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IS PRODUCTIVITY PARADOX RELATED TO LOGISTICS? RESEARCH ON POLISH AGRI-FOOD INDUSTRY

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Abstract: Paper presents research results of modern IT technologies and systems using impact for logistics activities in Polish food processing enterprises. Results indicate that a higher used IT solutions advancement level and, consequently, incurred expenditures on IT infrastructure do not directly translate to lower logistics costs. A clear relationships, according to which a higher IT solutions advancement level translates into a better company market position in the field of logistics and a higher level of knowledge about logistics solutions were found. Results confirmed productivity paradox existence in Polish agri-food processing companies identified earlier in relation to financial results.

Keywords: productivity paradox, information technologies, e-logistics, food processing, logistic costs

JEL classification: O33, Q19

INTRODUCTION

Agri-food producing industry is a significant sector of the Polish economy. According to data from the Central Statistical Office (GUS), in 2012, the value of its production sold accounted for 17.1% of production sold by the entire Polish industry and 20.4% of the value of sold production of industrial processing. In terms of food production, Poland ranks as the 6th place in Europe, and the food industry notes in recent years systematically increasing, a positive balance in foreign trade. In 2010-2012 trade balance increased in comparison to the previous year respectively by 9.3%, 21.3% and 59.6%. Polish sector of of food processing is responsible for producing approximately 6% of gross domestic product (GDP), its added value is approximately 4% of the total national economy value. Employment in the food

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industry was represented 4.3% of total employment and 15.6% of total employment in the industry.

The sector of food processing in Poland is quite varied. According to the data in the database REGON, consists of 11 branches, of which by far the largest industry is bakery covering 44.3% of the companies. Significantly larger than other a meat industry is covering 20.2% of the companies. The share of other industries do not exceed 8.5%, and by far the smallest are oil-fat industry (0.8%) and tobacco (0.1%). It should also be noted that the Polish sector of of food processing is highly fragmented. The vast majority of 98.9% of the entities are companies belonging to the sector of small and medium-sized enterprises (SMEs), and as many as 69.7% are micro-enterprises employing up to 9 workers.

It is worth noting that the smaller companies, in particular, were classified as micro have far fewer opportunities in the acquisition, introduction and use of advanced IT technologies and systems. The reason is the need to incur significant costs the most, as well as relevant organizational preparation of company. But it is the ability to use in the practice of modern IT technologies is often mentioned as a key determinant of the market success possibility with regard to the SME sector. They just allow for more effective management of the enterprise, as well as being a kind of catalyst for innovation [Deep et al. 2004, Wong 2005, Wong and Aspinwall 2005, Terziovski 2010, Ząbkowski and Jałowiecki 2011]. Modern IT technologies and systems also play an important role in modern logistic systems to enable effective implementation and control of logistic processes, as well as the implementation of logistics services. Logistics implemented within the digital information systems or aided by them is defined as e-logistics nowadays. The obvious fact is so closely linking modern IT technologies and systems with modern logistics systems [Gnasekaran and Ngai 2003, Beheshti et al. 2007, Talbot et al. 2007].

A characteristic feature of the food industry in Poland is a large number of suppliers of agricultural raw materials and consumers of food products. The average food producing company acquires agricultural products from five categories of suppliers. Definitely the highest is the average number of farmers as suppliers (216.1), and in the dairy (492.2) and meat industries (371.4), it is still significantly higher. Subsequently, these are agricultural enterprises (14.0), purchasing companies (8.4), producer groups (6.9) and processing plants (6.0). Only in the case of fat-oil and other food products industries, you can talk about balance in terms of the average number of suppliers of agricultural raw materials belonging to each listed category [Jałowiecki and Jałowiecka, 2013].

A similar situation takes place with regard to recipients of food products of which there are 6 major categories. In this regard retail stores have a definite advantage (136.9). Subsequently, these are the warehouses (38.8), processing plants (27.3), institutional recipients (12.1), hotels and restaurants (10.3) and trading networks (6.1). The average number of retail stores as consumers of food products are significantly higher in the dairy (until 1809.1) and beverages industries (213.0).

