# EFFECTS OF NON-TARIFF MEASURES

# ON PRODUCTIVITY IN THE FOOD-PROCESSING INDUSTRY

by

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Abstract

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This thesis investigates the impact of NTMs on firm's productivity for the sample of 9,983 firms located in Ukraine for the period of 2004-2009. NTMs were defined as measures in trade relations, which imply non-price or/and non-quantity barriers. Firm's productivity was measured through the production function estimation with further collecting of TFPR and TFPQ. As additional measures of productivity, labor productivity was defined with labor productivity based on gross output and value added per worker. NTMs were presented through non-tariff barriers on input and output). Production function was estimated for each food-processing industry using Olley-Pakes methodology controlling for sub-industry specific demand and price shocks as suggested by De Loecker to calculate TFP of firms in food-processing industry. We detected that in the majority cases NTMs are associated with the negative impact on firm's productivity. Moreover, NTMs on both output and input are associated with the negative impact on firm's productivity if a firm is specialized in producing only one good and if it has employment more than ten. We find that NTMs on input are associated with the positive impact on labor productivity based on output.

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*Chapter 1*

# INTRODUCTION

The discussion of the effect of tariff and non-tariff measures on firm's productivity and, overall, on economic growth is the subject of rather wide speculation. Eventually, different restrictions are important tools in international trade negotiations. Trade restrictions might be an indicator for political and economic course in states. Implementing tariff or non-tariff measures could also be a significant sign of relations between different countries.

Non-tariff measures (NTMs) are usually defined as a protectionist tool in trade relations, which implies non-price or/and non-quantity barriers. In words, of one syllable it means that domestic firms in order to export their goods have to comply with specific non-tariff requirements of the country-importer. Movchan and Shportyuk (2015) defined NTMs as "measures, other than tariffs, which are tightly connected with state (administrative) activity and influence prices, quantity, structure and/or direction of international flows of goods and services as well as resources used to produce these goods and services".

According to Movchan and Shportyuk (2015), Ukraine's history of NTMs system has experienced several noticeable transformations over the past two decades. First changes of NTMs took place when the Soviet Union was collapsed and Ukraine received its independence and sovereignty. Then our country became a member of the World Trade Organization and, therefore, new standards of NTMs were introduced, particularly in terms of technical restrictions. Finally, moving to the European vector of development and signing the Ukraine-European Union Association Agreement implies changes in NTMs.

In academic literature it is well-known that trade liberalization has a positive impact on both firm performance and the economy (Melitz, 2003; Pavcnik, 2002; Amiti & Konings, 2007; Edwards, 1998). Over the recent years international trade drastically moved from tariff barriers to non-tariff measures (NTMs). On the one hand, NTMs plays the role of protectionism instrument as it should be by the definition. It is widely known, that NTMs eventually increase the firm production costs. On the other hand, NTMs could improve the quality of imported goods.

In thesis we consider food-processing industry as one that is highly regulated using NTMs because of the food safety issue. Moreover, according to the World Trade Organization (2012), the popularity of NTMs caused by food safety issue and concerns about sustainability of the environment. However, it is claimed that if in developed countries NTMs do not lead to any significant harmful effect, on the contrary, developing countries might face rather negative impact on trade. The influence of NTMs might be very controversial. The usage of NTMs could lead to a certain decrease in import and increase in domestic prices.

According to the Organization for Economic Co-operation and Development (2012), food-processing industry constitutes 20% of total manufacturing in Ukraine. Moreover, production is especially successful in dairy sector, vegetable and fruit processing etc. The impact of NTMs on firm's productivity should be investigated, since food-processing industry is so important for our country as a whole.

Usually, country regulates import using NTMs through two ways (WTO terms): imposing sanitary/phytosanitary measures (SPS) and introducing technical barriers to trade (TBT). Both of these trade restrictions have an eventual impact on food-processing industries. Movchan and Shportyuk (2015) made the analysis of NTMs, which is present in Ukrainian legislative system. The results of this analysis are presented in Table 1.

Table 1. NTMs regulation in Ukrainian legal system.

| **Type of NTMs** | **Ukrainian legislation** |
|---|---|
| Veterinary Control | Law on Veterinary Medicine |
| Sanitary Control | Law on Food Safety |
| Phytosanitary Control | Law on Quarantine of Plants |
| Ecological Control | Law on Environment Protection |
| Mandatory Certification | Orders of State Committee on Technical Regulation and Consumer Policy on List of Products of Mandatory Certification<br><br>Orders of State Standardization Office on List of Products of Mandatory Certification |

Source: Movchan & Shportuk (2015)

Total Factor Productivity (TFP) could be considered as the most reflective variable that responds to changes in NTMs. Furthermore, TFP is often seen as a true mover of growth within every economy. Our main hypothesis is that there is a tangible impact of NTMs on TFP. We might also suggest here that for small firms the effect is negative, while for larger manufacturers the impact of NTMs on TFP could be positive.

The empirical research was conducted on the firm-level data from 2004 to 2009. We made estimation not only of TFP in revenues, as it is usually done in many scientific papers, but also TFP in quantities. TFPR approach might disturb estimation of physical productivity and firm-level prices as well (Eslava et al., 2013).

The paper is organized according to the following structure. In Chapter 2 analysis of the literature with theoretical and empirical evidence was stated. In Chapter 3 we described the general methodology used in our empirical analysis as well as specific methods used for estimating the effect of NTMs on firm's productivity. In Chapter 4 the main empirical findings were presented.

*Chapter 2*

# LITERATURE REVIEW

The relationship between NTMs and firm productivity has been the subject in many scientific researches. According to Gardner (2003), the main NTMs benefits are the reduction of low-quality food consumption and, thus, consumer protection, removal of asymmetric information problem etc. However, we can add here that NTMs could also increase competition among producers, which also improves the quality of goods. In addition, NTMs cause supplementary costs of controlling and monitoring food-processing industry by the governmental authority. Moreover, NTMs can impose additional costs as suppression of low quality products, implementation of new regulations etc. In Ukraine the intensity of usage of NTMs increased in 2001-2003 and reduced sharply in 2008-2009, following Ukraine's membership to the WTO.

