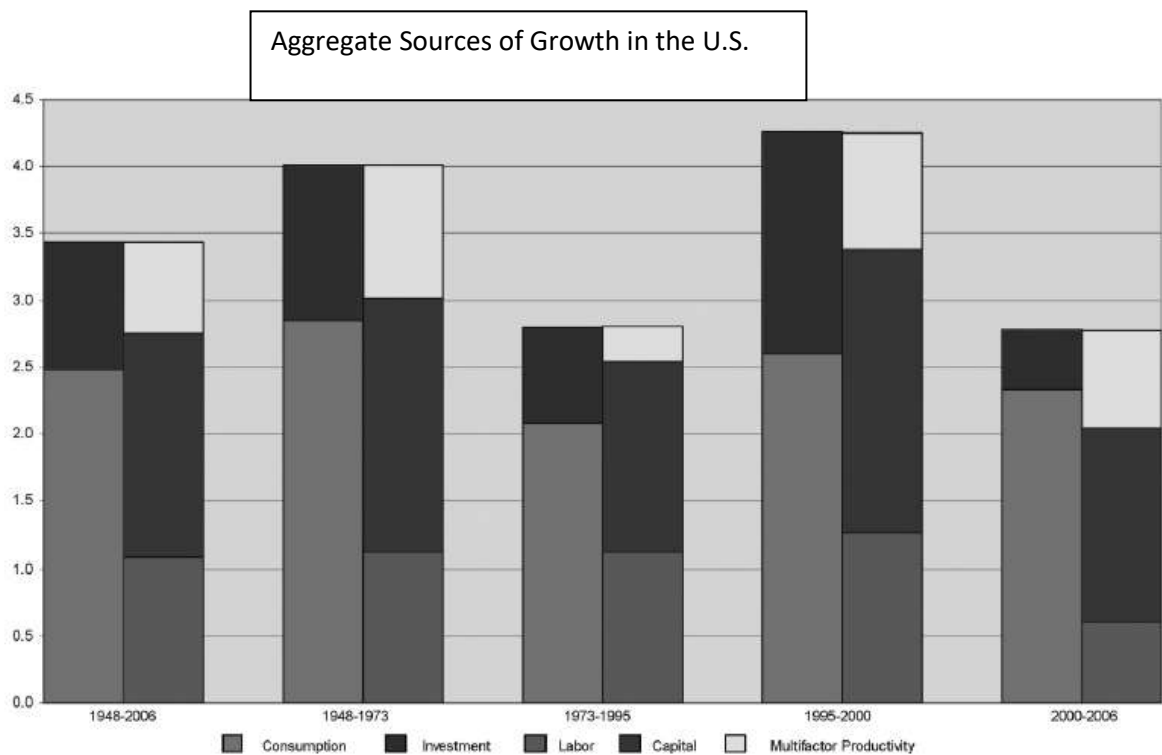**Chapter 4 – Extended Productivity (KLEMS) Accounts** – Lead Author BEA; Contributors – Eurostat, UNSD, Dale Jorgenson

1) The production account, KLEMS, and SEIGA
   a. The production account at the country level displays how income is generated, distributed and used throughout a national economy (SNA, 2008).
   b. The product side of the production account corresponds to country level GDP and includes spending on personal consumption expenditures, private investment, net exports, and government consumption and investment. The income side of the account corresponds to GDI and includes information on compensation of employees, operating surplus and consumption of fixed capital.
   c. A complete production account includes GDP and GDI in current and constant prices, along with productivity.
      i. The aggregate BEA/BLS account is an example of this, as is the example in (Jorgenson & Landefeld, 2006).
      ii. (SNA, 2008) includes a discussion of GDI in constant prices: "By also associating estimates of capital services with the standard breakdown of value added, the contributions of both labour and capital to production can be portrayed in a form ready for use in the analysis of productivity in a way entirely consistent with the accounts of the SNA."
      iii. It is worth emphasizing that this not only permits and analysis of productivity, but a broader analysis of the source of growth.
   d. The purpose of KLEMS is to provide national accounts consistent production account data in current and constant prices at the industry level, decomposed into the inputs used in production: capital (K), labor (L), Energy (E), Materials (M), and Services (S), and productivity. Thus, the KLEMS approach provides an internally consistent decomposition of economic growth across industries and factors of production.
   e. The production account at the world level displays how income is generated, distributed, and used throughout the world economy.
   f. The purpose of introducing KLEMS into SEIGA is to provide national accounts consistent production account for the world economy, in current and constant prices. Thus, SEIGA-KLEMS can provide an internally consistent decomposition of the sources of world economic growth and economic growth across world regions.
   g. At its core, SEIGA-KLEMS is about tracing the production process across producers through the entire value chain across borders and all providers of inputs.
2) Example application of aggregate production account data in the national accounts: Decomposition of the Sources of Economic growth including multiple outputs and productivity.