It should also be noted that both the average number of farmers as suppliers of agricultural raw materials, as well as retail stores as consumers of food products is steadily increasing with the increase of the number of employees in the enterprise [Jałowiecki and Jałowiecka 2013]. Such large variations in both customers and market partners of Polish enterprises of food processing is one of the most important causative factors of enterprises functioning within the large and complex cooperative and logistics chains. In addition, most industries of agri-food sector, agri-food processing produces food for which a particularly important quality parameters of both agricultural raw materials, finished products as a freshness, and consequently delivery. In addition, most industries sectors of agri-food processing branch produces food for which a particularly important there are quality parameters of both agricultural raw materials, final food products as a freshness, and consequently delivery time. All this makes proper effectiveness of logistics chains is one of the most important factors in ensuring the competitiveness of enterprises on the market, although the same solutions in the field of IT technology and logistics are essentially the same as in other industrial sectors [Mangina and Vlachos 2005, Clements et al. 2008, Wicki and Jałowiecki 2010].

Known and frequently signaled in the literature phenomenon is called "Productivity paradox". In short, it consists in the fact that expenditure on informatization does not translate directly into financial results of companies. The paradox of productivity has been identified and formulated in the late 80s of the twentieth century by the famous American economists Robert Sollow and Norbert Strassman [Solow 1987, Strassmann 2010]. Increase in expenditure on information systems is usually caused by the implementation of more and more advanced, more complex and have greater possibilities of IT.

In the research conducted so far, in the food production sector enterprises, no correlation between the level of advancement of used IT technologies and financial situation was found, regardless of company size [Jałowiecki and Gostkowki 2013]. Still unpublished results of further studies indicate that such relationships exist in Poland only in the meat and dairy industries. In other sectors of agri-food processing branch, such relationships were not found. Since modern IT technologies are so strongly associated with modern logistics, theoretically, a higher level of their advancement should affect the growth effectiveness of logistics systems and, consequently, decrease the cost of logistics operations. That left investigate whether indeed there are dependencies between the level of advancement of used IT technologies and better market position the company in terms of logistics well as the level of logistics costs.

MATERIAL AND METHODS

n the research the results of a survey of 511 companies of the Polish sector of food processing performed in 2010-2011 were used. Surveyed companies were divided by the number of employees in accordance with the classification of GUS

into 4 categories: micro (up to 9 employees), small enterprises (10-49 employees), medium (50-249 employees) and large (250 or more employees). Because of the small number of subjects, it was not isolated as a separate category of very large enterprises (1,000 or more employees). The studies were taken into account only 6 sectors: meat, fruit and vegetables, dairy, cereal and starchy, bread and other food products, which responded to the survey more than 20 companies.

The stage of advancement of used IT solutions was evaluated employing coefficient used in previous studies [6]. It takes into account factors such as: having the separated information system (yes, no) , computer aided each of the five areas of logistics (transportation, inventory, packaging and reverse logistics, warehouse management, order management and demand forecasting), transfer of information way in circulation within enterprises as well as between the company and the contractors and market partners (no specific, orally, on paper, by phone, fax , e-mail or Internet messengers, via the software), the class of used information system (no system, financial-accounting (FA), electronic data interchange (EDI), materiel resources planning (MRP), enterprise resources planning (ERP), business intelligence (BI) system) and the method The statistical significance of the correlation coefficients determined using the test was examined in accordance with the formula (2).of preparing forecasts of demand for manufactured products (no forecasts , production on the basis of received raw materials, production based on orders received, based on historical data from the company, based on market forecasts, based on data from the company and market). Coefficient could have values ranging from 0 to 6. In order to ensure the comparability with the rest of examined variables, its value categorized into 5 categories by assigning a value from 1 to 5, which marked level: very low, low, average, high, very high.

Their knowledge in the field of logistics evaluated on the basis of the respondents declaration also was categorized into 5 categories from 1 to 5: woefully inadequate; usually insufficient; as often enough as insufficient; usually sufficient and more than sufficient knowledge. On the basis of the declaration of the respondents also an assessment of the market position of the company against the industry in terms of each of the five areas of logistics activities (transportation, inventory, packaging and reverse logistics, warehouse management, order management and demand forecasting) were based. It was categorized into five categories: one of the worst in the against the sector, slightly weaker than the sector average, average, slightly better than the average in the sector, one of the better against the sector. Moreover, the total value of the coefficient of the market position of the company in terms of logistics was designated, and also categorized into 5 categories: very low, low, average, high, very high. The costs of logistics enterprises categorized into 5 values (less than 1%, from 1% to 4%, from 5% to 9%, from 10 to 14% and 15% or more of the total cost of the enterprise).