Trade liberalization is one of the key trends around the world during last decades. Consequently, pure tariff restrictions are less used as an element of protectionism policy and, therefore, NTMs are widespread tools in current time. According to empirics, one of the main impacts of trade liberalization on firm's behavior are observable prices, which are set in order to be as much closer as it is possible to marginal costs. Moreover, there are findings that support the idea that imported goods might discipline the behavior of national manufacturer (Levinsohn, 1993; Harrison, 1994; Roberts and Tybout, 1996). Bodenstein et al. (2003) found that in transition countries governments tended to simultaneous increase of NTMs and capital control.

We should add that evaluation of trade policy is a topic of various papers. However, the procedure of measuring trade policy is a hard methodological and even theoretical question. For example, Baldwin (1989) claimed that there are two major ways for estimating trade barriers – by incidence and by outcome. Both these approaches have positive and negative sides. Estimation of trade barriers using incidence-based approach implies measuring trade policy by straightforward estimation of the policy tools and instruments. For instance, simple counting the amount of NTMs is already one of the illustrations of incidence-based approach.

However, such direct and trivial approach cannot be used in cross-country comparison, since it is well-known that less-developed countries (LDCs) have a tendency for setting various tariffs, especially NTMs for imported goods. Outcome-based method for estimating trade policy implies evaluating the difference between deviations of the actual outcome and the hypothetical outcome without the impact of trade barriers. Therefore, both price and trade flow could be treated as actual and estimated outcomes.

TFP is a widely used indicator of firm productivity. According to Comin (2006), TFP is defined as the share of output which could not be explained by the amount of inputs in production process. Thus, studying and estimating TFP is an important part of evaluation and interpretation of firm's growth and fluctuation in the current state. Also TFP may be used for forecasting procedures in order to determine the direction of future development of the firm.

Solow residuals are the common measurement of TFP and, moreover, TFP could be estimated using the country-level data and firm-level data as well. However, according to the literature analysis, Solow residual might measure TFP growth as long as the production function is neoclassical, growth rates of all inputs are measured precisely and perfect competition is observable in inputs markets.

Solow (1956) stated that the growth in income per capita in an economy in the long-run perspective is determined by the growth of TFP. It was also defined that cross-country technological differences lead to distinctions in income per capita. Moreover, there are plenty of evidences that the rupture in income per person between rich and poor countries is caused by the differences in TFP growth (Klenow and Rodriguez-Clare, 1997; Hall and Jones, 1999). Technological differences and efficiency in using these technological forces are main grounds for cross-country differences in TFP growth.

In academic literature there is the distinction between two different types of firm productivity: physical productivity (TFPQ, where Q means "in quantities") and revenue productivity (TFPR). As a rule, (Eslava et al., 2013) scholars prefer to measure firm productivity through TFPR, since firm-level deflators are often not available. However, this approach potentially discomfits physical productivity and firm-level prices. Moreover, using TFPR might be misleading to endogeneity of firm-level prices.

Foster et al. (2008) claim that TFPQ "reflects dispersion in physical efficiency and possibly factor input prices". Basically, TFPQ is a measure of producer's average costs per one unit of good. In later papers Foster et al. (2016) define physical TFP as "ratio of the plant's output quantity in physical units to its inputs, where the inputs are the standard composite index of labor, capital, and intermediates weighted by their respective output elasticities". Moreover, estimated TFPQ should have explanatory power over prices.

According to Eslava et al. (2013), TFPR is quite "standard measure of revenue productivity". Researches usually used TFPR when price-level prices are not tangible in the datasets. TFPR is calculated as "the output measure plant-level revenue divided by sector-level price indices and using as the material measure plant-level expenditures on material divided by sector-level materials price indices". However, as authors claim, it is still unknown what are the actual size and the direction of the bias in measurement of revenue productivity. Moreover, endogeneity of firm-level prices and the fact that they can reflect different direction effects, make TFPR sometimes difficult to interpret.

The literature analysis demonstrates the existence of researches, the main goal of which was to find a relationship between productivity level and NTMs. One the one hand, there are a lot of studies, which detected a particular positive effect of tariff deregulation on productivity (Schor, 2004; Amiti and Konings, 2007; Balakrishnan et al., 2000; Pavcnik, 2002; Hay, 2001; Krishna and Mitra, 1998). However, on the other hand, there is an obvious lack of studying the effect of NTMs on firm-level productivity (Shepotylo and Vakhitov, 2015).

Looi Kee et al. (2009) claim that one of the most difficult questions in trade barriers studying is measuring of trade policy procedure. Mentioned authors estimated ad-valorem equivalents (AVE) of NTMs for each country depending on the specific tariff line level. Scholars empirically proved that countries with lower GDP not only demonstrated more restrictive trade behavior, but more measures on their exports as well.

In our opinion, such results are absolutely logical, since poor countries more often use protectionism policy in order to defend their own producers. Other interesting empirical finding shows that the existence of NTMs makes a significant contribution to a substantial fraction of trade restrictiveness throughout states. Moreover, on average, NTMs add supplementary almost 90% to the total restrictiveness caused by protectionism policy of the state. According to the data, researchers also concluded that in 34 countries (out of 78), NTSs are more restrictive tools than pure tariff barriers. Eventually, the main conclusion of debating research might be the absolute importance of NTMs instead of tariff regulations.

Disdier et al. (2008) analyzed the impact of NTMs in countries-importer on bilateral trade flows. Scholars decided to consider SPS and TBT in members of Organisation for Economic Co-operation and Development (OECD). The main results of the research defined in general negative effect of SPS and TBT on trade in agricultural sector. However, authors also showed that OECD countries as exporters to other OECD members basically were not influenced by those NTMs. Another interesting conclusion of this research is that developing countries, which export goods to OECD, are significantly and negatively affected by these restrictions.

Another important result of this studying implies that quite a negative impact of SPS and TBT is even more significant if the focus is on export to the EU countries. Despite the fact that in general EU countries declare lower SPS and TBTs than OECD members, in particular these NTMs are more trade-resisting than in OECD space. Authors claim that NTMs should not be treated as absolutely evil trade phenomena. Firms in economically developed countries can easily follow the NTMs and successfully export goods. However, enterprises in developing countries might find following NTMs as an obstacle.

