knowledge of distilling, or of the production line process or of selling. Fifth, the model aligns with National Accounts since data is collected, by industry, on outputs and inputs such as capital, labour, materials, energy and services use, and, more recently on R&D.

3 Supply chains

3.1 A simple supply chain model

Consider now the following supply chain: water is distilled into whisky, whisky is delivered to retailers, retailers sell to consumers. Thus we set out three transformation functions set out in Figure 2. In the first output stage whisky is produced, next transport services are rendered and finally retail services are rendered.

The following points are worth noting. Consider first the input/output relations at each point of the supply chain. In the initial stage, the only intermediates (i.e. goods used up in the course of production) are water, power and services. In the second stage, the bottles of distilled whisky are the intermediates for they are merely transported at that stage. Finally, in the retail stage, the transported bottles are the intermediates.

Second, and related, note a point familiar to students of measuring GDP. It is that that total output in this economy does not equal the value of sales at each stage of production. Suppose that a firm undertakes both the distilling and trucking. Then the value of sales to the retailer equals the wholesale price of distilled and delivered whisky, say £100. The retailer then sells this for, say £150. But, as is well known, production in the economy is not worth £250, for that double counts the whisky. Rather, value added in the economy is the relevant concept, which subtracts off the intermediate goods at each stage. This is why it is correct to treat the delivered distilled whisky as an intermediate at the retail stage. And this is the "value added" concept that national accountants are trying to capture in GDP.

Third, whilst statistical officers might look to measure value added many management scholars look at "value chains". To the extent this is nothing more than a description of the stages of transformation, there is no additional insight. To the extent a value chain attempts to describe at which point along the transformation stages there are high returns to be made then this requires additionalinformation to which we return.

3.2 A more complicated supply chain model

Before proceeding to the role of value chains and manufacturing, it will be apparent that the framework is incomplete as it stands for we have specified three outputs but not specified where the inputs needed for that output (e.g. capital/machines) are produced. To keep things simple, we add another industry on the left, which we call the capital goods industry and suppose that it produces capital (which here are distillery machines, trucks and buildings). We can also suppose there is an energy and business services industry producing energy and business services, but to avoid clutter on the diagram suppress the energy industry and let us just show business services. This gives us Figure Figure 3. Note the arrows from the capital goods and business services industry who supply K and S to each of the transformation stages. So in this model, implicitly, capital goods and services are bought in from the outside.

4 How big is manufacturing?

With these building blocks in mind we are now in a position to consider some scenarios.