To assess the relationship between examined variables (advancement of used IT technologies, the assessment of the market position of the company in terms of individual areas of logistics activities, market position in terms of logistics and of

logistics costs ratios) was used Spearman's rank correlation coefficient due to the categorization of all the studied variables. The statistical significance of determined correlation coefficients was examined with the test based on t-Student distribution. Correlations for all companies together, in 4 groups of employment size and for the six selected sectors separately were examined.

RESULTS

Among all surveyed companies the level of advancement of used IT solutions was at the level $\bar{x}$ = 2.51, which is in the middle between low and average. Its dispersion was ρ = 0.99, which accounted for 39.6% arithmetic average. This level definitely increased with the increase in the size category of employment of $\bar{x}$ = 2.07 for micro to $\bar{x}$ = 3.83 for large enterprises (see Table 1). Among the sectors by far the highest level of applied IT solutions was found among dairy enterprises $\bar{x}$ = 3.33, while by far the lowest among the baking $\bar{x}$ = 2.24 (see Table 2).

The average level of costs associated with logistics for all companies was as $\bar{x}$ = 2.92, which is on the border of categories from 1% to 4% and from 5% to 9% of the total costs of the company. Their dispersion was s = 1.10, which accounted for 37.6% of the arithmetic average. The average level of logistics costs incurred increased with increasing size class of enterprise from $\bar{x}$ = 2.57 in micro-enterprises to $\bar{x}$ = 3.07 in large enterprises, in which the dispersion was by far the lowest (see Table 1).

Table 1. Average levels of used IT solutions advancement, logistics solutions knowledge, market positions in term of five logistic activity areas, and in term of all logistic activities, share of logistic costs in total costs of company coefficients and its diversification in companies of Polish agri-food production sector according to employment size ($\bar{x}$ – average, s – standard deviation, V_x – diversification coefficient)

Employment size	Micro	Small	Middle	Large	All
Used IT solutions advancement level	$\bar{x}$ = 2.07 s = 0.71 V_x = 0.34	$\bar{x}$ = 2.30 s = 0.84 V_x = 0.37	$\bar{x}$ = 3.10 s = 1.04 V_x = 0.34	$\bar{x}$ = 3.83 s = 0.92 V_x = 0.24	$\bar{x}$ = 2.51 s = 0.99 V_x = 0.39
Knowledge of logistics solutions	$\bar{x}$ = 3.62 s = 1.16 V_x = 0.32	$\bar{x}$ = 3.46 s = 1.15 V_x = 0.33	$\bar{x}$ = 3.52 s = 1.03 V_x = 0.29	$\bar{x}$ = 3.55 s = 0.83 V_x = 0.23	$\bar{x}$ = 3.50 s = 1.11 V_x = 0.32
Market position in term of inventory control	$\bar{x}$ = 2.97 s = 1.15 V_x = 0.39	$\bar{x}$ = 3.40 s = 1.17 V_x = 0.34	$\bar{x}$ = 3.54 s = 1.13 V_x = 0.32	$\bar{x}$ = 3.69 s = 0.99 V_x = 0.27	$\bar{x}$ = 3.38 s = 1.18 V_x = 0.35
Market position in term of storage management	$\bar{x}$ = 2.93 s = 1.14 V_x = 0.39	$\bar{x}$ = 3.35 s = 1.19 V_x = 0.36	$\bar{x}$ = 3.51 s = 1.11 V_x = 0.32	$\bar{x}$ = 3.83 s = 0.99 V_x = 0.26	$\bar{x}$ = 3.35 s = 1.19 V_x = 0.36