Aggregate Sources of Growth in the U.S.

Legend: Consumption, Investment, Labor, Capital, Multifactor Productivity

Source: (Jorgenson, 2010)

3) Examples of industry-level production account
    a. BEA/BLS integrated industry-level production account
    b. World KLEMS
4) According to (Landefeld, 2016), "Major issues needing resolution for the SEIGA Handbook" are divided into two efforts.[1]
    a. Short-run: "use existing data and indirect estimates." Note that even the short-run effort may require additional information for users. For example, if users do not know where Apple is classified and how Apple shipments from China to France are classified, analysis using existing data is becoming less informative.
    b. Longer run: "the effort should probably shift toward new micro-data data collection, sharing, and estimation."
        i. The Longer run effort for SEIGA-KLEMS should start with reconsidering the model of the production process of globally engaged firms and how to link to production process to existing or new data sources (based on double-entry accounting whenever possible). For example, to understand Apple's productivity as a globally engaged firm, we need to understand the complete production

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[1] See presentation http://unstats.un.org/unsd/trade/events/2016/newyork-egm/presentations/Steve%20Landefeld%20-%20Major%20Issues%20Needing%20%20Resolution%20For%20SEIGA%20Handbook%20-%20Jan%202016.pdf

process for all of Apple's revenue. If we only want to compare productivity across industries, the existing data and indirect estimates may be sufficient.

    c. The outline for this chapter will focus on the "short-run" effort, but longer run effort deserves considerable attention.

5) Motivating SEIGA-KLEMS with economic questions.

    a. KLEMS in the SEIGA framework allows for a price quantity decomposition of the sources of growth by producers across borders. For example, how much do U.S. intangibles contribute to productivity growth in Chinese manufacturing? SEIGA-KLEMS permits this type of analysis in a way that is consistent with the SEIGA global accounts.

    b. SEGIA-KLEMS permits a decomposition of world economic growth across regions and factors of production.

    c. SEIGA-KLEMS is necessary to understand comparative advantage.

        i. The recent literature on TiVA establishes that advanced nations specialize in production that is relatively intensive in high skilled labor, for example, but gross trade flows obscure this relationship. See (Timmer, Erumban, Los, & de Vries, 2014).

        ii. Yet, economic models of comparative advantage rely on the assumption of equivalent technologies across countries. The Extended Supply Use tables themselves are not informative for assessing technology and productivity across countries because productivity indexes require measures of output and input quantities in constant quality comparable units. Empirical studies of productivity across countries and industries conclude that the assumption of identical technologies is not supported. See (Jorgenson, 1995) (Jorgenson, 1995) and (Jorgenson & Vu, 2005).

        iii. Thus, linking Extended Supply Use tables and KLEMS productivity statistics helps provide a more comprehensive picture of international competition.

        iv. Consistent growth accounts across countries are complimentary to TiVA statistics. For example, factor movements, thus value added and trade in value added depend on relative prices and relative productivities across countries. Growth accounting in the KLEMS framework shows how countries grow over time.

6) SEIGA Production Account at the Aggregate Level

    a. The World Bank's International Comparison Program presents output side measures at the aggregate level.

    b. The Total Economy Database maintained by the Conference Board includes information on the input side.

    c. But, the SEIGA aggregate production account should provide the framework and manual to provide consistent global accounts.

7) SEIGA-KLEMS starting point: World Input-Output Tables in current and constant prices

    a. Current prices:

        i. Country x industry x year, industry and commodity output.

        ii. Country x industry x commodity x country x year, intermediate input.

   iii. The extended supply and use tables in Chapter 3 of the manual provide national accounts consistent nominal tables.

   iv. Valuation: Industry output in prices received by the producer, industry intermediate in prices paid by the purchaser. Requires information on taxes on production.

  b. Constant price version involves choosing a deflator for each of the cells in the input-output table and each commodity and industry output.

   i. A typical assumption is that each commodity produced domestically has its own price and each commodity produced by the ROW has its own price, and all industries pay the same price for each commodity.

   ii. For detailed cells, the assumption that all industries pay the same price for a given input from the same source is easier to defend. For aggregated cells this becomes more difficult to defend.

   iii. Ideally would have separate deflators for the imports from each country and exports to each country.