*Chapter 3*

# METHODOLOGY

Testing the hypothesis includes next steps: 1) extract firms operating in food-processing sector on a 6-digit level according to State Classifier of Products and Services; 2) calculate average price for each firm in each year (sorting by United State Register of Enterprises and Organizations of Ukraine); 3) use constant elasticity of substitution (CES) system for constructing unique deflated price index for each firm in each year; 4) adjust inputs by deflated price index (preparation for TFPQ estimation) and by deflators from State Statistics Service of Ukraine (TFPR); 5) measure TFP and then TFPQ/TFPR with estimation of production function; 6) regress separately TFPQ and TFPR on NTMs.

The original firm-level dataset were raw, meaning that we had an unique "id" of firms, but the produced output was not aggregated in a proper way. Basically, we had to aggregate all firm's product to 6-digit codes. Results of this procedure gave us the opportunity to divide all firms into several groups (e.g. meat and fish products, fruit and vegetables etc.).

We estimated the production function for each food-processing industry using Olley-Pakes methodology (Olley and Pakes, 1996) controlling for sub-industry specific demand and price shocks as suggested by De Loecker (2011) to calculate TFP of firms in food-processing industry.

In our research we have decided to choose the methodology introduced by Eslava et al. (2013) and aimed to measure TFP in quantities or physical productivity (TFPQ). TFPQ could also be defined as a specific firm-level deflator. Eslava et al. claim that "TFPQ estimates are constructed using the factor elasticities estimated using downstream industry demand to instrument inputs, while plant-level demand estimation uses TFPQ as an instrument". Thus, TFPQ measure should be higher correlated with TFP estimates using different measures of the factor elasticities. Researchers estimated total factor productivity for plant *i* in year *t* as the residual from a production function:

$$Y_{it} = K_{it}^{\alpha}(L_{it}H_{it})^{\beta}E_{it}^{\gamma}M_{it}^{\varphi}V_{it} \quad (1)$$

$Y_{it}$ is output, $K_{it}$ is capital, $L_{it}$ is total employment, $H_{it}$ is hours per worker, $E_{it}$ is energy consumption, $M_{it}$ are materials, and $V_{it}$ is a productivity shock. Then TFPQ was estimated in the following way:

$$TFPQ_{it} = logY_{it} - \alpha logK_{it} - \beta(logL_{it} + logH_{it}) - \gamma logE_{it} - \varphi logM_{it} \quad (2)$$

where α, β, γ and φ were defined as the factor elasticities for capital, labor hours, energy, and materials. In our case we do not have variables stated for hours per worker and energy consumption. Thus, our production function is the following:

$$Y_{it} = K_{it}^{\alpha}{L_{it}}^{\beta}M_{it}^{\gamma}V_{it} \quad (3)$$

Eventually, TFPQ was estimated in the following way:

$$TFPQ_{it} = logY_{it} - \alpha logK_{it} - \beta logL_{it} - \gamma logE_{it} - \varphi logM_{it} \quad (4)$$

The next step is to use CES system for constructing unique deflated price index for each firm. Thus, we should introduce here CES demand system (Shepotylo and Vakhitov, 2012):

$$Y_{it} = Y_{st}(\frac{p_{it}}{p_{st}})^{\sigma_s}\exp(\varepsilon_{it}) \quad (5)$$

where $Y_{st}$ defines the total expenditures on goods produced by manufacturing industry *s*, in which firm *i* operates in year *t*. Basically, in our case manufacturing industry is the same for all firms. $p_{it}$ is an industry-wide price at time *t*. $\varepsilon_{it}$ states a demand shock that is not observed. Sigma is an elasticity of substitution the value of which we have to take as assumption.

Demand and price shocks were defined using variation in sub-industry output at time *t* and time fixed effects. Under the assumption of CES demand system, unobserved prices are captured by aggregate demand and also by the variation in inputs. We should add that each unobserved price also does not reflect technological discrepancies within an industry. Calculation of CES indices is crucial step for TFPQ estimation.

NTMs were calculated according to the methodology as in Movchan et al. (2015). The procedure of calculating NTM intensity index is the following:

$$NTM_t = \frac{\sum_{t=1}^{N}(IM_{it}\sum_{j=1}^{J} NTM_{ij,t})}{NJ\sum_{i=1}^{N} IM_{it}} \quad (6)$$

In the formula (6), NTM index is basically the share of cases when the pre-selected NTMs were actually applied to the given number of tariff lines, where *N* states for the total amount of tariff lines, and *J* is a total amount of considered types of NTMs. $IM_{it}$ is the total amount of imported to Ukraine product *i* at time *t* and $NTM_{ij,t}$ is a dummy variable that is one, if a type *j* of NTMs is applied to a tariff line *i* at time *t*, and, consequently, zero otherwise.

Since the data includes 4-digit Harmonized System (HS-4), it is possible now to modify (6) and compute import-weighted measures of NTM intensity:

$$NTM_t{}^{HS4} = \frac{\sum_{t=1}^{N_{HS4}}(IM_{it}\sum_{j=1}^{J} NTM_{ij,t})}{N_{HS4}J\sum_{i=1}^{N_{HS4}} IM_{it}} \quad (7)$$

The same procedure was implied for calculating export-weighted measures of NTM intensity. Overall, the final regression is the following

$$logY_{it} - \alpha logK_{it} - \beta logL_{it} - \gamma logE_{it} - \varphi logM_{it} = NTM_t{}^{HS4} \quad (8)$$

*C h a p t e r 4*

# DATA DESCRIPTION

In our empirical research, we make use of the unique data of Ukrainian firms in 2004-2009. The database came from several statistical records submitted annually to the State Statistics Service of Ukraine by all manufacturing and services firms in Ukraine between 2004 and 2009. The assembled data refer to the next statistical statements: Financial Results Statement, Balance Sheet Statement, Enterprise Performance Statement, Sectoral Expenditures Statement.

Original dataset containes the statistical information about firms from different industries. Overall, we get rid of firms that were operating in other industries, which are different from food-processing. In our dataset, which contains only food-processing firms, we have 8 groups per each year:

- meat and fish products (NACE 151&152),
- fruit and vegetables (NACE 153),
- vegetable and animal oils and fats (NACE 154),
- dairy products (NACE 155),
- grain mill products, starch products (NACE 156),
- prepared animal feeds (NACE 157),
- other food products (NACE 158),
- beverages (NACE 159).

