Uziakov Yantovsky

Influence of the price structure on the economy's dynamics

One of the determinants of the growth rates and the possibilities of the economic growth is the value structure of production, and in particular, relation between revenues and expenditures and the cost structure. At the same time, the value structure of production is determined by the technological factors (physical flows of resources/products between the sectors of the economy), and the sectoral prices. As the choice of units of measurement does not impact the production structure, it is relations between the sectoral prices, which matter. So, it is obvious that changes in price proportions affect the economy's dynamics. As an example we can consider the economy of the Russian Federation during the transition period of economic reforms, when distorted price and cost proportions, which had resulted from price liberalization, were one of the factors of high inflation and production decline. Transition from a closed centralized system of national economy to the open market, made the world market and its price proportions powerful factors of domestic pricing. The domestic price proportions approached world market price proportions, and as a result, the price dynamics differed a lot in various sectors of the economy. Below we show the dynamics of deflators in various industries of the economy in 1990-2002.

Dynamics of deflators	1992	1995	1998	2000	2002*
(by a factor of, relative to 1990)	*1*	*2*	*3*	*4*	*5*
Electric power	53	6883	14946	29282	49986
Oil production	257	8026	22127	71642	77618
Oil refining	124	11703	24083	59771	85155
Gas	122	5608	14745	49934	87596
Coal	92	5626	9245	20888	30172
Other fuel sectors	28	3290	9720	17078	23785
Ferrous metals	83	6218	10755	24553	30361
Non-ferrous metals	104	5925	11455	28508	24970
Chemistry	70	8264	16959	34289	40311
Machine-building	36	3302	5637	12524	17248
Wood and pulp & paper	61	6181	11005	26926	34734
Construction materials	41	5865	11445	20878	30960
Light industry	35	2730	4171	8518	11754
Food industry	29	3431	5445	11468	15557
Other branches of industry	27	2348	4984	9382	12715
Construction	44	7353	12241	26837	39697
Agriculture and forestry	17	1526	3144	6626	9398
Freight transport and communications for production purposes	49	6670	13694	30998	47233

Dynamics of deflators	1992	1995	1998	2000	2002*
(by a factor of, relative to 1990)	*1*	*2*	*3*	*4*	*5*
Passenger transport and communications for non-production purposes	22	4530	7603	14392	22222
Trade and procurement	159	9381	20034	43037	70613
Other material production	73	2775	6433	11412	16111
Education, health, culture	22	2923	5031	9792	14789
Communal services	26	5928	17655	33351	51802
General government, finance	42	5957	11609	21605	30860
Science and scientific services	23	2499	5180	11747	14364
Economy, total	*51*	*4671*	*9248*	*20560*	*29540*

The Russian economy which was established in the pre-reform decades, had been developing for a long time in the situation of totally different price proportions ("cheap resources") that is why the technological structure and cost structure were adjusted to different price proportions. There was neither enough time, nor investments, nor adequate managerial efforts to change and adjust the technological structure, so the majority of enterprises reacted to the increase in costs not by changing their technology, but by increasing prices for their output, which meant that they tried to return to the previous price proportions and aggravated the situation. In the end, the Russian economy adjusted to the new price relations, but it has paid a high price of production decline and decrease in the living standards of the population.

Let us try to consider the effects of changes of relative on the economy's dynamics. The uneven growth of the sectoral prices (including price increase in a single sector) is nothing else but change in the relative price proportions. When this happens, the value added is to be re-distributed between the industries of the economy. When prices increase in a single industry, its revenues increase and the revenues of other industries decrease. If total output of that industry is consumed by other industries (not meant for final consumption), the nominal increase in its revenues is equal to the sum of nominal decreases in the revenues of other industries.

If a certain share of output produced by the industry, where prices were raised, went to final consumption, the increase in revenues in this industry would be larger than the decrease in revenues of other consuming industries; hence the total nominal revenues of the economy would increase. It should be kept in mind, though, that the increased revenues are confronted by a final product increased by the same nominal amount. Therefore, it is not easy to determine how price increase in a certain industry influences the total final demand and the economy's growth rates.

However, it is clear that the changing price proportions affect the dynamics of monetary flows, and hence, the size of final demand, level and structure of output. The problem is to understand what the mechanisms of this influence are.

The impact of the value structure of production on the economic growth is dynamic in nature. Increase of the share of value added in the economy (and in certain industries) provides an opportunity to increase final demand and intermediate demands of the industries. In its turn it predetermines the economy's dynamics. We observe a raise in intermediate and final demand in real terms only when expenditures of final consumers grow faster than prices. The size of

expenditures depends, first of all, on the sizes of income, which in their turn are determined by costs. However, both costs and income depend on the level and structure of prices. Therefore incomes depend on prices and shape price levels in the economy.