Employment size	Micro	Small	Middle	Large	All
Market position in term of packaging management	$\bar{x}$ = 2.97 s = 1.17 V_x = 0.39	$\bar{x}$ = 3.09 s = 1.21 V_x = 0.39	$\bar{x}$ = 3.31 s = 1.14 V_x = 0.34	$\bar{x}$ = 3.45 s = 1.12 V_x = 0.32	$\bar{x}$ = 3.13 s = 1.20 V_x = 0.38
Market position in term of transport management	$\bar{x}$ = 3.15 s = 1.22 V_x = 0.39	$\bar{x}$ = 3.40 s = 1.23 V_x = 0.36	$\bar{x}$ = 3.70 s = 1.14 V_x = 0.31	$\bar{x}$ = 3.90 s = 0.99 V_x = 0.25	$\bar{x}$ = 3.45 s = 1.23 V_x = 0.36
Market position in term of information management	$\bar{x}$ = 2.87 s = 1.15 V_x = 0.40	$\bar{x}$ = 3.10 s = 1.18 V_x = 0.38	$\bar{x}$ = 3.28 s = 1.18 V_x = 0.36	$\bar{x}$ = 3.52 s = 1.04 V_x = 0.30	$\bar{x}$ = 3.13 s = 1.18 V_x = 0.38
Market position in term of all logistic activities	$\bar{x}$ = 3.16 s = 1.16 Vx = 0.37	$\bar{x}$ = 3.50 s = 1.16 V_x = 0.33	$\bar{x}$ = 3.74 s = 1.04 V_x = 0.28	$\bar{x}$ = 4.00 s = 1.02 V_x = 0.26	$\bar{x}$ = 3.53 s = 1.15 V_x = 0.33
Share of logistic costs in total costs of company	$\bar{x}$ = 2.57 s = 0.98 V_x = 0.38	$\bar{x}$ = 2.95 s = 1.12 V_x = 0.38	$\bar{x}$ = 2.99 s = 1.08 V_x = 0.36	$\bar{x}$ = 3.07 s = 0.88 V_x = 0.29	$\bar{x}$ = 2.92 s = 1.10 V_x = 0.38

Source: own preparation

In terms of logistics costs, studied sectors can be divided into 2 groups. In the first, including companies producing other food products ($\bar{x}$ = 3.18), dairy ($\bar{x}$ = 3.17) and fruit and vegetable processing ($\bar{x}$ = 3.09) the average level of logistics costs was much higher than in the second, covering the remaining branches (see Table 2). Assessing the relationship between the level of advancement of used IT solutions, and the level of costs connected with the logistics of all companies, there is a weak, but statistically significant correlation r_S = 0.20, according to which a higher level of IT solutions meant a higher level of logistics costs. Among the groups of companies similar relationship was found only in small enterprises r_S = 0.22, in the meat industry r_S = 0.27, bakery r_S = 0.21 and the strongest in the industry of other food products r_S = 0.36. Among the companies belonging to other groups of the number of employees and in other industries, there was no statistically significant relationships between the level of advancement of information technology used and the level of logistics costs. It is worth also be noted that although no statistical significant but negative correlations meaning depending on logistics costs decline with increasing severity of used IT technologies and systems found in large enterprises (r_S = -0.14), fruit and vegetable processing (r_S = -0.15) and milk (r_S = -0.10) (see Tables 3 and 4). The results of research conducted by the author indicate that they are a group of companies characterized by far the greatest complexity of the logistics structure [Jałowiecki et al. 2014]. The results obtained with regard to the level of logistics costs also confirmed the results of previous studies on the relationship between the level of used IT technology advancement, and the financial situation of companies in the branch of food production [Jałowiecki and Gostkowski 2013]. According to them only in small enterprises and in the meat and dairy industries statistically significant dependencies according to which a

higher level of advancement of used IT technologies and systems translated into better financial results of companies. For all surveyed enterprises whereas there was no such statistically significant correlation.

Table 2. Average levels of logistics solutions knowledge, market positions in term of five logistic activity areas and its diversification in companies of Polish agri-food production sector according to sector of functioning ($\bar{x}$ – average, s – standard deviation, V_x – diversification coefficient)

