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Documentation Note

Calculations of value-added shares conveyed in the Box “A trade conflict will affect the Norwegian economy through various channels” in Monetary Policy Report 1/25

About the publication

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Calculations of value-added shares conveyed in the Box "A trade conflict will affect the Norwegian economy through various channels" (MPR 1/25)

This analytical note provides details on the chart presented in the box on trade conflict in MPR 1/25. The chart illustrates the share of value added in exports to the United States for selected countries. Importantly, it considers not only the direct exports, but also the indirect exports, as countries produce intermediate goods and services, which are used by other countries to produce goods (intermediate or final) exported to the United States. Moreover, it considers value-added, and not the value of exports. As exports often use a significant amount of imported intermediate goods in the production, the former is a better measure of the economy's actual dependence on exports to the US. Accounting for both the exposure through indirect exports and the use of imported inputs, the total value-added in exports can be either smaller or larger than the value of exports reported in official trade statistics.

To calculate the value added in exports, we make use of the foundational insights of input-output analysis discovered by Leontief (1936). The framework was originally developed to represent interdependencies between sectors of a domestic economy but has since been extended to represent global interdependencies. We provide a simple exposition. For a more thorough review, interested readers are referred to Koopman et al. (2014).

For simplicity, consider the two-country, two-good case. Country 1 produces gross output x_1, which is used either as intermediate input at home, intermediate input in country 2, or sold as a final good at home (y_1) or in country 2 (y_2). Define $a_{ij}$to be the amount of intermediate input from country *i* needed to produce one unit of gross output in country *j* (i,j=1,2). $a_{ij}x_j$ is then the value of intermediate goods *i* needed to produce x_j. Then, the following accounting identity for gross output in country 1 must hold:

$$x_1 = a_{11}x_1 + a_{12}x_2 + y_1 + y_2$$

And similarly for country 2:

$$x_2 = a_{21}x_1 + a_{22}x_2 + y_1 + y_2$$

Defining the vector of gross output in the two countries as X, the matrix of input coefficients as A, and the final demand as Y, we can represent the two equations in matrix form as

$$\mathrm{X} = \mathrm{AX} + \mathrm{Y}$$

Note that, as long as the matrix $(\mathrm{I} - \mathrm{A})$ is invertible, this can be rewritten as

$\mathrm{X} = (\mathrm{I} - \mathrm{A})^{-1}\mathrm{Y} = \mathrm{BY}$, where B is the *Leontief inverse*, or the *Leontief multiplier*.

Each element b_{ij} in B corresponds to the total value of gross output generated in country *i* from satisfying one unit of final demand in country *j* (i,j=1,2), including the interlinkages through intermediate inputs between countries.

Notice that this simple two-country, one-sector example extends to an arbitrary large number of countries and sectors. In our analysis, we rely on an inter-country input-output table, constructed by the OECD on the basis of national input-output tables, and benchmarked to national accounts and balance of payments data.[1] The table maps the flow of intermediate and final goods across 76 countries and 45 sectors. It also includes a measure of the rest of the world to ensure consistency. The accounting framework remains the same as in the above example, however, the Leontief inverse matrix no longer has dimensions 4x4, but 3465x3465.

Finally, to derive the value-added in exports to the United States, we pre-multiply the Leontief inverse by a vector with the shares of value added (VA) in the production of each national sector, and we post-multiply by a vector with the value of exports from each sector of every country to the United States (EX):

$$\text{Value-added in exports to the US} = \mathrm{VA} * \mathrm{B} * \mathrm{EX}$$

To find the total value-added of a given country in exports to the US, we let all elements in the vector VA be zero except for those that correspond to the given country's sectors. The intuition is the following: EX denotes the amount of production that must be met to satisfy US demand for imported intermediate and final goods. By multiplying by the Leontief multiplier, we derive how much production each sector of every country must produce to satisfy this demand. Finally, by multiplying by the value-added share in the given country's sectors, we find the total amount of value-added in the given country needed to satisfy the demand. Finally, we divide by gross domestic production to find the share of the economy that is related to US exports, either directly or indirectly.

Chart 3.D further decompose this share into exports originating domestically, from the EU, or from other countries. The value added in exports originating domestically is derived by letting all elements in the export vector be zero, except those that correspond to exports from the given country's sectors. Notice that this measure includes both value-added in the domestic sector's direct exports to the United States, and the value-added in the production of the intermediate goods they use originating from other domestic sectors.

[1] https://www.oecd.org/en/data/datasets/inter-country-input-output-tables.html

To consider the domestic value-added in the production of intermediate goods that eventually are used in EU exports to the United States, we let all elements in the EX-vector be zero excepts those that correspond to sectors in EU countries. The VA vector remains unchanged. Finally, the red bars are derived by retaining only the exports from countries that are neither in the EU, nor Norwegian. Turégano (2025) provide a similar decomposition.

As the Norwegian economy is dominated by the production of oil and gas, which likely will be less affected by trade conflict, we derive the measure for the mainland-economy, i.e excluding the production of petroleum. In the value-added vector, we remove the value-added in NACE industry B05_06 (Mining of coal and lignite, and Extraction of crude petroleum and natural gas). Moreover, in the export vector, we only consider sectors producing goods, as services will not be liable to tariffs. This implies only considering exports from sectors with NACE level 1 codes A, C, D or G. Finally, we remove exports to B05_06 and C19 (Manufacture of coke and refined petroleum products) to remove any other petroleum related activities, as well as H50 (water transports) and Direct purchases abroad by residents.

References:

Koopman, Robert, Zhi Wang, and Shang-Jin Wei. 2014. "Tracing Value-Added and Double Counting in Gross Exports." *American Economic Review* 104 (2): 459–94.

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