Assessing contribution of a sector to GDP: Input-Output approach

Dmitry Polzikov

27th Inforum Conference, Sochi, September 2019
Methodology: simple output multiplier effect assessment

1. Single output multiplier effect: \[ \Delta x = (I - A^d)^{-1} \cdot \Delta f^d \]

where \( A^d \) is the matrix of technical coefficients (excluding imports in intermediate consumption)

\[
A^d = \begin{pmatrix}
    a_{11} \cdot (1-imp_{11}) & a_{12} \cdot (1-imp_{12}) & \cdots & a_{1n} \cdot (1-imp_{1n}) \\
    a_{21} \cdot (1-imp_{21}) & a_{22} \cdot (1-imp_{22}) & \cdots & a_{2n} \cdot (1-imp_{2n}) \\
    \vdots & \vdots & \ddots & \vdots \\
    a_{n1} \cdot (1-imp_{n1}) & a_{n2} \cdot (1-imp_{n2}) & \cdots & a_{nn} \cdot (1-imp_{nn}) \\
\end{pmatrix}
\]

Single output multiplier of sector \( j \) : \[ m(o)_j = \sum_{i=1}^{n} l_{ij} \]

where \( l_{ij} \) are the coefficients of the total requirements matrix \( L : L = (I - A^d)^{-1} \) (impact on gross output)

2. Single output multiplier of sector \( j \) : \[ m(va)_j = \sum_{i=1}^{n} \left( l_{ij} \cdot \frac{va_i}{x_i} \right) \]

(impact on GDP)
Methodology: induced effects assessment

\[ \Delta f^d \rightarrow \Delta x \rightarrow \Delta va \]

Assessing induced final demand

\[ \Delta va \rightarrow \Delta wages \rightarrow \Delta c \rightarrow \Delta c^d \]
\[ \Delta va \rightarrow \Delta taxes \rightarrow \Delta gc \rightarrow \Delta gc^d \]
\[ \Delta va \rightarrow \Delta profit \rightarrow \Delta inv \rightarrow \Delta gfcf \rightarrow \Delta gfcf^d \]
\[ \Delta f_{induced}^d = \Delta c^d + \Delta gc^d + \Delta gfcf^d \]

Assessing induced value added

\[ \Delta f_{induced}^d \rightarrow \Delta x_{induced} \rightarrow \Delta va_{induced} \]
\[ \Delta va_{total} = \Delta va + \Delta va_{induced} \]

\* for domestic goods and services
Methodology: investment multiplier effects assessment

1. Assessing increase in gross fixed capital formation: \( \Delta \text{gfcf} = T \cdot \Delta \text{inv} \)
   where \( T \) is the gross fixed capital formation matrix

2. Assessing increase in final demand for domestic investment goods: \( \Delta \text{gfcf} \rightarrow \Delta \text{gfcf}^d \)

3. Assessing indirect and induced effects of output increase in fund-creating sectors:
   \( \Delta \text{gfcf}^d \rightarrow \Delta x = (I - A^d) \cdot \Delta f^d \)
   \( \Delta x \rightarrow \Delta va \)
   \( \Delta va \rightarrow \Delta f_{\text{induced}} \rightarrow \Delta f^d_{\text{induced}} \rightarrow \Delta x_{\text{induced}} \rightarrow \Delta va_{\text{induced}} \)
   \( \Delta va_{\text{total}} = \Delta va + \Delta va_{\text{induced}} \)
Methodology: some issues

1. Need to normalize multipliers since data on total output in agriculture and food production are only available

   For example: 1 ruble of output in food industry in 2000 resulted in 2.4 rubles of total output, including 1.4 rubles of output in food industry $\rightarrow$ impact of output in food industry on total output is $\left( \frac{2.4}{1.4} \right) = 1.7$

2. Need to avoid double counting when assessing multipliers for agriculture and food production separately

   Since agriculture output impact on GDP is estimated with the help of multipliers for agriculture, it is necessary to exclude this sector when assessing multipliers for food production. For this, the matrix of technical coefficients is adjusted (the row of coefficients for agriculture is set to zero).

   Similarly, food production is excluded when assessing multipliers for agriculture.
Output and investment multiplier estimates (impact on GDP)

Output and investment multiplier estimates for agriculture

Output and investment multiplier estimates for food production

Induced impact of output on GDP (per unit of output in the sector)
Indirect impact of output on GDP (per unit of output in the sector)
Direct impact of output on GDP (per unit of output in the sector)
Impact of investment on GDP (per unit of capital expenditure in the sector)

Source: Institute of economic forecasting of the Russian academy of sciences
Total impact of agricultural and food production on GDP

Main points:

1. Indirect and induced effects of output and investment in agriculture and food production influence significantly.

2. Total impact of agriculture and food production on Russian GDP has decreased from 20.7% in 2000 to 15.5% in 2015.

3. The bulk of this decline is due to reducing indirect and induced effects of output in agriculture (which is a result of growing productivity in the sector and in the economy).
Growing productivity in Russian agriculture in 2000-2015

Key technical coefficients for Russian agriculture (constant 2010 prices)

Main points:

1. Trends of changing technical coefficients for agriculture reflect shifts both in its production structure and in technologies.

2. Intermediate consumption of such inputs as feeds, seeds, petroleum products and electricity has decreased significantly.

3. Consumption of financial and insurance services was increasing due to using loans to fund investment projects in the sector.
Structural shifts in the Russian economy in 2000-2015

trillion rubles, constant 2010 prices

Intermediate consumption / Gross output (%, current prices)

Source: Institute of economic forecasting of the Russian academy of sciences
Import in intermediate and final consumption in 2000-2015

trillion rubles, constant 2010 prices

Import / Gross output (%, current prices)

Source: Institute of economic forecasting of the Russian academy of sciences
Summary

1. Input-Output approach can be used not only to assess macroeconomic impact of future projects, but also for various purposes of retrospective analysis.

2. Agriculture and food production remain an important part of the Russian economy. Direct impact of these sectors on GDP is estimated at 7-8%. Total impact on GDP is much higher, but decreasing (from 20.7% in 2000 to 15.5% in 2015).

3. The main factors of reducing total impact of agriculture and food production on GDP are:
   - technological modernization and growing productivity in these sectors;
   - growing productivity and structural shifts in the Russian economy;
   - increasing import shares (integration of the Russian economy into the global economy).
Thank you

www.ecfor.ru / polzikov

dmitry.polzikov@gmail.com