Resource misallocation and productivity in Ukrainian food industry

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Abstract

The paper studies resource misallocation in Ukraine's food industry and its impact on industry's total factor productivity during the period of 2002-2010. Applying Hsieh and Klenow (2009) framework to the dataset of 8,410 Ukrainian food producers, I found that optimal allocation of resources can potentially increase the productivity of this sector by 166-400%. The extent of misallocation in the manufacturing of food and beverages is not uniform across industries, as well as across regions of Ukraine. Results also show that in the case of optimal allocation of resources, small and medium enterprises should have a higher role in food production sector.

Keywords: resource misallocation, food industry, total factor productivity, output distortions, capital distortions

JEL Classification: D24, D61, L66, O12, Q18

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1. Introduction

Years of growth theory development proved that total factor productivity is one of the main determinants of differences in countries' output. Hsieh and Klenow (2010) showed that growth literature attributes TFP with an explanation of 50-70% of these differences. One of the mechanisms, which explains differences in TFP and output is described in Hsieh and Klenow (2010) and consists of economic policy, which affects the allocation of resources, their productivity, and total factor productivity, in the end affecting the total output of the economy.

These policies can affect sectors of economy differently. Thus, it is important to study resource misallocation in different sectors, especially in those having a significant share in the economy of the country. In this study, I consider food industry of Ukraine, including the manufacture of food and beverages. Food industry accounts for approximately 5% of aggregate value added of the Ukrainian economy and 14% of exports of goods. It is also one of the main consumers of agricultural produce, processing approximately 40% of total intermediate consumption of agricultural output, or 23.1% of total usage of agricultural produce[1].

The paper studies resource misallocation in the Ukrainian food industry, which lowers productivity of the sector and moves its output from the optimal one. Research agenda includes the following research questions: (i) What are the potential productivity gains of optimal allocation of resources? (ii) What are the firm-level implications of resource misallocation in food processing? (iii) How does misallocation differ by industries and regions? (iv) How would the sector produce in case of optimal allocation of resources?

Addressing these questions, I apply Hsieh and Klenow (2009) methodology to a dataset of 8,410 producers of food and beverages over the period of 2002-2010. In this framework, I calculate firm-specific output and capital distortions, which move allocation of resources from the optimal one and lower industry productivity. Results reveal huge resource misallocation in food production sector. In the case of fully optimal allocation of resources, food production can potentially be 166-400% more productive. Comparing these figures to the results for overall Ukrainian manufacturing from Ryzhenkov (2016), food production significantly underperformed overall manufacturing in terms of allocation of resources in 2002-2003, but afterward the situation became comparable to the overall extent of misallocation; moreover, in 2010 food processing showed had even slightly better allocation.

The issue of resource misallocation in the framework of Hsieh and Klenow (2009) model is actively studied during the recent years. Starting with Hsieh and Klenow (2009) study, where potential TFP gains for China, India and USA were estimated, a number of another studies emerged on various countries. Speaking about Europe, Bellone and Malen-Pissano (2013) produced estimates for France, Dias, Marques and Richmond (2015) - for Portugal, Gopinath, Kalemli-Ozcan, Karabarbounis, Villegas-Sanchez (2015) and Garcia-Santana, Moral-Benito, Pijoan-Mas, and Ramos (2016) – for Spain, Benkovskis (2015) – for Latvia, Calligaris (2015) – for Italy, and Ryzhenkov (2016) – for Ukraine. Among Asia countries, in addition to China and India, Dheera and Aumpon (2014) provided calculations for Thailand, Hosono, and Takizawa (2015) – for Japan, Ha, Kiyota, and Yamanouchi (2016) – for Vietnam, and Nguyen, Taskin, and Yilmaz (2016) – for Turkey. Another actively explored region is South America, where Camacho and Conover (2010) made research on Colombia, Machicado and Birbuet (2012) – on Bolivia, Oberfield (2013) and Chen and Irarrazabal (2015) – on Chile, as well as Busso, Madrigal, and Pages (2013) – on Argentina, Bolivia, Chile, Colombia, Ecuador, El Salvador, Mexico, Uruguay, Venezuela, Brazil, Guatemala, Honduras, and Nicaragua.

[1] Value added and intermediate consumption shares are computed based on input-output of Ukraine for 2005. Share in exports is for 2015 and calculated based on ComTrade database.

As in this paper I consider food industry, sectoral estimates from these papers are of specific interest. Garcia-Santana et al. (2016) find that 51 out of 58 two-digit level industries experience deterioration of allocation period, but allocation of in manufacturing of beverages improved. In the earlier version of their paper, Garcia-Santana et al. (2015) also provide detailed estimates for different industries. Thus, while for the whole economy of Spain potential gains are estimated at 24-49%, productivity of manufacture of food could increase by 24-32% and productivity of manufacture of beverages could be 32% higher. Dheera and Aumpon (2014) find that potential TFP gains in Thailand equal to 147.8% with manufacture of food products, processing and preserving of fish and fish products, and manufacture of grain mill products among top industries, which contribute the most to TFP gain. Hosono and Takizawa (2015) find that while potential TFP gains for Japan are equal to 39.6%, this estimate equal to 74.8% for manufacture of beverages, 58.0% for manufacture of flour and grain mill products, 44.9% for manufacture of prepared animal foods and organic fertilizers – 44.9%, as well as 35.7% for manufacture of miscellaneous foods and related products[2]. Nguyen, Taskin, and Yilmaz (2016) that productivity of the economy of Turkey can be increased by 69.1-123.1% in case of fully optimal allocation of resources, while for food industry this estimate varies between 63% to 165%; moreover, food industry significantly underperformes overall economy in the early 2000s, but after gradual improvement TFP gains become comparable and in certain years food industry becomes more efficient than economy in whole. Ryzhenkov (2016) find that manufacture of food and beverages was in the middle range by resource misallocation among the manufacturing industries.

The rest of the paper is structured as follows: section 2 contains a description of methodology, section 3 describes the data on Ukrainian food industry, section 4 presents empirical results at aggregate, firm, industry and regional levels, section 5 concludes.

2. Methodology

In this paper, I stick to basic Hsieh and Klenow (2009) methodology and apply it to food production sector. This is needed in order to make results comparable with previously obtained results for the entire Ukrainian manufacturing by Ryzhenkov (2016). In this framework, the industry consists of a number of heterogeneous firms, which operates at the monopolistically competitive market. The firms produce under two-factor Cobb-Douglas production technology and differ by their productivity and distortions they face.

Here I distinguish between two types of distortions at the level of firms, which move allocation of resources from the optimal level. Capital distortions move capital-labor ratio from the optimal value. Under this type of distortions, one can understand unequal conditions of access to banking financing (lower interest for some producers or restricted access to young firms without credit history) or distortions in the labor market which makes legal employment more expensive comparing to illegal. For this type of distortions, I use the following formula:

$$1+\tau_{Ksi}=\frac{\alpha_s}{1-\alpha_s}\frac{wL_{si}}{RK_{si}}, \quad (1)$$

where α_s - share of capital in firm's value added, wL_{si} – labor compensation (wage rate w is normalized to 1), R – rental price of capital, K_{si} – fixed capital.

Another type of distortions is output distortions, which move allocation of capital and labor in one direction, thus, moving the whole scope of production. Output distortions include subsidies, special conditions of tax administration or lucrative contracts to some producers. Here I apply the following formula:

$$1-\tau_{Ysi}=\frac{\sigma}{\sigma-1}\frac{wL_{si}}{(1-\alpha_s)P_{si}Y_{si}}, \quad (2)$$

[2] Figures are calculated by the author using data prodived by Hosono and Takizawa (2015)

where σ is the elasticity of substitution between plant's value added, and $P_{si}Y_{si}$ is firm's value added.