Sector	Meat	Fruits and Vegetables	Milk	Cereal and Starch	Bakery	Other Grocery
Used IT solutions adv. level	$\bar{x}$ = 2.59 s = 1.01 V_x = 0.39	$\bar{x}$ = 2.97 s = 1.03 V_x = 0.35	$\bar{x}$ = 3.33 s = 0.91 V_x = 0.27	$\bar{x}$ = 2.47 s = 1.16 V_x = 0.47	$\bar{x}$ = 2.24 s = 0.82 V_x = 0.37	$\bar{x}$ = 2.76 s = 0.99 V_x = 0.36
Knowledge of logistics solutions	$\bar{x}$ = 3.40 s = 1.12 V_x = 0.33	$\bar{x}$ = 3.70 s = 0.74 V_x = 0.20	$\bar{x}$ = 3.79 s = 0.48 V_x = 0.13	$\bar{x}$ = 3.66 s = 1.06 V_x = 0.29	$\bar{x}$ = 3.45 s = 1.23 V_x = 0.36	$\bar{x}$ = 3.62 s = 0.86 V_x = 0.24
Market position in term of …						
inventory control	$\bar{x}$ = 3.36 s = 1.07 V_x = 0.32	$\bar{x}$ = 3.39 s = 1.14 V_x = 0.34	$\bar{x}$ = 3.75 s = 0.84 V_x = 0.22	$\bar{x}$ = 3.08 s = 1.21 V_x = 0.39	$\bar{x}$ = 3.40 s = 1.25 V_x = 0.37	$\bar{x}$ = 3.53 s = 0.91 V_x = 0.26
storage management	$\bar{x}$ = 3.31 s = 1.08 V_x = 0.33	$\bar{x}$ = 3.52 s = 1.10 V_x = 0.31	$\bar{x}$ = 3.50 s = 0.92 V_x = 0.26	$\bar{x}$ = 3.26 s = 1.30 V_x = 0.40	$\bar{x}$ = 3.31 s = 1.24 V_x = 0.37	$\bar{x}$ = 3.56 s = 0.94 V_x = 0.26
packaging management	$\bar{x}$ = 3.03 s = 1.12 V_x = 0.37	$\bar{x}$ = 3.18 s = 1.13 V_x = 0.36	$\bar{x}$ = 3.54 s = 0.83 V_x = 0.23	$\bar{x}$ = 3.26 s = 1.22 V_x = 0.37	$\bar{x}$ = 3.08 s = 1.25 V_x = 0.41	$\bar{x}$ = 3.51 s = 0.87 V_x = 0.25
transport management	$\bar{x}$ = 3.37 s = 1.11 V_x = 0.33	$\bar{x}$ = 3.45 s = 1.15 V_x = 0.33	$\bar{x}$ = 4.08 s = 0.83 V_x = 0.20	$\bar{x}$ = 3.50 s = 1.24 V_x = 0.35	$\bar{x}$ = 3.39 s = 1.29 V_x = 0.38	$\bar{x}$ = 3.62 s = 0.97 V_x = 0.27
information management	$\bar{x}$ = 3.03 s = 1.08 V_x = 0.25	$\bar{x}$ = 3.03 s = 1.08 V_x = 0.25	$\bar{x}$ = 3.46 s = 0.62 V_x = 0.24	$\bar{x}$ = 3.24 s = 0.83 V_x = 0.31	$\bar{x}$ = 3.12 s = 0.87 V_x = 0.33	$\bar{x}$ = 3.24 s = 0.72 V_x = 0.29
all logistic activities	$\bar{x}$ = 3.45 s = 1.10 V_x = 0.32	$\bar{x}$ = 3.64 s = 1.09 V_x = 0.30	$\bar{x}$ = 4.04 s = 0.81 V_x = 0.20	$\bar{x}$ = 3.53 s = 1.20 V_x = 0.34	$\bar{x}$ = 3.47 s = 1.19 V_x = 0.34	$\bar{x}$ = 3.76 s = 0.95 V_x = 0.25
Logistic costs share	$\bar{x}$ = 2.78 s = 1.09 V_x = 0.39	$\bar{x}$ = 3.09 s = 0.84 V_x = 0.35	$\bar{x}$ = 3.17 s = 0.82 V_x = 0.27	$\bar{x}$ = 2.87 s = 1.08 V_x = 0.47	$\bar{x}$ = 2.88 s = 1.12 V_x = 0.35	$\bar{x}$ = 3.18 s = 1.00 V_x = 0.36

Source: own preparation

In terms of market position in the 5 areas of logistics activity, as well as in terms of logistics in general, in all the surveyed companies stated regularity according to which the higher average employment group meant better market

position. For example, the average summary assessment of logistics increased from $\bar{x}$ = 3.16, that is the average market position for micro to $\bar{x}$ = 4.00, which is slightly better market position than the average in the large companies. Top rated average market position of all surveyed enterprises was in the management of transport ($\bar{x}$ = 3.45), whereas the lowest were average market positions in terms of packaging and reverse logistics ($\bar{x}$ = 3.13) and information management ($\bar{x}$ = 3.13) (see Table 1). Taking into account sectors, definitely the highest average assessment of its market position in terms of logistics was found in dairy enterprises ($\bar{x}$ = 4.04), whereas the lowest in the meat ($\bar{x}$ = 3.45) and bakery industries ($\bar{x}$ = 3.47) (see Table 2).