Figure 2: three stages of production

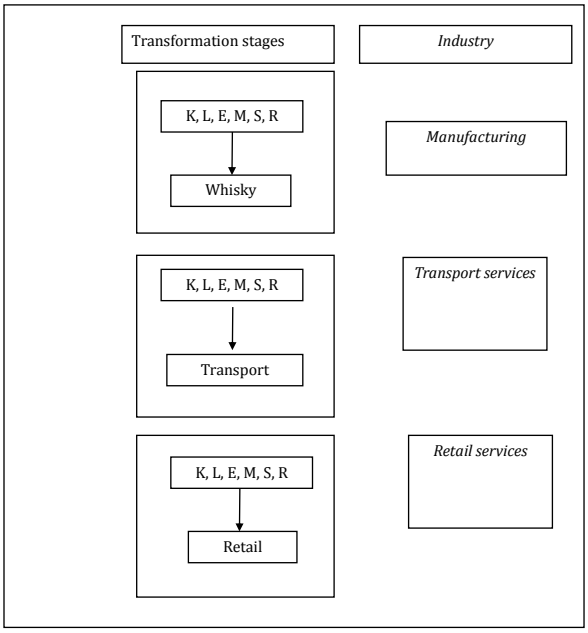


Figure 3: three stages of production with business services and capital goods

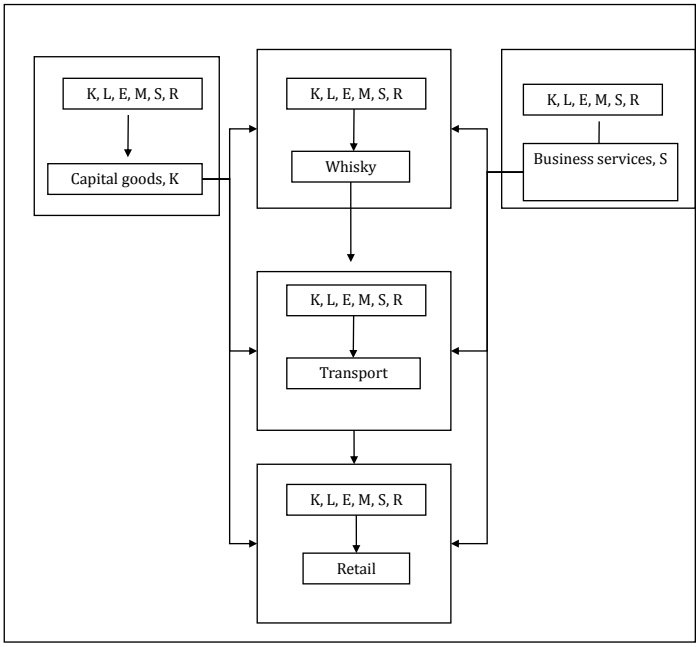
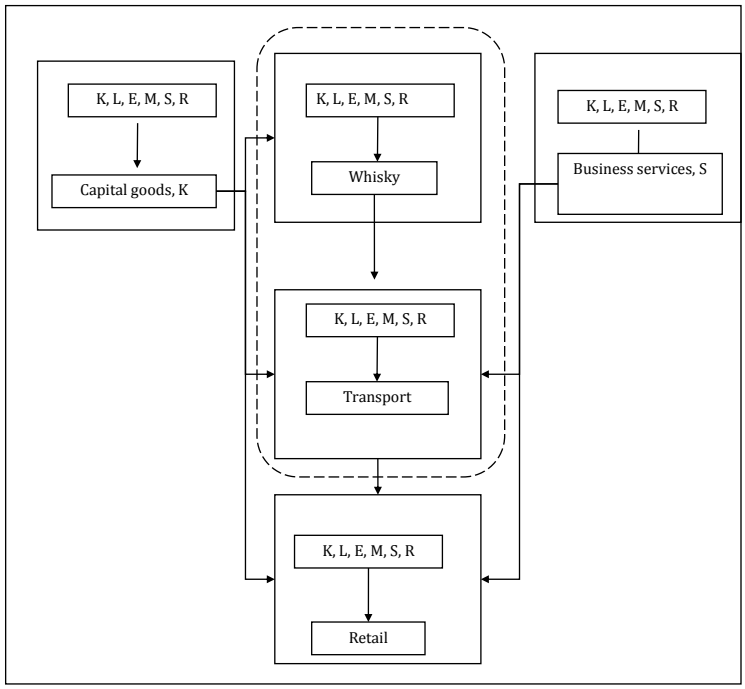


Figure 4: Economy definition with business services and transport produced internally



4.1 Internal production

We start in Figure 4 by considering the case where a single firm at one location a. Produces whisky, b. Produces business services, say catering, internally c. Has a fleet of delivery trucks, internally, although the trucks themselves are produced externally. Thus in the diagram below, we take off the arrow between the business services sector and whisky and draw a dotted box around the firm.

We are now in a position to ask: what is the size of manufacturing in this economy?

For most firms, ONS sends one questionnaire to one address, in this case the location of the dotted line firm. It classifies according to what activity most of the location's employees are undertake: if we assume 100 are in distilling (of whom 5 are actually in catering) and 20 in trucking, then this firm is classified as in manufacturing and total manufacturing employment will be 120 (omit for the moment the capital goods sector). Thus manufacturing includes the 20 truckers who are providing trucking services and includes5 cooks providing catering services.