Originally for each year we have three separated dataset, collected independently from each other. Naturally, it was quite an obstacle. However, in all datasets we have code for each firm, which corresponds to the United State Register of Enterprises and Organizations of Ukraine. It means that it is possible to construct one general dataset. We should add here that the original dataset and the number of observation changes according to the steps that were described in Chapter 3. During the first stage we aggregate all produced output to 6-digit codes. Before following this procedure, we had the data sample as illustrated in Figure 1. According to the Figure 1., in 2004 the dataset contains 13,568 firms operating in food-processing industry, in 2005 – 12,599 firms, in 2006 – 11,976 firms, in 2007 – 9,579 firms, in 2008 and 2009 – 10,271 and 7,958 firms, correspondently. Since the data belong to the long type, the number of observations is much bigger.

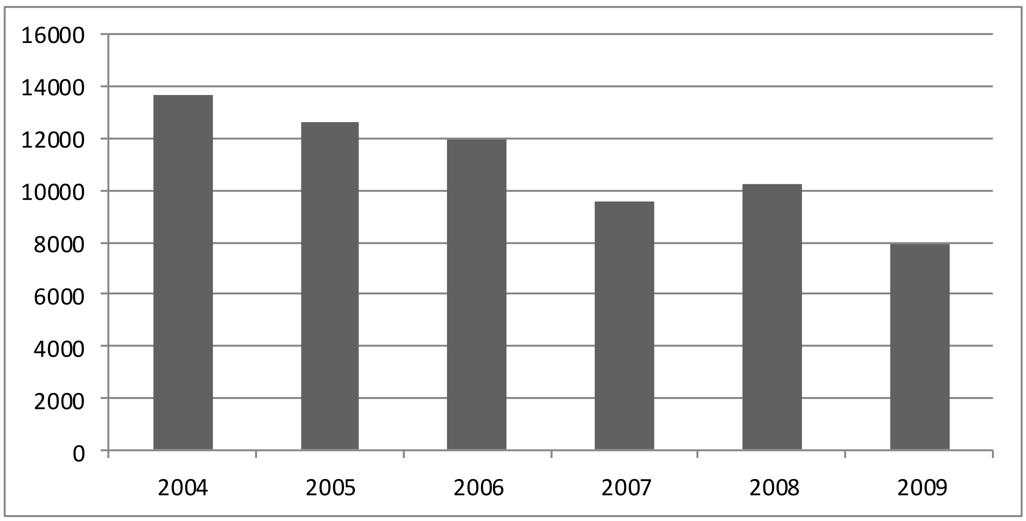


Figure 1. Firms with 6-digit production codes in the dataset.

One of the main variables in our empirical analysis are firm's revenue, prices and output produced by each firms (see Table 2). The minimal values of all these three main variables are zero, since not all the firms operate in each year. Other firms just shut down as it may be concluded from the Figure 1. A significant decline in the number of firms in food-processing industry were detected just before the Great Recession in 2007 and after it in 2009. However, as can be seen in Table 2, the variation of average prices is not large in comparison with output produced and revenues. Increase of inflation might be one of the reasons of such significant variation in revenues, since these values are not adjusted by inflation. However, for estimation TFP proper adjustment is done.

Table 2. Mean values of firms output, prices and revenues.

| Year | Firms | Output produced | Prices | Revenue |
|---|---|---|---|---|
| 2004 | 13,568 | 377.89 | 5.33 | 677.56 |
| 2005 | 12,559 | 384.64 | 5.28 | 907.19 |
| 2006 | 11,976 | 1,233.58 | 4.71 | 1,104.65 |
| 2007 | 9,579 | 1,825.27 | 5.30 | 2,055.51 |
| 2008 | 10,271 | 1,900.19 | 6.72 | 2,435.42 |
| 2009 | 7,958 | 2,434.72 | 7.73 | 3,746.05 |

Since we have different food-processing groups, it is interesting to see what is the percentage each group contains in each year (see Table 3).

Table 3. The shares of firms in each food-processing sector.

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| 151 | 23.6% | 21.9% | 21.5% | 21.4% | 21.2% | 20.7% |
| 153 | 2.5% | 2.6% | 2.5% | 2.3% | 2.6% | 2.7% |
| 154 | 10.6% | 10.5% | 10.1% | 9.1% | 9.4% | 9.2% |
| 155 | 3.6% | 3.3% | 3.0% | 3.0% | 2.8% | 2.8% |
| 156 | 18.9% | 17.4% | 17.0% | 15.1% | 15.1% | 14.4% |
| 157 | 17.7% | 22.2% | 23.7% | 25.9% | 25.9% | 27.2% |
| 158 | 19.4% | 18.9% | 18.8% | 19.7% | 19.5% | 19.0% |
| 159 | 3.8% | 3.3% | 3.4% | 3.5% | 3.5% | 3.9% |

As we can see from the Table 3, the amount of firms which produced meat and fish, were slightly higher in 2004 than in other years. In 2009 the firms in meat and fish production were the lowest in comparison with other years. Despite the fact that we can observe the diminishing amount of firms operating in this sector, the distribution of firms is more or less stable over the years, since the highest amount is 23.6% and lowest is 20.7%. If we take a look at firms being involved in fruit and vegetable production, we can see that the deviation through years is really small, since the lowest amount of firms in this sector is 2.3% and the highest is 2.7%. However, in the sector of fruit and vegetables production the amount of firms are not stable and we cannot observe any trends.

A different situation is in the production of vegetable/animal oils and fats, since in this case the amount of firms operating in this sector decrease and the trend is perfectly observable. In this sector the lowest amount of enterprises is 9.2% in 2009 and the highest amount was observed in 2004 (10.6%). The same situation is observable in the sector of dairy production, which is very important for domestic enterprises. In this sector the share of firms which operate in dairy sector has been diminishing over years.

The highest amount of firms in this sector was in 2004 and the lowest in 2008 and 2009. Sector "156" which states for grain mill and starch production shows the diminishing amount of operating firms. Moreover, we can see that this decrease is quite intensive, since in 2004 the share of firms measures as almost 19%, in 2006 it is already 17% and in 2009 – 14.4%.

