Regional Disparities in Labour Productivity and the Role of Capital Stock

Ben Gardiner*, Bernard Fingleton** and Ron Martin***

*Director, Cambridge Econometrics, Cambridge, UK
** Department of Land Economy, University of Cambridge
*** Department of Geography, University of Cambridge

Technical Appendix on Capital Stock Methodology

Summary

The regional (NUTS2) capital stocks for the UK were calculated as part of a wider European project for DG JRC (ISPRA). In summary the method:

- uses the Perpetual Inventory Method (PIM), as the most straightforward way of producing capital stock estimates.
- is based on reliable country-level estimates from EU-KLEMS, AMECO and the OECD, as well as using regional GFCF estimates produced by Cambridge Econometrics.
- does not produce estimates by investment asset, but instead focuses on disaggregation by broad sector, i.e. Agriculture, Industry, Construction, Financial Business Services, Other Private Services, and Non-Market Services.
- is able to go back to 1995[1] for all Member States and regions[2], and then annually to 2016.

The Perpetual Inventory Method

The most widely used method to compute capital stocks, and the one adopted here, is the so-called Perpetual Inventory Method (PIM), based on the following equation:

$$K_t = (1 - \delta)K_{t-1} + GFCF_t \qquad (1)$$

Where K stands for real net capital stock, δ stands for the depreciation rate and $GFCF$ stands for real Gross Fixed Capital Formation. The subscript t denotes the time period. To run this process three ingredients are needed:

- A value for the initial capital stock K_0
- A depreciation rate δ
- A time series of $GFCF$

The process described can be computed at the desired level of disaggregation (e.g. by sector) if the necessary data are available. The outcome of the present exercise is going to be estimates of regional capital stocks up to the NUTS 2 level, for six branches of activity, for the period 1995-2016.

Data

The following datasets were used to construct the capital stock database:

- AMECO is a database containing historical data and forecasts of the European Commission for the main macroeconomic variables. For the

[1] Although the data start with a base year in 1995, there is always some uncertainty / inaccuracy associated with the T0 estimate. The nature of the Perpetual Inventory Method is that, over time as new investment adds to stocks while old investment depreciates, this initial inaccuracy should reduce. It is therefore recommended to only use the data from 2000 for empirical analysis, to allow for some of these effects to take place.

[2] The focus of the methodological approach has been edited to refer mainly to the UK context, given the focus of this paper.

purpose of this exercise, it contains total real net capital stock estimates for all the Member States, which will be used to compute the initial capital stock.
- Regional (NUTS2) real GFCF estimates from Cambridge Econometrics, updated to 2016 by Cambridge Econometrics for the JRC data platform.
- EU-KLEMS is a database containing harmonised data about output, valued added, inputs in production, productivity and capital formation. It is the outcome of an EU funded project. For the purposes of this exercise, it contains estimates of nominal capital stocks for 26 Member States with varying level of details and depreciation rates by sectors and assets (same for all countries), which will be used to compute depreciation rates for each country.
- OECD STAN is a comprehensive tool for analysing industrial performance at a relatively detailed level of activity across countries. It includes annual measures of output, value added and its components, labour input, investment and capital stock.

Methodology

Initial capital stock

As described above, the PIM method needs an initial capital stock value to start the computation of the whole series. In order to get initial capital stock values at the regional level, a total initial capital stock estimate at the country level is shared among regions. The initial capital stock estimates at the country level are taken from AMECO, which contains only country totals without any regional or sectoral breakdown. The first step is to get a sectoral breakdown at the country level, and then share those figures among regions. The sectoral breakdown adopted in this exercise (referred to as "CE sectors" from now on), related to NACE2 classification, is the following:

- Agriculture: section A
- Industry: sections B to E
- Construction: section F
- Wholesale, Retail, Transport, Accommodation & Food Services, Information and Communication: sections G to J
- Financial and Business Services: sections K to N
- Non-market services: sections O to U

To get the required sectoral breakdown from country totals, the total figures from AMECO are shared among the CE sectors using shares computed from CE's GFCF data, i.e. GFCF in each sector as a share of total country GFCF, at time 0:

$$K_{Nj,0} = \frac{GFCF_{j,0}}{GFCF_{N,0}} K_{N,0} \tag{3}$$

With subscript j being the sector, N the total by country and 0 denoting the initial period. Once all countries have national data broken down by the CE

sectors, the regional breakdown is computed according to the following formula:

$$K_{ij,0} = \frac{\sum_t GFCF_{ij,t}}{\sum_t GFCF_{Nj,t}} K_{Nj,0} \quad (4)$$

With subscript i being the region, j the sector, and N the total by country. The ratio applied to the national figure represents the average share of total GFCF in region i and sector j within total GFCF for sector j at the country level over the whole period. The average share was used in order to avoid any particular year to influence the results.

Depreciation rates

EU-KLEMS provides depreciation rates by sectors and ten assets, which don't vary by country and over time. Depreciation rates are shown for 34 NACE2 sectors. Therefore, there is the need to aggregate these data to obtain a depreciation rate for each one of the CE sectors. The procedure entails the following steps[3]:

1. For each of the EU-KLEMS sectors, computing the average share across time of nominal capital stock by assets within total nominal capital stock also from EU-KLEMS. Nominal capital stock is considered to ensure that the shares sum up to 1, since this would not happen with real capital stock because of different price indices used between sectors and the total economy.

$$\bar{s}_{a,j} = \frac{\sum_t^T \left(\frac{k_{t,a,j}}{k_{t,j}}\right)}{T} \quad (5)$$

   With subscript a denoting the asset, k the nominal capital stock and T the overall number of periods.
2. Multiplying these average shares by assets/sectors with the corresponding depreciation rate and summing, thus obtaining one depreciation rate for each EU-KLEMS sector as a weighted average of depreciation rates by asset, with weights being the shares computed in equation (3).

$$\delta_j = \sum_A \delta_{a,j} \bar{s}_{a,j} \quad (6)$$

   With A denoting the set of assets.
3. For each of the EU-KLEMS sectors, computing the average share across time of nominal capital stock within the corresponding CE sector.

$$\bar{s}_j = \frac{\sum_t^T \left(\frac{k_{t,j}}{k_{t,CE}}\right)}{T} \quad (7)$$

   With subscript CE denoting the CE sector.

[3] This methodology is similar to the one followed in the Penn World Table (Feenstra, Inklaar, & Timmer, 2015)

4. Multiplying these average shares by sectors with the corresponding depreciation rate computed in point 2 and summing.

$$\delta_{CE} = \sum_{J} \delta_j \bar{s}_j \tag{8}$$

With J denoting the set of EU-KLEMS sectors within the CE sector.

For the UK a full breakdown by sector and assets was available and so this procedure was applied.