Obtaining the measures of distortions, it is possible to calculate actual marginal productivities by adjusting wages and rental rate of capital by distortions they are affected. Marginal revenue product of capital ($MRPK_{si}$) and marginal revenue product of labor ($MRPL_{si}$) are, thus, respectively defined as:

$$MRPL_{si} = w\frac{1}{1-\tau_{Ysi}}, \tag{3}$$

$$MRPK_{si} = R\frac{1+\tau_{Ksi}}{1-\tau_{Ysi}}. \tag{4}$$

Completing the firm-level stage of calculations, I calculate two types of total factor productivity, as suggested by Foster, Haltiwanger, and Syverson (2008): physical total factor productivity, TFPQ, which measures productivity in terms of output, as well as revenue total factor productivity, TFPR, which measures productivity in terms of revenue.

Physical TFP here is measured as the ratio of actual production over employed inputs:

$$TFPQ_{si} = A_{si} = \kappa_s \frac{(P_{si}Y_{si})^{\frac{\sigma}{\sigma-1}}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}} \tag{5}$$

where κ_s stands for $w^{1-\alpha_s}(P_sY_s)^{-\frac{1}{\sigma-1}}/P_s$ and equals to 1[3].

Revenue productivity is measured as a geometric mean of capital and labor marginal productivities:

$$TFPR_{si} = \frac{\sigma}{\sigma-1}\left(\frac{MRPK_{si}}{\alpha_s}\right)^{\alpha_s}\left(\frac{MRPL_{si}}{w(1-\alpha_s)}\right)^{1-\alpha_s} \tag{6}$$

Due to its construction, TFPR contains distortions mentioned above, which move it from the optimal level. According to Hsieh and Klenow (2009) model, more productive firms should be able to set lower prices, implying equal TFPR within the industry. Thus, moving TFPR from the optimal level, distortions lead to higher dispersion of TFPR within the industry, which magnitude signals about the severity of resource misallocation.

In the following, I move to the level of industry and aggregate total factor productivity. Sectoral TFP is calculated using CES production function as harmonic average of firms' TFPQ weighted by the deviations of TFPR from the sector average:

$$TFP_s = \left\{\sum_{i=1}^{M_s}\left(A_{si}\frac{\overline{TFPR_s}}{TFPR_{si}}\right)^{\sigma-1}\right\}^{\frac{1}{\sigma-1}}, \tag{7}$$

where M_s is the number of firms in the industry[4]. As the deviation of TFPR in this framework shows the extent of distortions the firm face, the higher the extent of resource misallocation in the industry, the lower the sectoral TFP would be. Following this logic, optimal sectoral TFP, in case of no distortions, is equal to the average physical productivity:

$$TFP_s^e = \overline{A_s} = \left(\sum_{i=1}^{M_s} A_{si}^{\sigma-1}\right)^{\frac{1}{\sigma-1}} \tag{8}$$

Finally, I aggregate total TFP of food production using Cobb-Douglas production function:

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[3] Please refer to equation (19) in Hsieh and Klenow (2009) for explanation of TFPQ derivation.

[4] Following Hsieh and Klenow (2013), average sectoral TFPR in (7) is computed as $\overline{TFPR_s} = \frac{\sigma}{\sigma-1}\left[\frac{R}{\alpha_s\sum_{i=1}^{M_s}\frac{1-\tau_{Ysi}}{1+\tau_{Ksi}}\frac{P_{si}Y_{si}}{P_sY_s}}\right]^{\alpha_s}\left[\frac{1}{(1-\alpha_s)\sum_{i=1}^{M_s}1-\tau_{Ysi}\frac{P_{si}Y_{si}}{P_sY_s}}\right]^{1-\alpha_s}$ or $\overline{TFPR_s} = \frac{\sigma}{\sigma-1}\left(\frac{\overline{MRPK_{si}}}{\alpha_s}\right)^{\alpha_s}\left(\frac{\overline{MRPL_{si}}}{w(1-\alpha_s)}\right)^{1-\alpha_s}$.

$$TFP = \prod_{s=1}^{S} TFP_s^{\theta_s} = \prod_{s=1}^{S} (\sum_{i=1}^{M_s} \{A_{si} \frac{\overline{TFPR_s}}{TFPS_{si}}\}^{\sigma-1})^{\frac{\theta_s}{\sigma-1}} \quad (9)$$

where S is the number of analyzed food-producing industries and θ_s shows the share of specific industry in aggregate output of food production sector. Plugging sector-specific results of (7) into (9) gives me the actual aggregate TFP of food processing, whereas using results of (8) in equation (9) gives me the optimal TFP. Comparing both these variables brings to relative gains from liberalization within sectors:

$$\frac{TFP}{TFP_e} = \prod_{s=1}^{S} [\sum_{i=1}^{M_s} (\frac{A_{si}}{\overline{A_s}} \frac{\overline{TFPR_s}}{TFPR_{si}})^{\sigma-1}]^{\theta_s/(\sigma-1)} \quad (10)$$

3. *Data description*

3.1. Construction of dataset

For this paper, I use data from Ryzhenkov (2016), which contains a number of financial indicators of all manufacturing enterprises for the period of 2002-2010. This dataset contains 211,794 observations for 52,035 manufacturing firms (after initial data cleaning, but before trimming outliers). As in this paper I analyze only food processing, I trim all the firms except those corresponding to division 15 of NACE Rev. 1.1 classification “Manufacture of food products and beverages”. Also, I drop section 1595 “Manufacture of other non-distilled fermented beverages” as it contains only few observations, as well as firms without reported location. As a result, I obtain a dataset of 38,575 observations for 9,203 food-processing firms. After trimming 1% tails of productivity outliers, the final dataset, which enters to analysis, shrink to 35,599 observations for 8,410 unique food producers.

The dataset provides information on a number of variables. These variables include total turnover, wage bill, social benefits, employment, book value of fixed capital (both at the beginning and at the end of period), material cost, industry code (industries are defined by 4-digit code of NACE Rev. 1.1 classification), date of establishment and liquidation, type of ownership, exporting and importing indicators, region of location.

All the monetary variables are deflated by corresponding indexes reported by State Statistics Service of Ukraine. Sector-specific output deflators are used for total turnover, producer price index – for the book value of fixed capital and material cost, and consumer price index – for wage bill and social security.

A number of variables are additionally constructed, including value added, capital, labor compensation, age, export and import indicators, as well as region and ownership. *Value added (VA)* is constructed as total turnover minus material cost, while *capital* is an average book value of fixed capital in given year. *Labor compensation* in defined as the sum of the wage bill and social security, adjusted by non-reported payments[5]. *Age* of firm is defined as reporting year minus year of establishing. As the year of establishing I take actual information on establishing, or, alternatively, if the firm is present in the sample since 2002, I assume that its year of establishing is equal to 2002 minus 3. Exit year is set equal to an actual year of liquidation or the last year the firm appeared in the dataset. *Export* and *Import* dummies show whether the firm has active international trade operations in the reporting year.

[5] Ryzhenkov (2016) compare labor share in value added in actual data to labor share in VA from input-output table of Ukraine for 2005. All the labor compensations are evenly multiplied in order to move median labor share in the data to those in IO table. In this study I compare corresponding shares only for manufacturing of food and beverages.

3.2. Description of data

Basic descriptive statistics on key monetary variables are presented in Table A1. Deflating data lead to lower indicators of real data, comparing to the nominal one. However, due to adjustment of labor compensation in order to account for “shadow payments”, mean real labor compensation is higher than mean nominal labor compensation even after deflating.

Table 1 provides insights into evolution of the median food producer in Ukraine during the period of 2002-2010. To start with, a number of food producers in the sample decrease significantly over the analyzed period: while in 2002-2006 more than 4000 firms operate in the sector, by 2010 their number shrink to less than 3000. Analysis of financial indicators shows that median firm expands before 2009, while afterward shrink with the following slight recovery in 2010. Utilization of production factors, including labor and fixed capital, does not vary significantly. Value added per capita steadily improves by 2009, but decreases afterwards. Nominal labor compensation in the sample increased over 2002-2010, following the trend reported by the State Statistic Services of Ukraine for total manufacturing. However, analysis of real labor compensation reveals structural break of 2009 in a steady trend of real labor compensation improvement.