The share of firms involved in prepared animal feeds production increases from year to year. As we can see from Table 3, the highest share of enterprises in this sector was in 2009, which is the last year observed. The lowest share is 17.7% (2004). Thus, in this sector the increasing trend is present, meaning that over years more domestic firms were involved in production of prepared animal feeds from 2004 to 2009. The share of firms involved in other food production varies over years. The lowest amount of enterprises in this sector was observed in 2006 and the highest – in 2007, meaning that some shock is present since the difference between two years is so significant. The share of firms producing beverages slightly varies over times. The lowest share of firms operating in this sector was in 2005 (3.3%) and the highest – in 2009 (3.9%). Overall, we can see that a significant amount of firms operate in production of meat and fish, prepared animal feeds, grain mill and starch products, other food products.

After the first preliminary results we noticed that the dataset contained extreme outliers. For solving this problem and reducing volatility, we decided to implement top coding procedure in order to replace outliers with values of tails at the level of 5% and 95%. After implementing this procedure CES indices were calculated as a part of preparation of TFP estimation. As mentioned above, some firms were not producing anything in some years, meaning that it is impossible to obtain CES for some firms in some years. Consequently, the number of firms in dataset was decreased.

The final dataset contains 9,983 firms. In 2004 we obtained 6,246 firms, in 2005 – 5,911 firms, in 2006 – 5,951, in 2007 – 5,627 firms, in 2008 – 5,078 and, finally, in 2009 – 5,078. Again, since our data are the unbalances panel type, it is clear that each firm did not operate in each year. In average, each firm operates 11 months per year. Overall, the detailed descriptive statistics is available in the Table 4.

Table 4. Mean of main variables in the final dataset.

| **Year** | **Employment** | **Output** | **Material cost** | **Material investment** | **Capital** |
|---|---|---|---|---|---|
| 2004 | 83 | 10,096.5 | 6,265.7 | 1,607.55 | 2,817.75 |
| 2005 | 87 | 12,379.3 | 7,957.79 | 1,996.07 | 3,437.27 |
| 2006 | 86 | 13,640.9 | 8,198.97 | 2,531.85 | 3,847.42 |
| 2007 | 93 | 20,516.7 | 12,299.51 | 4,209.28 | 5,877.01 |
| 2008 | 93 | 29,141.1 | 17,373.79 | 6,672.26 | 7,628.96 |
| 2009 | 88 | 33,177.7 | 19,437.19 | 5,096.91 | 8,450.87 |

As can be seen from Table 4, all variables contain increasing values. However, we can see that the average value of employment varies from 2004 to 2009. We should add that all values are not adjusted by inflation, which might be one of the explanation of increasing values. We also can take a look at share of firms operating in different food-processing sector. The results of this analysis are presented in Table 5 below.

Table 5. The shares of firms in each food-processing sector after top coding.

| **Year** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|
| 151 | 16.6% | 17.0% | 17.7% | 19.0% | 19.3% | 18.8% |
| 153 | 5.7% | 5.7% | 6.0% | 5.4% | 5.4% | 5.5% |
| 154 | 6.0% | 5.7% | 5.5% | 6.0% | 6.0% | 6.2% |
| 155 | 9.2% | 8.8% | 8.8% | 8.0% | 7.5% | 7.3% |
| 156 | 12.3% | 12.8% | 12.3% | 11.9% | 11.7% | 11.1% |
| 157 | 3.6% | 3.3% | 3.3% | 3.2% | 3.3% | 3.5% |
| 158 | 33.4% | 33.8% | 33.6% | 33.8% | 34.0% | 34.7% |
| 159 | 13.2% | 12.9% | 12.9% | 12.7% | 12.8% | 12.8% |

As we can see from Table 5, the biggest share of firms operates in food-processing sector, which produce other food products. Also a lot of firms are involved in production of meat and fish, grain mill and starch products and beverages. The most significant share of firms operating in beverages production was observed in 2004 (13.2%) and the lowest – in 2007 with the share 12.7%. The sector of other food production contain, as mentioned above, the biggest share of firms.

The most significant share of firms operated in 2004 and the least significant in 2004. Sectors "153", "154" and "157" have a similar tendency in increasing the amount of operating firms from 2007 to 2009. Firms involved in meat and fish production varies over years: the highest amount of firms in this sector was detected in 2008 (19.3%) and the lowest – in 2004 with the share of 16.6%.

It is also interesting to see whether firms produce only one particular product or they are multi productive. Overall, we have detected that in 2004 51% of all firms produce only one product and, therefore, 49% produce more than one product. In 2005 the shares of firms that produce only one product and more than one product are the same. In 2006 the share of firms that produce only one product is higher than in 2004 and 2005, and it is equal to 56%. The share of firms that produce more than one product in 2006 is 44%.

In 2007 the share of firms that produce only one product increases by 1% to 57%. Therefore, the amount of food-processing firms that produce more than one product is 43%. In 2008 the share of firms are the same as in 2007. Finally, in 2009 the share of firms which produced one product is 56% and the share of firms that produced more than one product is 44%. As we can see in all tangible years the share of firms that produced only one product is higher. Firms in our dataset could be defined as importers and/or exporters. In the Table 6 we can observe how many firms from our dataset are importers.

The bigger amount of importers operates in production of beverages, other food products, meat and fish, fruit and vegetables, dairy. When we say that a firm is an importer we mean that in order to produce something the firm has to import particular inputs. The least the amount of firms is importers if they are involved in production of vegetable/animal oils and fats, prepared animal feeds and grain mill and starch products.

Table 6. Firms-importers in the final dataset.

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| 151 | 119 | 139 | 126 | 140 | 144 | 114 |
| 153 | 103 | 104 | 102 | 104 | 97 | 99 |
| 154 | 48 | 48 | 57 | 63 | 72 | 75 |
| 155 | 121 | 103 | 86 | 94 | 84 | 80 |
| 156 | 95 | 84 | 73 | 87 | 108 | 95 |
| 157 | 31 | 29 | 29 | 34 | 32 | 43 |
| 158 | 301 | 297 | 307 | 308 | 286 | 273 |
| 159 | 226 | 228 | 227 | 210 | 200 | 183 |
| N | 1,044 | 1,032 | 1,007 | 1,040 | 1,023 | 962 |

We think that this distribution is quite clear, since all inputs for vegetable oils and similar products can be found in Ukraine or producer simple does not need any imported substitution for production. In our dataset we have NTMs imposed on imported goods. Following the same logic, we can define firms-exporters from our final dataset (Table 7).