Mutual influence of prices and incomes in the industries of the economy are well studied and is described by a system of price equations of the Leontief model. So, it is always possible to calculate the price changes in other industries when price change in a certain industry is given. However, the Leontief model by itself does not allow to estimate the impact of price changes on the economic growth. It is necessary to construct the function of income generated by the economy of the size of final demand. However, one can find some "hints" in the Leontief price model, which can lead to determining the relations between production, income, and prices. It is important to analyze the changes in the proportions of intermediate consumption and value added, which occur as a result of price changes.

When we carried out calculations using price model of IOT and RIM, we noticed that in several industries price growth resulted in increase of output and in several industries — in decline of output. For example, we tried to estimate the impact of the electricity tariffs growth. Below we provide the results of our calculations where the assumption was made that changes had occurred in electricity and gas prices and freight transport tariffs, while other factors did not have any impact.

	Price increase	Changes in GDP production	Changes in household consumption	Changes in fixed capital formation	Changes in government consumption
	% , per year				
	1	2	3	4	5
Electric power	1.181	0.974	0.971	0.962	0.986
Gas	1.198	1.018	1.002	1.040	1.043
Transport	1.164	0.995	0.977	1.011	1.020
All natural monopolies		**0.988**	**0.963**	**0.989**	**0.991**

Having analyzed the results of the calculations and the above theoretical considerations, we made an attempt to find out the regularity in the influences of the sectoral prices on the economy's dynamics, and as a result, allowed ourselves to formulate the following statement as a **Theorem** :

If the ratio of the intermediate consumption to the gross output in a certain industry is higher than the ratio of intermediate consumption to the gross output in the economy as a whole, than an increase of relative prices for the products of this industry, all other things being equal, results in the fact that price index for the intermediate products in the economy will be higher that value added index.

Proof

To simplify the proof, we will introduce the following variables

out_i - gross output in constant prices for the i-industry (row) of IOT

p_i - price (index) for the products of the i-industry

$A = [a_{ij}]$ - technological coefficients matrix

IC_j - intermediate consumption of the j-industry

$$IC_j = \sum_i a_{ij} \cdot out_j \cdot p_i$$

DC_i - distribution of the products of the i-industry between other industries

$$DC_i = \sum_j a_{ij} \cdot out_j \cdot p_i$$

gva - gross value added

$m\cos t$ - intermediate consumption

Let us introduce following

$p = (p_1, p_2, ...)$ - initial prices (price indices)

$p' = (p_1', p_2', ...)$ - new prices, where $p_1' > p_1$ и $p_i' = p_i, i > 1$ -by the theorem condition.

Then value added index is equal to

$$G = \frac{gva(p')}{gva(p)} = \frac{\sum_j out_j \cdot p_j' - \sum_j \sum_i a_{ij} \cdot out_j \cdot p_i'}{\sum_j out_j \cdot p_j - \sum_j \sum_i a_{ij} \cdot out_j \cdot p_i} =$$

$$= \frac{\sum_j out_j \cdot p_j + out_1 \cdot (p_1' - p_1) - \sum_j \sum_i a_{ij} \cdot out_j \cdot p_i - \sum_j a_{1j} \cdot out_j (p_1' - p_1)}{\sum_j out_j \cdot p_j - \sum_j \sum_i a_{ij} \cdot out_j \cdot p_i} =$$

$$= \frac{\sum_j out_j \cdot p_j - \sum_j \sum_i a_{ij} \cdot out_j \cdot p_i + (p_1' - p_1)(out_1 - \sum_j a_{1j} \cdot out_j)}{\sum_j out_j \cdot p_j - \sum_j \sum_i a_{ij} \cdot out_j \cdot p_i} =$$

$$= 1 + \frac{p_1' - p_1}{p_1} \cdot \frac{out_1 \cdot p_1 - \sum_j a_{1j} \cdot out_j \cdot p_1}{\sum_j out_j \cdot p_j - \sum_j \sum_i a_{ij} \cdot out_j \cdot p_i} = 1 + \frac{p_1' - p_1}{p_1} \cdot \frac{out_1 \cdot p_1 - P\Pi_1}{\sum_j out_j \cdot p_j - \sum_j IC_j}$$