Table 1. Evolution of median firm in manufacturing of food and beverages

Year	Number of firms	Turnover, UAH m	VA, UAH m	Fixed capital, UAH m	Materials, UAH m	Labor compen-sation, UAH m	Employ-ment, # of workers	VA per capita, UAH	Real monthly labor compen-sation, UAH	Nominal monthly labor compen-sation, UAH
2002	4,393	0.77	0.34	0.29	0.33	0.10	30	11,385.2	317.3	234.3
2003	4,780	0.63	0.25	0.22	0.31	0.09	n/a	n/a	n/a	n/a.
2004	4,614	0.80	0.39	0.22	0.35	0.12	25	15,052.9	407.5	345.4
2005	4,380	1.00	0.51	0.24	0.40	0.15	26	18,862.7	491.2	472.6
2006	4,192	1.31	0.68	0.27	0.53	0.20	29	22,194.0	577.2	604.3
2007	3,694	1.38	0.68	0.27	0.58	0.21	29	21,244.4	631.5	745.4
2008	3,450	1.56	0.88	0.25	0.58	0.23	28	29,401.4	675.4	997.8
2009	3,168	1.37	0.68	0.25	0.55	0.20	28	23,494.3	626.3	1,073.5
2010	2,928	1.16	0.63	0.21	0.47	0.21	25	24,094.2	732.2	1,371.7

Note: Inflation-adjusted data over 2002-2010. Turnover, value added, fixed capital, material cost and labor compensation are the medians and expressed as UAH m; employment is expressed as a number of employees (data for 2003 is missing); value added per capita and monthly labor compensation per capita (reported wages+social benefits+”shadow” payments) are expressed as UAH (data for 2003 is not available as data on employment for 2003 is missing)

Size structure of Ukrainian food processing is presented in Table 2, which shows the distribution of mass of firms, labor and value added in 2005 by the size of enterprises. Panel (b) of Table 2 shows that small and medium enterprises in food processing account for 95.5% of the mass of firms, which employ 39.5% of labor and generate 32.7% of value added. Comparison of raw and final dataset structure shows that elimination of outliers moves size structure from micro and big firms to small and medium ones.

According to Table A2, during 2002-2010 collective ownership is the prevailing type of ownership in food production. Table A3 shows that 26-32% of firms in food production trade internationally. Most of these firms are pure exporters, following by firms both exporting and importing, with pure importers being the least numerous group within internalized firms. Analysis of geography of food processing (Table A4) reveals that while most of the firms are located in the Northern Ukraine, Eastern Ukraine stands for the highest share of value added and the highest share of employment. Table A5 shows that operation of dairies and cheese making, as well as manufacture of bread, fresh pastry goods and cakes belongs to top-5 industries by a share in the mass of firms, share in value added and share in employment. Also manufacture of grain mill products, production of meat and poultry meat products, and production of mineral waters and soft drinks belong to top industries by share of mass of firms; manufacture of distilled potable alcoholic beverages, manufacture of crude oils and fats, and manufacture of cocoa; chocolate and sugar confectionery belong to top industries by share in value added; manufacture of cocoa; chocolate and sugar confectionery, production of meat and poultry meat products, and manufacture of sugar belong to top industries by share in employment.

Table 2. Size distribution of in the raw data and the final dataset

Number of employees	Firms		Labor		Value added, real	
	Total (#)	Share, %	Total (#)	Share, %	Total (UAH bn)	Share, %
			(a) Raw dataset			
<10	1117	24.0%	5,122	1.1%	0.25	0.7%
10-19	832	17.9%	11,554	2.4%	0.96	2.6%
20-49	1017	21.8%	32,124	6.6%	1.34	3.6%
50-99	547	11.7%	39,292	8.1%	2.18	5.9%
100-249	642	13.8%	103,169	21.3%	7.40	19.9%
250-499	296	6.4%	102,691	21.2%	6.17	16.6%
500-999	157	3.4%	104,685	21.6%	8.54	23.0%
>=1000	52	1.1%	86,132	17.8%	10.26	27.7%
All	4,660		484,769		37.10	
			(b) Final sample			
<10	981	22.9%	4,569	1.0%	0.20	0.7%
10-19	773	18.0%	10,772	2.5%	0.34	1.3%
20-49	955	22.3%	30,197	6.9%	1.01	3.8%
50-99	512	11.9%	36,808	8.4%	1.70	6.4%
100-249	594	13.9%	95,409	21.7%	5.34	20.2%
250-499	280	6.5%	96,941	22.1%	5.32	20.1%
500-999	148	3.5%	98,349	22.4%	7.32	27.7%
>=1000	42	1.0%	66,160	15.1%	5.21	19.7%
All	4,285		439,205		26.45	

Note: figures refer to the year of 2005; real value added is expressed in UAH bn.

3.2 Calibration of parameters

In order to apply Hsieh and Klenow (2009) framework to the data, such parameters as the rental price of capital, the elasticity of substitution between plants' value-added, and the elasticity of output with respect to capital should be calibrated.

The rental price of capital (R) is calibrated at 7%, which includes the real interest rate (RIR) equal to 2% and the depreciation rate at 5%. According to the World Development Indicators database of the World Bank, the real interest rate in Ukraine during the period of 2002-2010 varies between -8.6% in 2008 to 19.2% in 2010 with the mean at 1.8% and the median at 1.9%. As a result, real interest rate comes to the model as 2%. Depreciation is set at 5% based on analysis of Ukrainian legislation.

Following Hsieh and Klenow (2009) and the resulting flow of literature, the elasticity of substitution between plants value-added is set to σ=3. The elasticity of output with respect to capital (α_s) is equal to unity minus labor share (share of labor compensation in value added) in the corresponding US industry. The US labor shares are used here for a baseline case, as it is assumed that US economy is less distorted, so its factor shares would be non-distorted. US labor shares are calculated based on the NBER Productivity Database. I multiply the obtained US labor shares by 1.5 in order to account for non-wage forms of compensation, as it is done by Hsieh and Klenow (2009)

4. *Empirical results*

4.1. Total misallocation in food processing

As the first step of the analysis, I compute both physical and revenue productivities for each firm, compute distributions of both type of productivities adjusting them by sectoral means, and trim 1% tail of outliers in each distribution. Afterward, I follow one more time all steps of TFP calculation and obtain new distributions.

Panel (a) of Figure 1 shows TFPQ distribution, $log(TFPQ_{si}M_s^{\frac{1}{\sigma-1}}/\overline{A_s})$, in selected years. The distribution is weighted by the share of industry in total value added of food production sector in given year. The distribution is negatively skewed with its mean higher that its median. This implies that there is some granularity in food production sector, when total productivity is driven by a number of firms, whereas the remaining mass of firms underperforms the average productivity and has negligible impact on productivity in corresponding industry. Panel (b) of Figure 1 shows TFPR distribution, $log(TFPR_{si}/\overline{TFPR_{si}})$, in selected years. Wide dispersion of the distribution, signals about huge resource misallocation in food processing.