Table 3. Spearman correlation between the level of used IT solutions advancement, logistics solutions knowledge, market positions in term of five logistic activity areas, and in term of all logistic activities, share of logistic costs in total costs of company coefficients depending on the employment size (r_S – correlation coefficient, t – empirical value of test statistic, tα – critical value of test statistic, α – significance level)

Employment size α = 0.05	Micro $t_\alpha = \pm 2.00$	Small $t_\alpha = \pm 1.97$	Middle $t_\alpha = \pm 1.99$	Large $t_\alpha = \pm 2.05$	All $t_\alpha = \pm 1.96$
Knowledge of logistics solutions	r_S = 0.27 t = 2.12 p = 0.04	r_S = 0.34 t = 6.44 p < 0.01	r_S = 0.46 t = 5.11 p < 0.01	r_S = 0.64 t = 4.34 p < 0.01	r_S = 0.32 t = 7.00 p < 0.01
Market position in term of …					
inventory control	r_S = 0.16 t = 1.22 p = 0.23	r_S = 0.31 t = 5.79 p < 0.01	r_S = 0.46 t = 5.16 p < 0.01	r_S = 0.61 t = 3.96 p < 0.01	r_S = 0.35 t = 8.40 p < 0.01
storage management	r_S = 0.38 t = 3.11 p < 0.01	r_S = 0.40 t = 7.65 p < 0.01	r_S = 0.47 t = 5.27 p < 0.01	r_S = 0.55 t = 3.45 p < 0.01	r_S = 0.43 t = 10.72 p < 0.01
packaging management	r_S = 0.21 t = 1.63 p = 0.11	r_S = 0.32 t = 6.07 p < 0.01	r_S = 0.35 t = 3.70 p < 0.01	r_S = 0.54 t = 3.35 p < 0.01	r_S = 0.34 t = 8.19 p < 0.01
transport management	r_S = 0.27 t = 2.16 p = 0.04	r_S = 0.39 t = 7.44 p < 0.01	r_S = 0.45 t = 4.97 p < 0.01	r_S = 0.55 t = 3.41 p < 0.01	r_S = 0.41 t = 10.20 p < 0.01
information management	r_S = 0.22 t = 1.74 p = 0.09	r_S = 0.39 t = 7.56 p < 0.01	r_S = 0.57 t = 6.91 p < 0.01	r_S = 0.50 t = 2.98 p = 0.01	r_S = 0.42 t = 10.37 p < 0.01
logistic activities	r_S = 0.26 t = 2.03 p = 0.05	r_S = 0.37 t = 7.05 p < 0.01	r_S = 0.43 t = 4.53 p < 0.01	r_S = 0.57 t = 3.56 p < 0.01	r_S = 0.39 t = 9.48 p < 0.01
Logistic costs share	r_S = 0.11 t = 0.84 p = 0.41	r_S = 0.22 t = 3.90 p < 0.01	r_S = 0.15 t = 1.45 p = 0.15	r_S = -0.14 t = -0.70 p = 0.49	r_S = 0.20 t = 4.36 p < 0.01

Source: own preparation

Assessing the relationship between the level of advancement of used IT solutions and market position of enterprises in terms of five areas of logistics activity, as well as in terms of logistics in general, it was found that the strength of this association increased with a higher and higher groups of the size of employment the enterprise. For example, the average aggregate assessment of market power in terms of logistics of $r_S = 0.26$ for micro to $r_S = 0.57$ for large enterprises. (see Table 3). Significantly stronger dependence was found in the areas of storage management ($r_S = 0.43$), transportation management ($r_S = 0.42$) and information management ($r_S = 0.41$) than in the areas of inventory management ($r_S = 0.35$) and the management of packaging and reverse logistics ($r_S = 0.34$). Taking into account individual, investigated sectors, conclusion is that there were significant differences between them in terms of the impact of used IT technologies and systems advancement level on the market position of enterprises in terms of five areas of logistics separately, as well as in terms of logistics in general. However, definitely strongest was the influence on fruit and vegetable, and dairy industries, whereas deciding the weakest in the cereal and starchy (see Table 4).