Table 7. Firms-exporters in the final dataset.

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| 151 | 119 | 140 | 127 | 140 | 144 | 114 |
| 153 | 104 | 104 | 103 | 104 | 97 | 99 |
| 154 | 49 | 50 | 57 | 64 | 72 | 7 |
| 155 | 124 | 104 | 88 | 94 | 84 | 80 |
| 156 | 96 | 85 | 74 | 88 | 108 | 95 |
| 157 | 31 | 29 | 29 | 34 | 32 | 43 |
| 158 | 307 | 299 | 310 | 311 | 286 | 273 |
| 159 | 231 | 230 | 227 | 210 | 200 | 183 |
| N | 1,061 | 1,041 | 1,015 | 1,045 | 1,023 | 962 |

From the Table 7 we can observe that the majority of firms-exporters operate in production of other food, beverages, meat and fish, fruit and vegetable and dairy products. Also we can conclude that firms involved in production of vegetable and animal oils/fats, grain mill and starch products and prepared animal feeds export less.

Now we can see in more details on NTMs data and its connection with food-processing sectors that we defined. NTMs were calculated according to the sector in which firms operate. Moreover, we can observe not only NTMs, but also NTMs on input for firms-importers and NTMs on output for firms-exporters. The average information is presented in the Table 8. As we can see, extreme cases of volatility are not present in our NTMs data. The higher the value is, the more NTMs are imposed on product.

Table 8. NTMs for KVEDs.

| ***Year*** | ***Mean*** | ***Standard Deviation*** | ***Min*** | ***Max*** |
|---|---|---|---|---|
| 2004 | 36.58 | 11.60 | 14.43 | 58.28 |
| 2005 | 40.30 | 9.60 | 23.28 | 56.35 |
| 2006 | 39.58 | 10.08 | 20.68 | 59.22 |
| 2007 | 38.44 | 10.20 | 22.53 | 54.67 |
| 2008 | 40.88 | 11.03 | 19.61 | 57.76 |
| 2009 | 30.66 | 7.56 | 20 | 48.40 |

As stated, we also have NTMs on imported inputs and on exported output. The information about these data you can see in Table 9 and Table 10. For TFPR estimation we took deflators from State Statistics Service of Ukraine. Overall, rich data gives us an opportunity to check out the hypothesis about impact of NTMs on firm's productivity.

*Chapter 5*

# EMPIRICAL RESULTS

Before estimating the production function, we calculated CES indices for each firm from 2004 till 2009 years. CES indices are essential in order to obtain TFPQ or, in other words, we use CES indices as a firm-level deflator for the own-produced output. After calculation we got the following results (Table 11).

Table 11. CES indices.

| ***Year*** | ***CES indices*** | ***Standard Deviation*** | ***Min*** | ***Max*** |
|---|---|---|---|---|
| 2004 | 3.05 | 5.33 | .00021 | 150.51 |
| 2005 | 3.15 | 6.24 | .0005 | 200.58 |
| 2006 | 3.13 | 6.94 | .000014 | 262 |
| 2007 | 3.98 | 25.57 | .000035 | 1,858.66 |
| 2008 | 4.98 | 17.56 | .000129 | 1046 |
| 2009 | 6.14 | 24.57 | .000026 | 1468 |

Each firm has its own CES index in each year. Using CES indices we deflated output for further TFPQ estimation TFPQ. Overall CES as firm-specific deflator does not vary significantly over time. However, we observed dramatic increase of CES index from 2007 to 2009. For TFPR estimation we used price deflators for food-processing industry from State Statistics Service of Ukraine.

After collecting the residuals, we estimated production function with deflated output (see Table 12). As we can see, coefficients of variables that state for the amount of employment and material costs of firm are statistically significant for every food-processing industry in our sample. It is quite logical that the sign of coefficients is positive; meaning that the increase in employment and material is associated with the increase in firm's productivity. Moreover, coefficients of material costs are also significant in economic terms. Statistically significant coefficient has variable "capital" for firms in food-processing sector of beverages production. However, it is also has an unexpected negative sign of the coefficient. The coefficient of capital is also negative for meat and fish production, production of animal oils and fats. But those coefficients are not statistically significant.

Table 12. Production function estimation using deflated output.

| | **ln(capital)** | **ln(employment)** | **ln(material costs)** |
|---|---|---|---|
| Meat and fish products | -.001<br>(.046) | .309***<br>(.029) | .646***<br>(.023) |
| Fruits and vegetables | .032<br>(.046) | .326***<br>(.078) | .591***<br>(.042) |
| Animal oils, fats | -.0607<br>(.0723) | .187**<br>(.062) | .692***<br>(.041) |
| Dairy products | .010<br>(.056) | .384***<br>(.050) | .537***<br>(.038) |
| Grain mill and starch products | .052<br>(.0503) | .275***<br>(.038) | .628***<br>(.027) |
| Prepared animal feeds | .165<br>(.127) | .224**<br>(.074) | .667***<br>(.045) |
| Other food products | .049**<br>(.0214) | .379***<br>(.030) | .522***<br>(.023) |
| Beverages | -.079*<br>(.044) | .270***<br>(.041) | .661***<br>(.031) |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

We also estimated production function using output deflated by CES (see Table 13). The first difference between TFPR and TFPQ is that in the second case variable "employment" became more statistically and economically significant. However, as we can see, material costs in TFPQ seem to be more economically significant than in TFPR.

Table 13. Production function estimation using output deflated by CES.

| | **ln(capital)** | **ln(employment)** | **ln(material cost)** |
|---|---|---|---|
| Meat and fish products | -.005 | .415*** | .656*** |
| | (.079) | (.066) | (.040) |
| Fruits and vegetables | -.005 | .350** | .792*** |
| | (.165) | (.121) | (.109) |
| Animal oils, fats | .217* | .824*** | .314** |
| | (.161) | (.187) | (.106) |
| Dairy products | -.053 | .431*** | .775*** |
| | (.085) | (.133) | (.074) |
| Grain mill and starch products | .166** | .579*** | .491*** |
| | (.080) | (.074) | (.047) |
| Prepared animal feeds | .033 | .526*** | .547*** |
| | (.226) | (.124) | (.088) |
| Other food products | .006 | .288*** | .718*** |
| | (.065) | (.073) | (.048) |
| Beverages | .060 | .239* | .794*** |
| | (.085) | (.128) | (.068) |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The next step is to use different specifications for determining whether NTMs has any statistically significant effect on firm's productivity. First of all, we estimated so call "base" TFPR and TFPQ, meaning that we use the data for firms from the whole final dataset without any differentiation for size or production one good or more than one.