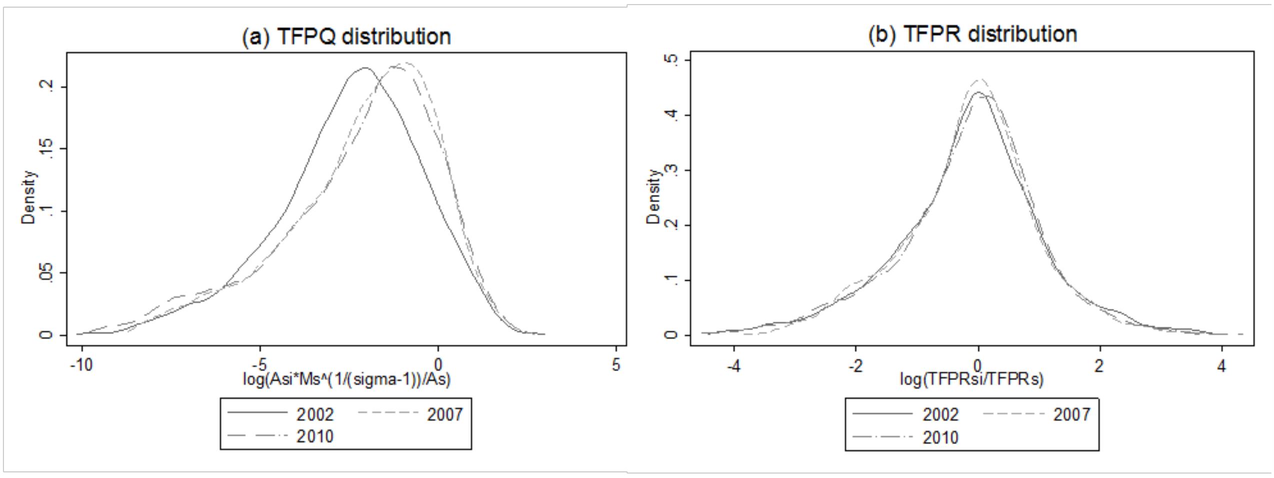

Figure 1. TFPQ and TFPR distribution for selected years

Note: panel (a) plots the distribution of TFPQ, $log(TFPQ_{si}M_s^{\frac{1}{\sigma-1}}/\overline{A_s})$*, for 2002, 2007 and 2010; panel (b) plots the distribution of TFPR,* $log(TFPR_{si}/\overline{TFPR_{si}})$*, for 2002, 2007 and 2010. Distributions are weighted by the shares of industries in total manufacturing value added.*

Table 3 provides some insights into the evolution of productivity and distortions variance. Distribution of TFPQ is rather volatile during 2002-2008 with the lowest values of standard deviation in 2005 and 2006. However, in 2009 and 2010 TFPQ distribution variance significantly widens as a result of the financial crisis of 2009. The variance of TFPR distribution also shows that allocation improves before the crisis of 2009, but afterwards misallocation increases. Output wedge is volatile with some trend of improvement during the mid-2000s, but again increases in 2009. The same jump occurs for the capital wedge in 2009, but before it is less volatile than output distortion.

Finally, applying formula (10) to the dataset on Ukrainian food producers, I obtain TFP gains of moving to the optimal allocation of resources, presented as a percentage of current productivity of the sector (Figure 2). Results show that Ukrainian food processing could be 166-400% more productive in case of fully optimal allocation of resources. In 2002-2003 food processing significantly underperforms total manufacturing in terms of resource allocation optimality, but since 2004 food processing productivity gains become more comparable to the overall manufacturing

TFP gains and follows the same path over time. However, in 2010 situation slightly improves in food processing comparing to the overall manufacturing as its gains become less than overall gains.

Table 3. Dispersion of TFPQ, TFPR, and wedges in Ukrainian food processing

Year	TFPQ			TFPR			Output wedge	Capital wedge
	S.D.	75-25	90-10	S.D.	75-25	90-10	S.D.	S.D.
2002	2.02	2.56	5.20	1.20	1.36	2.91	0.93	1.38
2003	2.18	2.84	5.69	1.28	1.42	3.11	1.03	1.44
2004	2.03	2.64	5.15	1.21	1.37	2.89	0.97	1.42
2005	1.93	2.41	4.96	1.16	1.27	2.78	0.88	1.41
2006	1.95	2.57	5.00	1.12	1.25	2.76	0.87	1.40
2007	2.06	2.71	5.24	1.10	1.26	2.78	0.90	1.42
2008	2.09	2.77	5.38	1.13	1.28	2.80	0.91	1.46
2009	2.19	2.72	5.73	1.21	1.33	3.00	1.02	1.50
2010	2.25	2.86	5.84	1.19	1.32	2.86	0.93	1.51

Note: for each plant i in industry s, $TFPQ_{si} = \frac{Y_{si}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}}$, $TFPR_{si} = \frac{P_{si}Y_{si}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}}$, $1 - \tau_{Ysi} = \frac{\sigma}{\sigma-1}\frac{wL_{si}}{(1-\alpha_s)P_{si}Y_{si}}$, *and* $1 + \tau_{Ksi} = \frac{\alpha_s}{1-\alpha_s}\frac{wL_{si}}{RK_{si}}$. *Statistics are for deviations of log(TFPQsi), log(TFPRsi), log(1-*τ_{Ysi}*) and log(1+*τ_{Ksi}*) from the respective industry means: S.D. is standard deviation, 75-25 is the difference between the 75*th *and the 25*th *percentiles, 90-10 is the difference between the 90*th *and 10*th *percentiles. Industries are weighted by value-added shares.*

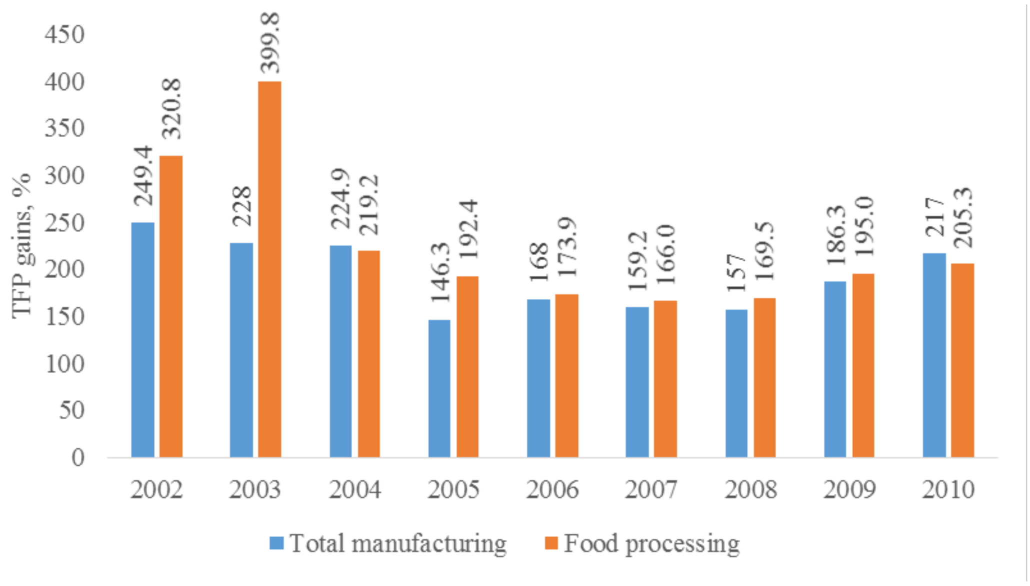

Figure 2. TFP gains from optimal allocation of resources for food processing and total manufacturing

Note: entries are $\left(\frac{TFP_e}{TFP} - 1\right) * 100\%$, *where* $\frac{TFP}{TFP_e} = \prod_{s=1}^{S}[\sum_{i=1}^{M_s}(\frac{A_{si}}{\bar{A}_s}\frac{\overline{TFPR_s}}{TFPR_{si}})^{\sigma-1}]^{\theta_s/(\sigma-1)}$. *Calculations for total manufacturing are taken from Ryzhenkov (2016)*

4.2. Firm-level implications

In order to get additional insights in firms' productivity and distortions they face, I run a number of regressions of TFPQ and TFPR on firms' characteristics, including ownership, age, size, exporting and importing activity, as well as indicators of entering and exit.

As columns (9) and (10) of Table A6 show, state-owned enterprises are the least productive, whereas private ownership (both domestic and foreign) brings the most benefits in terms of TFP. Physical productivity negatively correlates with age, but positively correlates with size. Column (1) of Table A9 shows that entering foreign markets also positively correlates with TFP, as exporters and importers are more productive, especially those both exporting and importing, than those selling only domestically.