Table 4. Spearman correlation between the level of used IT solutions advancement, logistics solutions knowledge, market positions in term of five logistic activity areas, and in term of all logistic activities, share of logistic costs in total costs of company coefficients depending on the employment size (r_S – correlation coefficient, t – empirical value of test statistic, t_α – critical value of test statistic, α – significance level)

Sector $\alpha = 0.05$	Meat $t\alpha = \pm 1.98$	Fruits and Vegetables $t\alpha = \pm 2.04$	Milk $t\alpha = \pm 2.07$	Cereal and Starch $t\alpha = \pm 2.03$	Bakery $t\alpha = \pm 1.97$	Other Grocery $t\alpha = \pm 2.02$
Knowledge of logistics solutions	$r_S = 0.42$ $t = 4.96$ $p < 0.01$	$r_S = 0.14$ $t = 0.78$ $p = 0.22$	$r_S = 0.39$ $t = 1.99$ $p = 0.06$	$r_S = 0.31$ $t = 1.99$ $p = 0.05$	$r_S = 0.32$ $t = 4.87$ $p < 0.01$	$r_S = 0.27$ $t = 1.84$ $p = 0.07$
Market position in term of …						
inventory control	$r_S = 0.27$ $t = 3.05$ $p = 0.12$	$r_S = 0.66$ $t = 4.92$ $p < 0.01$	$r_S = 0.50$ $t = 2.68$ $p = 0.01$	$r_S = 0.12$ $t = 0.73$ $p = 0.47$	$r_S = 0.35$ $t = 5.45$ $p < 0.01$	$r_S = 0.41$ $t = 2.99$ $p < 0.01$
storage management	$r_S = 0.37$ $t = 4.30$ $p < 0.01$	$r_S = 0.74$ $t = 6.14$ $p < 0.01$	$r_S = 0.41$ $t = 2.10$ $p = 0.05$	$r_S = 0.28$ $t = 1.72$ $p = 0.09$	$r_S = 0.43$ $t = 6.86$ $p < 0.01$	$r_S = 0.47$ $t = 3.47$ $p < 0.01$
packaging management	$r_S = 0.38$ $t = 4.38$ $p < 0.01$	$r_S = 0.36$ $t = 2.15$ $p = 0.04$	$r_S = 0.44$ $t = 2.32$ $p = 0.03$	$r_S = 0.23$ $t = 1.44$ $p = 0.16$	$r_S = 0.33$ $t = 5.10$ $p < 0.01$	$r_S = 0.40$ $t = 2.88$ $p = 0.01$
transport management	$r_S = 0.37$ $t = 4.19$ $p < 0.01$	$r_S = 0.44$ $t = 2.72$ $p = 0.01$	$r_S = 0.59$ $t = 3.46$ $p < 0.01$	$r_S = 0.36$ $t = 2.33$ $p = 0.03$	$r_S = 0.38$ $t = 5.97$ $p < 0.01$	$r\mathbf{S} = 0.37$ $t = 2.58$ $p = 0.01$

Sector α = 0.05	Meat tα = ±1.98	Fruits and Vegetables tα = ±2.04	Milk tα = ±2.07	Cereal and Starch tα = ±2.03	Bakery tα = ±1.97	Other Grocery tα = ±2.02
information management	r_S = 0.43 t = 5.03 p < 0.01	r_S = 0.61 t = 4.31 p < 0.01	r_S = 0.34 t = 1.70 p = 0.10	r_S = 0.38 t = 2.46 p = 0.02	r_S = 0.40 t = 6.42 p < 0.01	r_S = 0.40 t = 2.83 p = 0.01
all logistic activities	r_S = 0.36 t = 4.10 p < 0.01	r_S = 0.64 t = 4.59 p < 0.01	r_S = 0.55 t = 2.96 p = 0.01	r_S = 0.10 t = 0.62 p = 0.54	r_S = 0.36 t = 5.56 p < 0.01	r_S = 0.45 t = 3.26 p < 0.01
Logistic costs share	r_S = 0.27 t = 2.92 p < 0.01	r_S = -0.15 t = -0.77 p = 0.45	r_S = -0.10 t = -0.44 p = 0.67	r_S = 0.01 t = 0.07 p = 0.94	r_S = 0.21 t = 2.98 p < 0.01	r_S = 0.36 t = 2.36 p = 0.02