For final specification we use NTMs on output, NTMs on inputs. Also we use the variable "MFN", which states for tariff measures on imported or exported input or output. Other important variables define whether firm is exporter or importer. In the final specification we control exit of firms and entry in the food-processing industry. In Table 14 we presented results that describe the impact on firm's productivity is associated with NTMs and other variables. Specifications (3) and (4) were estimated on firms that produce only one particular food product.

Table 14. Effects of NTMs on firm's productivity.

| | (1) TFPR | (2) TFPQ | (3) TFPR (mono) | (4) TFPQ(mono) |
|---|---|---|---|---|
| ln(NTMs on input) | 0.110 | -0.228 | 0.048 | -0.962*** |
| | (0.071) | (0.198) | (0.120) | (0.214) |
| ln(MFN on input) | -0.365* | -2.596*** | -0.715* | 0.463 |
| | (0.156) | (0.524) | (0.332) | (0.472) |
| ln(NTMs on output) | 0.016 | 1.006*** | 0.244 | -0.485 |
| | (0.080) | (0.208) | (0.156) | (0.269) |
| ln(MFN on output) | -0.001 | -1.033* | 0.183 | 0.154 |
| | (0.096) | (0.445) | (0.140) | (0.231) |
| exporter | 0.152*** | 0.138* | 0.219*** | 0.232*** |
| | (0.019) | (0.063) | (0.033) | (0.065) |
| importer | 0.043* | 0.030 | 0.039 | -0.037 |
| | (0.018) | (0.040) | (0.029) | (0.049) |
| exit | 0.184*** | 0.294*** | 0.120 | 0.246** |
| | (0.032) | (0.062) | (0.065) | (0.092) |
| entry | -0.198*** | -0.107* | -0.226*** | -0.209** |
| | (0.027) | (0.050) | (0.052) | (0.068) |
| N | 28,810 | 18,396 | 8,722 | 8,152 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As we can see from the Table 14, NTMs on input are associated with rather negative impact on firm's productivity in case of TFP in quantities estimation and if firm produces only one product. Also we noticed that tariff equivalent MFN is associated with negative influence on firm's productivity. Especially in the basic case of TFPQ when the coefficient is highly economically and statistically significant.

An interesting result was obtained regressing NTMs on output on TFPQ, because the coefficient of this variable is not only statistically significant, but with a positive sign as well. This means that imposing NTMs on output might lead to the increase in firm's productivity. The explanation of this result can be the following: when the producer follows all requirements associated with NTMs, it has an opportunity to increase its productivity. It is interesting that this effect does not depend on the firm's size. Moreover, in this specification variable "exporter" is statistically significant as well and has also a positive sign of the coefficient. The coefficient of this variable is statistically significant in all specifications. We can assume that if a firm is involved in export activity it could have higher productivity. However, the causality in this case is not so straight, because then we should answer the following question: firm is more productive because of being an exporter or vice versa? We can assume that only after achieving a particular level the firm can consider the opportunity to become an exporter.

Another interesting outcome, according to the Table 14, states that if firm produce one food product ($4^{th}$ specification) it is more sensitive to the impact of NTMs on input. The sign of the variable coefficient "NTMs on input" is negative as well for firms that are not specialized in one good production, but now this result became statistically significant. Overall, the main conclusion that could be done from the Table 15 is that NTMs are rather associated with the negative impact on firm's productivity.

As we mentioned, the previous specification does not include any size differentiation between firms. In Table 15 we can observe the impact of NTMs and other variables on firm's productivity, which are defined as "big". By big firms we mean the ones that have the amount of employment more than ten people. In our dataset 53% of all firms are the big ones, and, correspondently, 47% - have less than ten people in staff.

Table 15. Effects of NTMs on firm's productivity depending on size.

| | (1)<br>**TFPR**<br>**(big)** | (2)<br>**TFPQ**<br>**(big)** | (3)<br>**TFPR**<br>**(mono & big)** | (4)<br>**TFPQ**<br>**(mono & big)** |
|---|---|---|---|---|
| ln(NTMs on input) | 0.01 | -0.062 | -0.073 | -0.916*** |
| | (0.066) | (0.230) | (0.103) | (0.242) |
| ln(MFN on input) | -0.222 | -3.336*** | -0.452 | 1.042* |
| | (0.160) | (0.548) | (0.296) | (0.504) |
| ln(NTMs on output) | 0.031 | 1.103*** | 0.222 | -0.947*** |
| | (0.075) | (0.233) | (0.139) | (0.274) |
| ln(MFN on output) | -0.064 | -1.210* | -0.158 | -0.075 |
| | (0.092) | (0.485) | (0.092) | (0.251) |
| exporter | 0.133*** | 0.131* | 0.163*** | 0.217** |
| | (0.016) | (0.065) | (0.027) | (0.07) |
| importer | 0.04* | 0.029 | 0.009 | 0.003 |
| | (0.017) | (0.042) | (0.026) | (0.048) |
| exit | 0.067 | 0.252*** | 0.161* | 0.326* |
| | (0.034) | (0.071) | (0.076) | (0.135) |
| entry | -0.145*** | -0.069 | -0.097 | -0.172* |
| | (0.03) | (0.057) | (0.052) | (0.081) |
| N | 20,224 | 14,437 | 5,583 | 5,344 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Specification (1) contains the estimation of TFPR on NTMs and other variables for big firms. In this particular specification NTMs are not associated with any negative or at least statistically significant impact. However, in the second specification we can see that tariff equivalent has somewhat negative and statistically significant impact on firm's productivity that was estimated using TFPQ. The coefficient of this variable is not only statistically significant, but relative to other coefficients, highly economically significant. We found here a convincing evidence of the negative impact of tariffs imposed on input of firm's productivity. This result is in many other academic papers (e.g. Loo Kee et al., 2009). Also we can conclude that NTMs imposed on output are associated with somewhat positive effect on firm's productivity as TFPQ. The coefficient of variable "exporter" is statistically significant and positive as in TFPR case. The third and fourth specifications describe the relation between NTMs on firm's productivity when two conditions are hold: firstly, a firm produces only one good, and, secondly, its employment is more than ten people. In this case NTMs on input have rather negative impact on firm's productivity. The same effect has NTMs on output for firm's productivity.