Construction of TFPR, which is positively correlated with capital distortions and negatively correlated with output distortions, provides useful insights from the regression analysis. To start with, columns (11) and (12) of Table A6 shows that state-owned enterprises are subject to mainly output distortions, whereas private and collectively owned companies face mainly capital distortions. Young firms mainly face capital distortions, whereas the older the firm, the more output distortions it faces. There is a positive correlation between size and capital distortions, whereas output distortions and the higher among the smallest firms. Firms selling and purchasing domestically face mainly output distortions, while firms trading internationally face more capital distortions (Table A9).

According to Table A7, TFPQ is positively correlated with TFPR, which means that more productive firms face more capital distortions, while less productive enterprises face more output distortions. Firms' entry is not associated with a statistically significant difference in TFPQ comparing to incumbents, but entrants face more capital distortions (Table A8). Exiting firms are less productive and subject to output distortions.

4.3. Industry and regional breakdown

Resource misallocation in food production is also not uniform across industries and regions. Table 4 shows that, on average in 2002-2010, the smallest misallocation of resources is observed in production of ethyl alcohol from fermented materials, production and preserving of poultry meat, manufacture of malt, processing of tea and coffee, as well as operation of dairies and cheese making. On the other hand, industries affected by resource misallocation the most include manufacture of refined oils and fats, manufacture of prepared pet foods, processing and preserving of potatoes, manufacture of cider and other fruit wines, as well as manufacture of prepared feeds for farm animals. Extreme values of output and capital distortions only sometimes correspond to extreme values of TFPR variance, so there are industries with moderate level of overall resource misallocation, but with huge influence by one of the types of distortions.

Analysis of dynamics also shows that over 2002-2010 allocation of resources improves in 18 out of 32 food producing industries (Table A10). The best improvement is reported for manufacture of prepared pet foods, processing and preserving of potatoes, manufacture of distilled potable alcoholic beverages, processing and preserving of fish and fish products, as well as processing and preserving of fruit and vegetables n.e.c. The most negative dynamics occurs for production of ethyl alcohol from fermented materials, manufacture of sugar and manufacture of beer

Figure 3 presents geographical distribution of resource misallocation in Ukrainian food industry. One can see that the best allocation of resources is in Northern West (Sumy, Chernihiv, Kyiv, Zhytomyr, Rivne and Volyn regions) and South East (Zaporizhzhya and Donetsk regions). The most severe misallocation over 2002-2010 was observed in Kharkiv, Dnipropetrovsk, Kirovograd and Chernivtsi regions, cities of Kyiv and Sevastopol, as well as Crimea.

4.4. Optimal size distribution

As results show that there is significant resource misallocation in Ukrainian food production, it is important to see how sector's value added would be produced in case of optimal allocation of resources. For this purposes, I compare the actual and efficient distribution of production by firms. Figure 4 shows that efficient distribution is more dispersed with the higher role of small firms. Thus, comparison of distributions implies that only few of food producers underproduce their optimal level of production, whereas production of most firms should be downsized. This means that small and medium enterprises should have a more significant role in the sector.

Table 4. Variance of TFPQ, TFPR, and distortions by sectors, average for 2002-2010

NACE code	Name of industry	Sd of TFPQ	Sd of TFPR	Sd of output distortion	Sd of capital distortion
1511	Production and preserving of meat	1.93	1.28	1.01	1.37
1512	Production and preserving of poultry meat	1.67	0.93	0.86	1.27
1513	Production of meat and poultry meat products	1.88	1.17	0.91	1.62
1520	Processing and preserving of fish and fish products	2.02	1.36	1.06	1.54
1531	Processing and preserving of potatoes	2.03	1.55	1.01	1.78
1532	Manufacture of fruit and vegetable juice	2.25	1.33	1.34	1.47
1533	Processing and preserving of fruit and vegetables n.e.c.	2.07	1.41	1.10	1.47
1541	Manufacture of crude oils and fats	2.30	1.34	1.33	1.44
1542	Manufacture of refined oils and fats	2.60	1.54	1.35	1.29
1543	Manufacture of margarine and similar edible fats	2.15	1.32	0.90	1.33
1551	Operation of dairies and cheese making	1.86	1.06	0.84	1.20
1552	Manufacture of ice cream	1.95	1.14	0.99	1.31
1561	Manufacture of grain mill products	2.22	1.30	1.12	1.31
1562	Manufacture of starches and starch products	1.96	1.31	1.17	1.55
1571	Manufacture of prepared feeds for farm animals	2.36	1.65	1.15	1.50
1572	Manufacture of prepared pet foods	2.36	1.54	1.22	1.84
1581	Manufacture of bread, fresh pastry goods and cakes	1.70	1.07	0.70	1.46
1582	Manufacture of rusks, biscuits, preserved pastry goods	1.78	1.12	0.81	1.58
1583	Manufacture of sugar	1.72	1.11	1.11	1.31
1584	Manufacture of cocoa; chocolate and sugar confectionery	1.88	1.10	0.90	1.24
1585	Manufacture of macaroni, noodles, couscous	1.86	1.15	1.06	1.56
1586	Processing of tea and coffee	1.6	1.05	0.96	1.36
1587	Manufacture of condiments and seasonings	1.98	1.21	0.96	1.39
1588	Manufacture of homogenized food preparations	2.21	1.46	1.09	1.63
1589	Manufacture of other food products n.e.c.	1.97	1.37	1.04	1.66
1591	Manufacture of distilled potable alcoholic beverages	2.50	1.50	1.23	1.59
1592	Production of ethyl alcohol from fermented materials	1.26	0.81	0.62	0.60
1593	Manufacture of wines	1.98	1.23	1.12	1.18
1594	Manufacture of cider and other fruit wines	2.37	1.56	0.85	1.29
1596	Manufacture of beer	1.90	1.07	0.80	1.32
1597	Manufacture of malt	1.87	1.04	1.04	1.21
1598	Production of mineral waters and soft drinks	1.91	1.23	0.96	1.46

Note: TFPQ, TFPR, output distortion and capital distortion are expressed as log deviation from the industry mean in given year. All years are pooled. Industries are weighted by value-added shares

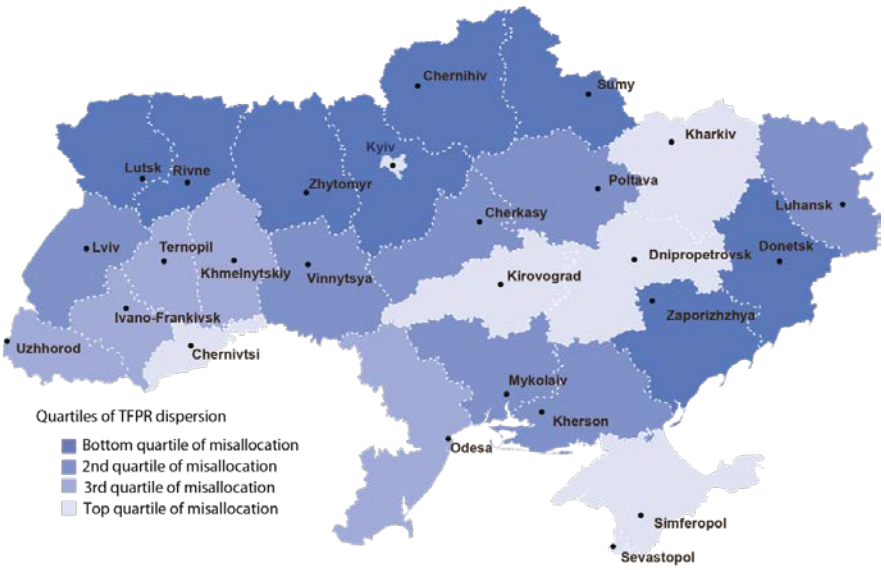

Figure 3. Geography of resource misallocation, average for 2002-2010

Note: TFPR is expressed as log deviation from the industry mean in given year. All years are pooled. Quartiles are computed for each year.