8) SEIGA-KLEMS: Labor

  a. Nominal value of total labor compensation (not just wages) by country x industry x worker type x time. Typical worker types divide workers by education group, age group, gender, class of worker.

  b. Quantity index should account for heterogeneous workers and substitution towards (or away from) more productive workers over time. Typically this is labeled "labor quality" or "labor composition" and relies on specifying on which dimensions workers differ and gathering (or estimating) hours worked and wages for each worker type.

  c. A common classification for worker types may be an important part of SEIGA-KLEMS.

  d. Issues: self-employed labor, unpaid family workers, multiple job holders, payments in kind.

9) SEIGA-KLEMS: Capital

  a. Nominal value of capital compensation by country x industry x capital type x time. Typical asset types divide capital into broad asset types including equipment, structures, inventories, land, and intangibles, but detailed assets types are important in estimating capital input.

  b. Quantity index should account for substitution towards (or away from) more productivity assets over time, but unlike the price of labor input, the price of capital input is typically not observed. The OECD manual on measuring capital describes methods to impute the capital service price.

  c. A common classification for asset types may be an important part of SEIGA-KLEMS.

  d. Issues: taxation, self-employed labor, land, inventories, rates of return, depreciation formula.

   i. While empirically taxation may not affect measured growth rates significantly, in a global setting with current attention on tax havens, taxation may be important to track in SEIGA.

10) Aggregation: SEIGA-KLEMS will need to address aggregation within and across countries. The production possibility frontier (PPF) approach to aggregation provides a method to decompose world GDP growth across countries, industries, and factors of production. See (Jorgenson & Vu, 2005) for an application. An important feature of the PPF is that it permits price differences across countries and industries, a key feature of the data. If KLEMS measures are integrated into SEIGA, these would be internally consistent across countries allowing for a straight forward comparison of the sources of growth and links between TiVA, factor prices, and productivity. But this would depend on a consistent approach to aggregation throughout the SEIGA accounts.

11) Level Comparisons: KLEMS Growth Accounts like those described above allow comparisons of countries' sources of growth over time, but do not permit cross-country level comparisons.
    a. Level comparisons are essential for assessing comparative advantage.
    b. At the aggregate level, this requires aggregate output and inputs in common constant-quality units. (Jorgenson & Vu, 2005) demonstrates how to implement this with international data.
    c. At the industry level, this requires industry output and inputs in common constant-quality units. (Jorgenson, Nomura, & Samuels, 2015) demonstrates how to implement this with data from the U.S. and Japan. An important link to the extended SEIGA IO tables is that industry-level comparisons require consistent input-output tables, like the bilateral table used in (Jorgenson, Nomura, & Samuels, 2015). Thus, the extended input-output tables of SEIGA provide an important input to productivity level comparisons.
    d. Integrating WIOD with production account data requires PPP's for outputs and inputs. WIOD currently uses exchange rates to convert national valued to $US.

12) Broad discussion: Estimating KLEMS measurement is very similar in nature to estimating the national accounts where imperfect information is assembled using the best available information, sometimes relying on analyst judgment. At its core, KLEMS simply provides the input side of the production account.

13) Conclusions and next Steps
    a. SEIGA is inherently tied to KLEMS.
    b. National Statistical offices are now producing KLEMS data, but somewhat different methodologies are used by contributors.
    c. SEIGA-KLEMS should be as unified as possible.
    d. Developing PPPs for outputs and inputs at the industry level for level comparisons is a substantial undertaking. Appropriate PPPs require detailed prices for each of the outputs produced and inputs used organized on a common classification. This is analogous in nature to the challenge of constructing a system of world input output tables. In particular, base year relative prices for each industry output and each of the detailed inputs (labor by type of worker and capital by type of asset) are necessary to construct the required PPPs used in industry productivity level comparisons.
    e. An objective of SEIGA-KLEMS should be to develop a common classification for inputs as well as outputs.

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