Another measurement for productivity is labor productivity that was defined as adjusted by the inflation difference between output and material costs to employment. Basically, this variable states for value added per worker (variable "VAR"). We have another variable for measuring labor productivity. It is labor productivity based on output ("LPQ"). After calculating these variables we run regressions that define the relation between labor productivity measures and NTMs. The results are presented in the Table 16.

Table 16. Effects of NTMs on labor productivity.

| | (1)<br>**VAR** | (2)<br>**LPQ** | (3)<br>**VAR (big)** | (4)<br>**LPQ (big)** |
|---|---|---|---|---|
| ln(NTMs on input) | 0.168 | 0.330** | 0.212 | 0.253** |
| | (0.113) | (0.103) | (0.109) | (0.093) |
| ln(MFN on input) | 0.101 | 0.121 | -0.096 | -0.054 |
| | (0.253) | (0.205) | (0.275) | (0.199) |
| ln(NTMs on output) | 0.260 | 0.227 | 0.217 | 0.098 |
| | (0.138) | (0.120) | (0.143) | (0.108) |
| ln(MFN on output) | -0.098 | -0.282* | -0.123 | -0.350** |
| | (0.121) | (0.118) | (0.115) | (0.110) |
| exporter | 0.244*** | 0.295*** | 0.216*** | 0.229*** |
| | (0.032) | (0.027) | (0.0301) | (0.024) |
| importer | 0.128*** | 0.146*** | 0.091*** | 0.106*** |
| | (0.029) | (0.025) | (0.027) | (0.022) |
| exit | 0.144*** | -0.125*** | 0.009 | -0.210*** |
| | (0.04) | (0.036) | (0.046) | (0.039) |
| entry | -0.338*** | -0.391*** | -0.246*** | -0.341*** |
| | (0.038) | (0.034) | (0.042) | (0.038) |
| N | 30,878 | 32,990 | 20,035 | 21,213 |

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

We found that NTMs on input are associated with the positive impact on labor productivity based on output. This result is the same for labor productivity based on output in firms with employment more than 10 people. However, we did not find any impact of NTMs on output of labor productivity. We should add here that variable "exporter" has both positive and statistically significant coefficient in specification with value added per worker and labor productivity based on output. The same result can be made for the variable that defines a firm as an importer. Overall, we can conclude that firms-exporters and firms-importers have significantly higher productivity.

# CONCLUSION

The paper investigates the impact of NTMs on firm's productivity. NTMs were defined as measures in trade relations, which implies non-price or/and non-quantity barriers. Firm's productivity was measured through the production function estimation with further collecting of TFPR and TFPQ. As additional measures of productivity, labor productivity was defined with labor productivity based on gross output and value added per worker. NTMs were presented through non-tariff barriers on input and output. The final dataset contains 9,983 firms from food-processing industry over the time period of 2004-2009.

The literature analysis suggests that a lot of papers focused rather on trade liberalization issue than on NTMs. Moreover, since rich firm-level data are usually not tangible in many countries, there is an obvious lack of studying the effect of NTMs on firm-level productivity. Production function was estimated for each food-processing industry using Olley-Pakes methodology controlling for sub-industry specific demand and price shocks as suggested by De Loecker to calculate TFP of firms in food-processing industry.

We detected that in the majority cases NTMs are associated with negative impact on firm's productivity. It was also found that there are differences between estimated effects on NTMs on TFPQ and TFPR. NTMs on input are not associated with negative impact on firm's productivity if firm is not specialized in one good producing and vice versa. An interesting result was obtained regressing NTMs on output on firm's productivity measuring with TFPQ, because the coefficient of this variable contains a positive sign. NTMs imposed on output are associated with the positive effect on firm's productivity if this firm has employment more than ten people. NTMs on both output and input are associated with the negative impact on firm's productivity if this firm is specialized in producing only one good and if it has employment more than ten.

We found that NTMs on input are associated with the positive impact on labor productivity based on output. This result is the same for labor productivity based on output in firms with employment more than ten people. Also it is found that firms-exporters and firms-importers have significantly higher productivity.

The results we obtained provide useful information for both policy-makers and business environment. It is shown in the paper that firm's productivity in food-processing industry overall is sensitive to NTMs on input and output, meaning that before and after imposing non-tariff barriers, estimation of its impact on firm's productivity should be done. In our future studying we will consider not only food-processing industry but also other manufacturing sectors. What is more, we will extract specific types of NTMs in order to find the impact of sanitary, phytosanitary and other measures on firm's productivity.

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APPENDIX A

Table 9. NTMs on inputs for KVEDs.

| *Year* | *Mean* | *Standard Deviation* | *Min* | *Max* |
|---|---|---|---|---|
| 2004 | 21.19 | 11.91 | 0 | 48.60 |
| 2005 | 19.36 | 11.53 | 0 | 43.80 |
| 2006 | 19.59 | 11.41 | 0 | 44.33 |
| 2007 | 22.01 | 10.79 | 0 | 49.98 |
| 2008 | 24.82 | 11.83 | .86 | 42.91 |
| 2009 | 25.15 | 6.83 | 7.43 | 41.06 |

Table 10. NTMs on output for KVEDs.

| *Year* | *Mean* | *Standard Deviation* | *Min* | *Max* |
|---|---|---|---|---|
| 2004 | 35.87 | 11.69 | 13 | 58.31 |
| 2005 | 37.97 | 9.91 | 0 | 56.35 |
| 2006 | 36.52 | 10.97 | 0 | 56.29 |
| 2007 | 35.39 | 10.20 | 21.16 | 53.76 |
| 2008 | 39.23 | 10.09 | 19.56 | 54.29 |
| 2009 | 29.77 | 7.01 | 19.75 | 48.40 |