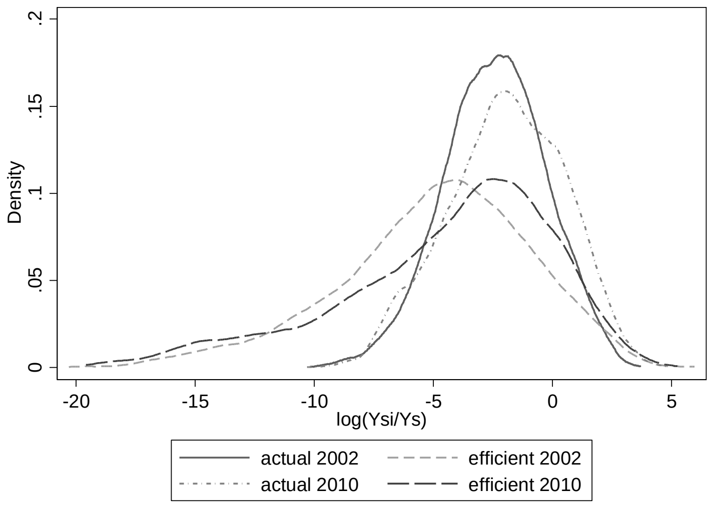

Figure 4. Actual vs. Efficient size distribution of plants in selected years

Note: size is measured as value added; figure plots actual and efficient distribution of value added comparing to the industry mean, $log(P_{si}Y_{si}/\overline{P_sY_s})$

Table 5 presents comparisons for 2002 and 2010 and provides more insights to the distance from the efficient distribution of production. Rows here correspond to productivity quartiles, while columns show deviations from the optimal level of production. Deviations are grouped as following: 0-50 – effective size is more than twice lower than the actual one; 50-100 - effective size is less than twice lower than the actual one; 100-200 - effective size is less than twice higher than the actual one; >200 - effective size is more than twice higher than the actual one.

Results for different years show that most of the food-processing firms overproduce and should be downsized more than twice (during 2002-2010, on average 55.2% are attributed to this group). Another numerous group is firms overproducing the optimal level by less than half. On average, 31.2% of food-processing firms belong to this group during 2002-2010. As a result, one can conclude that more than 4/5 of firms are implicitly subsidized, which leads to higher level of production than the optimal one. But there are firms, which growth is limited by resource misallocation. On average, 8.6% of firms over 2002-2010 can produce up to twice more, whereas 5.1% of firms can be more than twice larger. Comparing upper and lower panels of Table 5, size distribution slightly improved as the weight of huge over- or underproduction decreased, whereas the share of firms over- or underproducing by less than twice increased.

4.5. Robustness check and alternative specifications

As robustness check of basic results, I perform standard check for Hsieh and Klenow (2009) framework (2009) by calculating the potential gains, first, with another elasticity of substitution between plants value-added (σ=5), and, second, using the balanced panel. Table A11 shows that the productivity gains are increasing in the elasticity of substitution between plants' value added, which could be explained by slower reallocation of resources between firms in this case.

As alternative specifications, I use labor share based on Ukrainian data instead of US shares. The initial motivation for using US shares and adjusting labor compensation was eliminating potential biases caused by distortions to the data, including the misreporting of wages actually paid to workers in Ukraine. Comparing the baseline results to those using Ukrainian industry- or firm-level labor shares shows a substantial increase in potential TFP gains, so, baseline results could be considered as optimistic ones.

Table 5. Actual vs. Efficient size: share of different levels of deviations (value added quartiles)

2002	0-50	50-100	100-200	>200
Top quartile	18.9%	1.9%	2.5%	1.8%
2nd quartile	19.7%	3.1%	1.3%	0.8%
3rd quartile	14.0%	8.5%	1.8%	0.7%
Bottom quartile	11.3%	12.0%	1.5%	0.3%
# of firms	2,806	1,121	307	159
Share of total number	63.9%	25.5%	7.0%	3.6%
2010	0-50	50-100	100-200	>200
Top quartile	15.7%	3.7%	3.2%	2.4%
2nd quartile	16.8%	5.7%	1.5%	1.1%
3rd quartile	9.9%	10.7%	3.0%	1.4%
Bottom quartile	8.8%	13.4%	2.3%	0.6%
# of firms	1,500	977	290	161
Share of total number	51.2%	33.4%	9.9%	5.5%

Note: Columns are the ratio of efficient production to the actual one: 0-50 – effective level is more than twice less than the actual one, 50-100 – effective level is less than twice less than the actual one, 100-200 – effective level is less than twice lower than the actual one >200 effective level is more than twice lower than the actual ones. Rows are quartiles of size in terms of value added: top quartile stands for the biggest firms, bottom – for the smallest.

5. Conclusions

This paper finds significant resource misallocation in Ukrainian food industry. Allocation of resources improves during 2002-2008, but worsens after the financial crisis of 2009. In addition, the extent of misallocation in the food industry, being much worse in the early 2000s, improves to the average in manufacturing. Results show that in the case of optimal allocation of resources, the productivity of Ukrainian food processing can increase by 166-400%. Misallocation is not uniform in food production and varies at firm, industry regional levels. The analysis shows that in the case of fully optimal allocation of resources, small and medium enterprises should have more important role in the manufacturing of food and beverages.

Ryzhenkov (2006) contains recommendations on how the allocation of resources can be increased. The proposal includes lower barriers for entry and exit of firms, easier access to debt financing, liberalization of both financial and labor markets, facilitation of international trade, higher competition at the markets, privatization, as well as elimination of subsidies.

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APPENDIX

Table A1. Descriptive statistics of key monetary variables and employment

	N	Mean	S.D.
Turnover, nominal	35,599	21.96	115.76
Material cost, nominal	35,599	11.56	55.74
Labor compensation, nominal	35,599	1.65	6.62
Fixed capital, nominal	35,599	4.97	24.74
Turnover, real	35,599	12.58	55.73
Material cost, real	35,599	5.84	23.35
Value added, real	35,599	6.73	38.54
Labor compensation, real	35,599	1.35	4.69
Fixed capital, real	35,599	2.59	10.57
Employment	30,819	106.42	237.35

Note: all the monetary variables are expressed as UAH m; employment is expressed as a number of employees (data for 2003 is missing)

Table A2. Structure of Ukrainian food processing by type of ownership (average in 2002-2010)

	Share of number of firms, %	Share in VA, %	Share in employment, %
Collective	72.6%	70.9%	80.3%
Foreign	0.2%	9.1%	0.2%
Private	22.8%	11.9%	10.7%
State	4.4%	8.1%	8.7%

Note: ownership type share is computed as the sum of firms, VA or employment over 2002-2010 of relevant firms divided by the sum over 2002-2010 for the total manufacturing.

Table A3. Share of exporters and importers in Ukrainian food processing in selected years

	2002	2003	2004	2008	2009	2010
Share of exporters, %	14.2%	13.5%	15.0%	16.1%	18.7%	18.0%
Share of importers, %	11.7%	12.0%	11.1%	14.6%	13.0%	13.7%
Including:						
Both exporting and importing, %	6.3%	6.6%	6.6%	7.7%	8.1%	8.5%
Only exporting, %	7.9%	6.9%	8.3%	8.4%	10.6%	9.5%
Only importing, %	5.4%	5.4%	4.5%	7.0%	4.9%	5.1%

Note: exporters'/importers' share is computed for each year as the number of exporter/importers divided by the total number of firms operating during given year.