Does this mean that manufacturing employment is overstated? Three points are worth noting. First, there may be cases where, perhaps because manufacturing is very capital intensive, that very few workers are in the manufacturing part of the firm, say 20, but 100 truckers are. In this case, service sector employment is 120, which includes the 20 workers in manufacturing and so services is overstated.

Second, for some large firms, whom carry out distinct activities, ONS will send two surveys and record 100 in manufacturing and 20 in services.Note that 100 includes the 5 cooks, unless such activity is particularly large, in which case ONS might send a third survey. So even in the case of multiple surveys within a particular firm, there is likely to be some overlap.

Finally, there is another reason noted in the Allsopp report. Manufacturing is finely classified and services less finely. That means that a majority of workers might be in services just because it has a less fine

classification. That would understate manufacturing.

To investigate this, Hellebrandt and Davis (2008) rebuilt the manufacturing services data using data on "local units", that is, geographical locations of firms where separate locations were not added together. They showed that contracting out did not bias the size of manufacturing.

4.2 Contracting out.

Consider now when the firm buys in catering services, which is figure 2. In this case the 5 cooks are sacked and reemployed by the business services sector. Suppose as well the firm has been sent two forms. Thus manufacturing employment is 95, and services is 25. This then is how manufacturing can shrink when activities are contracted out. But note that such activities were service activities in the first place.

Note further that with a lot of contracting out the firm may reach a stage where it becomes classified entirely as a services sector firm, as above. So for example, the company who does all its manufacturing abroad will be classified as a services form.

Finally, consider the case where the firm hires labour from an external agency (more here).

5 Would employment be higher in an economy with more manufacturing?

No. As the economies set out above show, employment is exactly the same. A number of related points are worth making.

First, there is no long run relation between unemployment in an economy and the make up of manufacturing and services. Figure shows the relation between the fraction of employment in manufacturing (the upper line), and the unemployment rate (the lower line).

Second, it might be said that the implicit input/output linkages are such that manufacturing "supports" many other jobs. The answer to this depends upon the counterfactual question. Implicit in the statement is the question "what are the current links between the sectors"? Another question might be "suppose manufacturing were to shrink by 50%, what would the consequences be for employment". To say one can read this off from the current linkages ignores the process of adjustment that such a change might bring, with workers flowing from one sector to another. As the diagram above shows, there is simply no long run relation between unemployment and the structure of the economy, showing that in the long run adjustment occurs so that it is meaningless to think of manufacturing supporting other jobs.

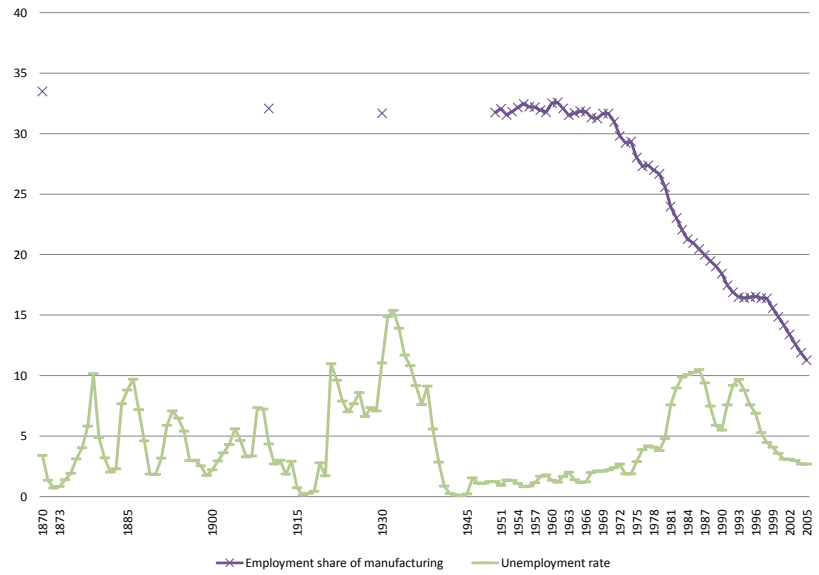
6 Would GDP be higher in an economy with more manufacturing?