Similarly for the index of intermediate consumption

$$M = \frac{m\cos t(p')}{m\cos t(p)} = \frac{\sum_j \sum_i a_{ij} \cdot out_j \cdot p_i'}{\sum_j \sum_i a_{ij} \cdot out_j \cdot p_i} = \frac{\sum_j \sum_i a_{ij} \cdot out_j \cdot p_i + \sum_j a_{ij} \cdot out_j \cdot (p_1' - p_1)}{\sum_j \sum_i a_{ij} \cdot out_j \cdot p_i} =$$

$$= 1 + \frac{p_1' - p_1}{p_1} \cdot \frac{\sum_j a_{ij} \cdot out_j \cdot p_1}{\sum_j \sum_i a_{ij} \cdot out_j \cdot p_i} = 1 + \frac{p_1' - p_1}{p_1} \cdot \frac{DC_1}{\sum_j IC_j}$$

$$G = 1 + \frac{p_1' - p_1}{p_1} \cdot \frac{out_1 \cdot p_1 - DC_1}{\sum_j out_j \cdot p_j - \sum_j IC_j}$$

$$M = 1 + \frac{p_1' - p_1}{p_1} \cdot \frac{DC_1}{\sum_j IC_j}, \quad p_1' > p_1$$

Consequently, to prove that $G < M$, it is enough to demonstrate that

$$\frac{out_1 \cdot p_1 - DC_1}{\sum_j out_j \cdot p_j - \sum_j IC_j} < \frac{DC_1}{\sum_j IC_j}$$

Let us show that:

$$\frac{out_1 \cdot p_1 - DC_1}{\sum_j out_j \cdot p_j - \sum_j IC_j} < \frac{DC_1}{\sum_j IC_j};$$

$$out_1 \cdot p_1 \cdot \sum_j IC_j - DC_1 \cdot \sum_j IC_j < DC_1 \cdot \sum_j out_j \cdot p_j - DC_1 \cdot \sum_j IC_j;$$

$$out_1 \cdot p_1 \cdot \sum_j IC_j < DC_1 \cdot \sum_j out_j \cdot p_j;$$

We should note that:

$$\sum_j IC_j = \sum_j \sum_i a_{ij} \cdot out_j \cdot p_i = \sum_i \sum_j a_{ij} \cdot out_j \cdot p_i = \sum_i DC_i = \sum_j DC_j$$

Consequently:

$$out_1 \cdot p_1 \cdot \sum_j DC_j < DC_1 \cdot \sum_j out_j \cdot p_j$$

Hence- $\dfrac{DC_1}{out_1 \cdot p_1} > \dfrac{\sum_j DC_j}{\sum_j out_j \cdot p_j}$ as it follows from the theorem conditions

Above we assumed that price increase affects the whole row of the IOT corresponding to this industry. It is rather strong simplification, and the reality is less straightforward. For example, we may not assume that increase in domestic prices will be followed by an increase in the respective export prices, which depend on the world prices. If we assume that export prices remain unchanged, the theorem conditions look as follows:

$$\frac{DC_1}{(out_1 - ex_i) \cdot p_1} > \frac{\sum_j DC_j}{\sum_j out_j \cdot p_j};$$

We can formulate a rather controversial consequence for the theorem: the relations given by the theorem conditions mean that price growth (for intermediate products) is higher than income growth, which generates an impulse to a decrease of the total production output in the economy. And vise versa, the gross value added of the economy grows faster than total material costs (in current prices) only if the ratio of the final product of the industry to its gross output is above average, that is higher than the ratio of the GDP to the gross output.

In this case, there is an impulse to production growth, because incomes grow faster that resource prices.

The table below shows :1) ratios of intermediate consumption to gross output for industries, 2) estimated impulse for a potential economic growth, when prices for the products of a respective industry raise by 100%

	ratio of intermediate consumption to gross output	impulse for a potential economic growth
Electric power	92.6%	91.1%
Oil production	36.3%	101.5%
Oil refining	96.4%	94.2%
Gas	19.1%	106.0%
Coal	88.7%	98.1%
Other fuel sectors	90.8%	99.7%
Ferrous metals	85.5%	96.2%
Non-ferrous metals	94.6%	93.2%
Chemistry	93.1%	95.8%
Machine-building	38.4%	100.8%
Wood and pulp & paper	43.2%	100.2%
Construction materials	73.1%	99.5%
Light industry	82.9%	97.2%
Food industry	68.2%	97.7%
Other branches of industry	79.2%	99.1%
Construction	0.0%	113.3%
Agriculture and forestry	38.5%	101.1%
Freight transport and communications for production purposes	91.0%	96.1%
Passenger transport and communications for non-production purposes	48.4%	99.9%
Trade and procurement	41.9%	104.4%
Other material production	98.3%	98.9%
Education, health, culture	6.9%	106.9%
Communal services	42.2%	101.3%
General government, finance	21.3%	104.9%
Science and scientific services	55.6%	99.4%
Economy, total	**47.70%**	