Table A4. Structure of Ukrainian manufacturing by regions (average in 2002-2010)

	Share of number of firms,%	Share in VA,%	Share in employment, %
Center	19.3%	21.9%	24.3%
East	19.4%	27.9%	27.0%
North	25.0%	23.4%	18.4%
South	16.5%	16.3%	16.8%
West	19.8%	10.6%	13.5%

Note: industry share is computed as the sum of firms, VA or employment over 2002-2010 of the region divided by the sum over 2002-2010 for the total manufacturing. Regions consists of the following territories: Center – Vinnytsia, Dnipropetrovsk, Kirovohrad, Poltava, Khmelnytskyi and Cherkasy oblasts; east – Donetsk, Luhansk and Kharkiv oblasts; north – Zhytomyr, Kyiv, Sumy, Chernihiv oblasts and the city of Kyiv; south – Autonomous Republic of Crimea, Zaporizhia, Mykolaiv, Odessa, Kherson oblasts and the city of Sevastopol; west – Volyn, Zakarpattia, Ivano-Frankivsk Lviv, Rivne, Ternopil and Chernivtsi oblasts

Table A5. Structure of Ukrainian manufacturing by industries (average in 2002-2010)

NACE code	Name of industry	Share in mass of firms, %	Share in value added, %	Share in employment, %
1511	Production and preserving of meat	4.8%	3.4%	3.9%
1512	Production and preserving of poultrymeat	0.4%	1.3%	1.1%
1513	Production of meat and poultry meat products	8.9%	6.0%	7.6%
1520	Processing and preserving of fish and fish products	3.2%	1.0%	1.7%
1531	Processing and preserving of potatoes	0.3%	0.1%	0.1%
1532	Manufacture of fruit and vegetable juice	0.9%	2.6%	1.6%
1533	Processing and preserving of fruit and vegetables n.e.c.	3.9%	1.6%	2.6%
1541	Manufacture of crude oils and fats	4.3%	9.4%	2.6%
1542	Manufacture of refined oils and fats	0.5%	4.3%	0.7%
1543	Manufacture of margarine and similar edible fats	0.4%	1.1%	0.7%
1551	Operation of dairies and cheese making	8.4%	14.6%	16.1%
1552	Manufacture of ice cream	1.1%	1.2%	1.8%
1561	Manufacture of grain mill products	11.5%	5.0%	5.9%
1562	Manufacture of starches and starch products	0.3%	0.4%	0.5%
1571	Manufacture of prepared feeds for farm animals	2.8%	2.3%	1.5%
1572	Manufacture of prepared pet foods	0.2%	0.1%	0.1%
1581	Manufacture of bread, fresh pastry goods, and cakes	19.6%	7.5%	16.9%
1582	Manufacture of rusks, biscuits, preserved pastry goods	4.3%	1.6%	3.2%
1583	Manufacture of sugar	2.3%	6.0%	6.9%
1584	Manufacture of cocoa; chocolate and sugar confectionery	2.2%	7.0%	8.2%
1585	Manufacture of macaroni, noodles, couscous	1.9%	0.4%	0.7%
1586	Processing of tea and coffee	0.7%	0.6%	0.4%
1587	Manufacture of condiments and seasonings	1.5%	1.1%	1.0%
1588	Manufacture of homogenized food preparations	0.4%	0.2%	0.2%
1589	Manufacture of other food products n.e.c.	2.3%	1.2%	1.1%
1591	Manufacture of distilled potable alcoholic beverages	1.3%	9.5%	2.6%
1592	Production of ethyl alcohol from fermented materials	1.5%	1.4%	2.3%
1593	Manufacture of wines	1.6%	3.1%	2.3%
1594	Manufacture of cider and other fruit wines	0.1%	0.1%	0.1%
1596	Manufacture of beer	1.2%	2.5%	1.7%
1597	Manufacture of malt	0.3%	0.8%	0.3%
1598	Production of mineral waters and soft drinks	7.1%	2.7%	3.4%

Note: industry share is computed as the sum of firms, VA, and employment over 2002-2010 of industry divided by the sum over 2002-2010 for the total food processing.

Table A6. WLS of TFPQ and TFPR on ownership, age and size dummies

	(1) TFPQ	(2) TFPR	(3) TFPQ	(4) TFPQ	(5) TFPR	(6) TFPR	(7) TFPQ	(8) TFPR	(9) TFPQ	(10) TFPQ	(11) TFPR	(12) TFPR
Private	0.977***	1.054***							1.685***	1.720***	1.285***	1.309***
ownership	(0.099)	(0.066)							(0.101)	(0.101)	(0.074)	(0.074)
Collective	1.104***	1.454***							1.337***	1.367***	0.940***	0.959***
ownership	(0.101)	(0.067)							(0.098)	(0.098)	(0.072)	(0.072)
Foreign	2.512***	1.646***							2.706***	2.726***	1.589***	1.605***
ownership	(0.281)	(0.186)							(0.320)	(0.320)	(0.235)	(0.234)
Age			-0.025***		-0.040***				-0.049***		-0.034***	
			(0.003)		(0.002)				(0.003)		(0.002)	
2nd quartile				0.092***		-0.082***				-0.032		-0.006
of age				(0.028)		(0.018)				(0.031)		(0.023)
3rd quartile				-0.232***		-0.385***				-0.448***		-0.305***
of age				(0.029)		(0.019)				(0.033)		(0.024)
4th quartile				-0.261***		-0.390***				-0.418***		-0.300***
of age				(0.028)		(0.018)				(0.031)		(0.023)
2nd quartile							0.941***	0.140***	0.959***	0.958***	0.163***	0.163***
of size							(0.027)	(0.020)	(0.030)	(0.030)	(0.022)	(0.022)
3rd quartile							1.587***	0.077***	1.693***	1.693***	0.174***	0.175***
of size							(0.027)	(0.020)	(0.032)	(0.032)	(0.023)	(0.023)
4th quartile							2.505***	0.056**	2.597***	2.618***	0.192***	0.206***
of size							(0.031)	(0.022)	(0.038)	(0.038)	(0.028)	(0.028)
Intercept	-2.980***	-1.256***	-1.983***	-3.116***	-0.140	0.110	-5.088***	-0.624**	-5.093***	-5.161***	-0.910***	-1.303***
	(0.310)	(0.334)	(0.242)	(0.404)	(0.265)	(0.158)	(0.376)	(0.274)	(0.307)	(0.307)	(0.228)	(0.345)
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	26534	26534	35599	35599	35599	35599	30819	30819	22884	22884	22884	22884
R^2	0.094	0.073	0.076	0.079	0.051	0.057	0.242	0.036	0.258	0.261	0.073	0.077

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable is the log deviation of TFPQ or TFPR from the industry mean. The independent variables in (1) and (2) are dummies for private, collective and foreign enterprises. The omitted group is state-owned enterprises. In (3) and (5) I use an actual age of firm as an independent variable. In (4) and (6) I regress TFPQ and TFPR on age quartiles, the bottom quartile of age is omitted. In (7) and (8) independent variables are the dummies of size quartiles with the bottom quartile is omitted. In (9)-(12) I combine all the previous regressions. Omitted group in (9) and (11) is small private enterprise, whereas in (10) and (12) – young small private enterprise. Entries are the dummy coefficients with standard errors in parentheses. Results are pooled for all years. Industry and year effects are included. Weights are industry value added share.