What happens to GDP in these cases? Mostly nothing. To see why let us consider a simple contracting out situation.

Case 1. A single firm produces output, Y, using 95 production line labour inputs and 5 chefs (L(p,y)) and L(c,y), with K quantity of capital and E units of energy (this is the only raw material). Then we can write its flow revenue and cost relations as

PyY=WpL(p,y)+WcL(c,y)+PkK(y) +PeE(y)

Figure 5: UK share of manufacturing in total employment and unemployment rate, 1870-2005



Source: Bank of England data set, OECD 2014

Where Wp are wages to production line workers, Wc wages to cooks and Pk returns to capital. Assume the energy sector produces energy using production line workers and capital from wind power (and wind is free). The for the energy sector we have

PeE(y)=WpL(p,e)+ PkK(e)

In this economy, GDP is value added in each sector. This is

PvV(e)=PeE =WpL(p,e)+ PkK(e)

And

PvV(y)=)=PyY-PeE(y)=WpL(p,y)+WcL(c,y)+PkK(y)

Thus GDP in the whole economy is the sum of value added

PvV= PvV(e)+ PvV(y)=PyY=WL+PkK

Case 2. Now the firm contracts out its 5 cooks who sell cooking services, PsS(c) to the firm. Thus we have

PsS(c)=WcL(c,s)

And for manufacturing we have

PyY=WpL(p,y)+ PkK(y) +PeE(y)+PsS(c)

Value added in the cooking services sector is

PvVs=PsS(c)=WcL(c,s)

Value added in manufacturing is sales less energy inputs, less the cooking services inputs

PyY-(PeE(y)+PsS(c))=WpL(p,y)+ PkK(y)

From which it is clear that GDP is the same.

7 Why should we care about the size of manufacturing?

Consider the following.

7.1 Contracting out raises efficiency.

Suppose that contracted out services are more efficient. Then manufacturing firms have an incentive to contract them out and the demand for service sector goods rises. In a competitive market more firms will enter the service sector until returns to capital equalize across sectors (suppose that returns to manufacturing are determined internationally). Thus economy-wide returns to capital remain the same. The composition of capital might change if for example, more capital than was previously the case flows into the service sector.

GDP rises, since by assumption efficiency has risen. The sources of that growth depend upon why efficiency has risen. If capital is more efficient when deployed in services then GDP rises due to a reallocation of capital and labour.

7.2 The scale of a particular sector matters.

GDP would be affected if the scale of activity in a sector affect efficiency either in that sector, or in another sector. So, for example, if manufacturing has economies of scale then if factors migrate away from it, then GDP will fall.

A more realistic example is where activities of a particular sector confer externalities. There are two obvious candidates. First, R&D, which is primarily in manufacturing, might convey an externality to itself and other sectors. But in that case, policy should target the externalitiy, R&D, not manufacturing.

Second, if there is a distorting subsidy to another sector, say banking and this causes high-skilled workers to go to that sector. The effect on GDP depends upon the extent to which workers go to banking, their relative productivity in each sector and any differential spillovers from skill in each sector.

7.3 Productivity is higher in mfring rather than services.

From an averaging point of view we would get higher productivity on average if this were the case. But then we might well have lower manufacturing employment if more can be done with fewer mfring workers. Also, whilst UK manufacturing productivity has been relatively higher in recent times, there is no given about mfring prod. Sometimes it has been high in the UK and sometimes low.

Finally, note the Rodrik (see e.g. http://www.project-syndicate.org/commentary/are-services-the-new-manufactures-by-dani-rodrik-2014-10) has argued that in a developing country context low mfring employment levels will be associated with low GDP growth. The reason is that, he argues, service sector productivity gains, since they are mostly non-tradable, worsen the within-country terms of trade against services, lower wages and in services and so have lower capacity to absorb rural employment at high wages.

References