Source: own preparation

Among all the surveyed companies declared level of knowledge in the field of logistics solutions reached the level of $\bar{x}$ = 3.50, or between equally often enough that insufficient knowledge and knowledge usually sufficient. Dispersion was ρ = 1.11, which accounted for 31.9% of the arithmetic average. With the exception of micro-enterprises, which are found the highest level of knowledge logistics declared $\bar{x}$ = 3.62, it increased slightly with the increase of the number of employees in the company since $\bar{x}$ = 3.43 in enterprises small to $\bar{x}$ = 3.55 in large enterprises. With increasing size of the company definitely decreased whereas dispersion of its values from s = 1.16 in the micro to s = 0.83 in large enterprises (see Table 1). The author believes declared the highest level of knowledge in the field of logistics, detected among micro-enterprises testifies rather to a lack of knowledge on modern logistics solutions than the real extensive knowledge in this field. An indirect confirmation of this interpretation are research results, according to which of micro-enterprises is by far the lowest level of complexity of the logistics and by far the lowest level of advancement of used logistic solutions [Jałowiecki et al. 2014]. Among the surveyed industries, by far the highest level of declared logistics expertise found among dairy enterprises $\bar{x}$ = 3.79, by far the lowest among enterprises meat $\bar{x}$ = 3.40 and bakeries $\bar{x}$ = 3.45 (see Table 2).

As in the case other variables studied, an increase in strength of the relationship between the level of advancement used IT solutions, and the claimed level of knowledge in the field of logistics with the increase of the number of employees in the company showed since r_S = 0.27 for micro to r_S = 0.64 for large enterprises (see Table 3). Among the sectors such dependence was statistically significant only among enterprises of meat (r_S = 0.42) and baking enterprises (r_S = 0.32). On the border of statistical significance, it was also found such relationships in the dairy industry (r_S = 0.39) and cereal and starchy (r_S = 0.31). The average strength of this relationship for all the companies was not too strong and was r_S = 0.32.

CONCLUSIONS

The results presented in the paper confirm the existence of the productivity paradox also in relation to the cost of logistics enterprises in the sector of food processing. A higher level of advancement of used IT solutions and, consequently, greater investment in implementation of modern technologies and IT systems do not translate into lower costs for the logistics. In the case of small enterprises on employment from 10 to 49 employees and in the industries of meat, bakery and other food products branches, it was quite a positive correlation between higher levels of advancement of used IT solutions, and the increase in logistics costs. The only exceptions, but statistically insignificant, was found in large enterprises employing 250 or more employees, and fruit and vegetable and dairy branches. This does not change the fact that a higher level of advancement used IT solutions results in better market position of companies in terms of logistics. The results confirm the results of previous research on the relationship between the advancement of IT technologies and systems, and the financial situation of enterprises [Jałowiecki and Gostkowski 2013].

It seems, therefore, that expenditures on modernization of existing and implementation of new IT solutions in the Polish sector of food production primarily brings about an immeasurable benefits, such as just a better position in the market. In addition, it is very likely that the use of modern IT technologies and systems is primarily the need for a more complex structure of logistics and can also affect the severity of applied logistics solutions. That does not mean that it must directly translate into better financial results or lower costs. These benefits are more long-term and their direct impact on the financial results can take place in a much longer time horizon. Of course, those theses need to be confirmed by empirical studies, however partial, unpublished results of previous studies conducted by the author, seem to indicate the validity of just such conclusions.

Given the close relationship between modern IT technologies and logistics systems, significant implementation costs of both modern IT systems, as well as e-logistics, results obtained in terms of strength of the relationship between the level of advancement of used IT solutions and the level of knowledge of logistics prove two things. Firstly, in smaller enterprises, much lower level of logistic knowledge seems to be the result of just the lack or limitations on the possibility of access to modern IT solutions. Second, in smaller enterprises rather traditional, "non-IT" approach to logistics activities is dominating. On the one hand it may be very large due to the financial capabilities of the other, in turn, no need for the use of modern, expensive and complex IT systems and e-logistics. Especially this last point should be clarified in relation to the sector of food processing in the near future.

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