Table A7. Regression of TFPQ on TFPQ and TFPR on TFPQ

	(1) TFPQ	(2) TFPR
TFPR	1.287***	
	(0.004)	
TFPQ		0.556***
		(0.002)
Intercept	-1.974***	1.213***
	(0.129)	(0.142)
Industry FE	YES	YES
Year FE	YES	YES
N	35599	35599
R^2	0.737	0.727

Standard errors in parentheses. * *p < 0.10,* ** *p < 0.05,* *** *p < 0.01*
Note: Both dependent and independent variables are the log deviation of TFPQ or TFPR from the industry mean. Results are pooled for all years. Industry and year effects are included. Weights are industry value added share

Table A8. WLS regression of TFPQ and TFPR on exit and enter

	(1) TFPQ	(2) TFPR	(3) TFPQ	(4) TFPR	(5) TFPQ	(6) TFPR
Entry	-0.123*	0.220***			-0.086	0.233***
	(0.064)	(0.042)			(0.063)	(0.042)
Exit			-1.157***	-0.400***	-1.157***	-0.402***
			(0.030)	(0.020)	(0.030)	(0.020)
Intercept	-1.858***	-0.601**	-1.966***	-0.151	-1.961***	-0.080
	(0.243)	(0.266)	(0.237)	(0.159)	(0.237)	(0.158)
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	35599	35599	35599	35599	35599	35599
R^2	0.074	0.040	0.111	0.050	0.111	0.051

Standard errors in parentheses. * *p < 0.10,* ** *p < 0.05,* *** *p < 0.01*
Note: The dependent variable is the log deviation of TFPQ or TFPR from the industry mean. The independent variables are the dummies for the firms entering or exiting the market. In (1) and (3) omitted group is all the firms not exiting the market next year. In (2) and (3) the omitted group is all the firms not entered the market last year. In (5) and (6) the omitted group is all the incumbent which are present at the market in both previous and next years. Results are pooled for all years. Industry and year effects are included. Weights are industry value added share.
*Equation formulation is the following: log(TFPRsi/TFPRs))=b0+b1*X+ind_fe+year_fe+e_si,*
where X is a set of dummies for entry and exit, ind_fe - industry fixed effects, year_fe – year fixed effects, e_si – error term.

Table A9. WLS regression of TFPQ and TFPR on exporter and importer status

	(1) TFPQ	(2) TFPR
Only export	1.124***	0.163***
	(0.043)	(0.030)
Only import	1.415***	0.356***
	(0.050)	(0.035)
Export and import	2.044***	0.381***
	(0.042)	(0.029)
Intercept	-2.596***	-0.916***
	(0.269)	(0.343)
Industry FE	YES	YES
Year FE	YES	YES
N	23333	23333
R^2	0.196	0.051

Standard errors in parentheses. * *p < 0.10,* ** *p < 0.05,* *** *p < 0.01*
Note: The dependent variable is the log deviation of TFPQ or TFPR from the industry mean. The independent variables are the dummies for the firms only exporting, only importing, both exporting and importing. The omitted group is all the firms operating only at the domestic market. Results are pooled for all years. Industry and year effects are included. Weights are industry value added share

Table A10. Standard deviation of TFPR by industry over 2002-2010

NACE code	Name of industry	2002	2003	2004	2005	2006	2007	2008	2009	2010	Improved?
1511	Production and preserving of meat	1.44	1.35	1.37	1.23	1.2	1.1	1.17	1.22	1.44	No
1512	Production and preserving of poultrymeat	0.83	0.53	0.65	1.44	0.92	0.86	0.98	0.78	0.93	No
1513	Production of meat and poultrymeat products	1.21	1.22	1.13	1.17	1.18	1.13	1.11	1.1	1.22	No
1520	Processing and preserving of fish and fish products	1.44	1.43	1.35	1.44	1.38	1.3	1.18	1.29	1.15	Yes
1531	Processing and preserving of potatoes	1.76	1.37	1.74	1.59	1.07	1.31	1.43	1.53	0.95	Yes
1532	Manufacture of fruit and vegetable juice	1.59	1.55	1.38	1.43	1.48	0.96	1.26	1.34	1.46	Yes
1533	Processing and preserving of fruit and vegetables n.e.c.	1.58	1.53	1.39	1.35	1.31	1.32	1.41	1.35	1.3	Yes
1541	Manufacture of crude oils and fats	1.24	1.4	1.38	1.27	1.33	1.3	1.35	1.34	1.42	No
1542	Manufacture of refined oils and fats	1.25	1.34	1.64	1.26	1.11	1.21	1.23	1.56	1.34	No
1543	Manufacture of margarine and similar edible fats	1.33	1.8	1.58	1.16	1.24	1.06	0.87	1.01	1.19	Yes
1551	Operation of dairies and cheese making	1.12	1.2	1.14	1.08	1.01	0.88	0.94	1.08	0.98	Yes
1552	Manufacture of ice cream	1.07	1.36	1.26	1.21	1.01	0.98	0.89	0.92	0.98	Yes
1561	Manufacture of grain mill products	1.29	1.29	1.35	1.27	1.25	1.22	1.28	1.34	1.33	No
1562	Manufacture of starches and starch products	1.54	1.1	1.18	1.52	1.24	1.13	1.38	1.51	1.59	No
1571	Manufacture of prepared feeds for farm animals	1.56	1.63	1.56	1.68	1.61	1.53	1.56	1.72	1.64	No
1572	Manufacture of prepared pet foods	1.96	1.5	1.39	1.58	1.53	0.93	1.07	1.22	0.72	Yes
1581	Manufacture of bread, fresh pastry goods and cakes	1.09	1.18	1.08	1.06	1.02	0.99	0.99	1.04	1.02	Yes
1582	Manufacture of rusks, biscuits, preserved pastry goods	1.24	1.25	1.11	1.13	1.02	0.98	1.01	1.04	1.13	Yes
1583	Manufacture of sugar	0.97	1.28	1.09	1.22	0.91	1.01	1.14	1.5	1.27	No
1584	Manufacture of cocoa; chocolate and sugar confectionery	1.25	1.05	1.07	1.11	1.01	1.01	0.95	1.16	1.21	Yes
1585	Manufacture of macaroni, noodles, couscous	1.31	1.33	1.29	1.16	1.03	1.05	0.99	1.07	1.2	Yes
1586	Processing of tea and coffee	1.17	1	1.18	1.31	1.07	0.81	0.82	0.96	0.98	Yes
1587	Manufacture of condiments and seasonings	1.24	1.16	1.2	1.19	1.11	1.21	1.17	1.15	1.28	No
1588	Manufacture of homogenized food preparations	1.56	1.41	1.58	1.09	0.96	1.46	1.72	1.52	1.33	Yes
1589	Manufacture of other food products n.e.c.	1.45	1.37	1.42	1.35	1.3	1.18	1.38	1.52	1.39	Yes
1591	Manufacture of distilled potable alcoholic beverages	1.76	1.73	1.49	1.28	0.96	1.29	1.41	1.5	1.32	Yes
1592	Production of ethyl alcohol from fermented materials	0.64	0.76	0.7	0.79	0.68	0.73	1.04	0.8	1.26	No
1593	Manufacture of wines	1.46	1.43	1.29	1.11	1.11	0.96	0.98	0.81	1.2	Yes
1594	Manufacture of cider and other fruit wines	1.79	n/a	1.69	0.45	1.97	1.62	1.54	2.25	n/a	No
1596	Manufacture of beer	1.01	1.19	1	0.93	1.17	0.88	1.09	1.22	1.22	No
1597	Manufacture of malt	1.22	0.71	1.05	0.81	0.95	1.28	0.93	1.17	1.1	Yes
1598	Production of mineral waters and soft drinks	1.22	1.4	1.15	1.21	1.12	1.14	1.24	1.18	1.27	No

Note: TFPR here is the log deviation of TFPQ or TFPR from the industry mean. Improvement means that standard deviation in 2010 was lower than those in 2002.

Table A11. Robustness check

Year	Baseline (sigma=3, unbalanced, US shares)	Alternative sigma (sigma=5, unbalanced, US shares)	Balanced panel (sigma=3, balanced, US shares)	Ukrainian shares (sigma=3, unbalanced, UA shares)	Firm-specific shares (sigma=3, unbalanced, firm's shares)
2002	320.8	413.2	75.7	625.1	948.4
2003	399.8	598.9	96.5	861.0	1288.5
2004	219.2	423.0	77.8	613.2	960.1
2005	192.4	310.3	62.3	544.6	751.9
2006	173.9	270.1	57.6	630.5	818.9
2007	166.0	202.5	67.6	392.4	447.7
2008	169.5	209.6	68.9	412.0	545.0
2009	195.0	262.2	83.3	469.1	696.3
2010	205.3	268.4	98.1	412.8	588.8

Note: entries are computed in the same manner as in Figure 2, but using different proxies for labor and labor share during calibration of the model.