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Article

Evaluation of the Impact of the Internet of Things on Postal Service Efficiency in Slovakia

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Abstract: This paper investigates the impact of technological advancements, particularly the integration of the Internet of Things (IoT), on the efficiency and productivity of the postal service industry in Slovakia. By employing the Cobb–Douglas production function, we analyze the relationship between key inputs—capital and labor—and output for six major postal service providers: Slovak Post, Packeta, DHL Express, DPD, TNT Express, and GLS. Using data from 2017 to 2021, this study quantifies the elasticities of capital and labor to assess how IoT adoption influences operational performance. The regression analysis reveals significant variations in input contributions across companies, highlighting the diverse effects of IoT integration. Findings suggest that while some companies benefit more from capital investments in technology, others rely heavily on labor efficiency. These insights offer valuable implications for policymakers and industry stakeholders aiming to optimize resource allocation and enhance productivity through technological innovation.

Keywords: Cobb–Douglas production function; Internet of Things; postal service efficiency; technological substitution; capital and labor elasticities; regression analysis



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1. Introduction

The postal service industry has long been a cornerstone of global communication and commerce. Historically, postal services were primarily responsible for the delivery of letters and parcels, serving as a critical link between individuals and businesses (Kováčiková et al. 2023). The origins of postal services date back to ancient civilizations, where systems of couriers and messengers were established to facilitate the exchange of information. Over time, these rudimentary systems evolved into more structured and reliable postal networks, becoming integral to the social and economic fabric of nations.

In the modern era, the postal service industry has expanded its scope far beyond traditional mail delivery. With the advent of the internet and e-commerce, postal services now play a vital role in the logistics and distribution of goods. The rise of online shopping has led to a significant increase in parcel volumes, compelling postal service providers to adapt to new demands and expectations. This shift has transformed postal services into multifaceted operations that encompass mail, parcel delivery, and a range of ancillary services, including financial services and digital communication solutions (Vial 2021).

Efficiency is a critical factor in the success and sustainability of the postal service industry. Efficient postal operations ensure that mail and parcels are delivered accurately and timely, which is essential for customer satisfaction and trust (Strenitzerova 2023). As the volume of parcels continues to grow due to the rise of e-commerce, postal service providers must optimize their processes to handle increased demand without compromising service quality. Efficiency in sorting, routing, and delivery can significantly reduce operational costs and improve the overall performance of postal services (Jucha and Corejova 2023).

Technological advancements have been at the forefront of the postal service industry's evolution. The introduction of automation and digital technologies has revolutionized

various aspects of postal operations, from sorting and tracking to customer service and delivery. Automation in sorting centers has significantly increased efficiency, enabling the rapid processing of large volumes of mail and parcels. Additionally, the implementation of advanced tracking systems has enhanced transparency and reliability, allowing customers to monitor their shipments in real-time.

The Internet of Things (IoT) represents a transformative technology for the postal service industry. IoT devices and sensors can be embedded in parcels, vehicles, and infrastructure to provide real-time data on location, condition, and environmental factors (Novák et al. 2024). This data enables postal service providers to monitor the status of shipments throughout the delivery process, ensuring that parcels are handled properly and delivered on time. IoT technology enhances transparency and accountability, allowing customers to track their shipments and receive notifications about delivery status.

Big data analytics is another technological advancement that significantly boosts efficiency in the postal service industry. By analyzing vast amounts of data collected from various sources, postal service providers can gain valuable insights into operational performance, customer behavior, and market trends (Janoskova et al. 2021). These insights can be used to optimize routes, predict demand, and improve resource allocation. For instance, data analytics can help identify peak delivery times and areas with high delivery volumes, enabling more efficient scheduling and routing of delivery vehicles.

The integration of artificial intelligence (AI) and machine learning (ML) into postal operations further enhances efficiency. AI and ML algorithms can analyze historical data to predict delivery times, identify patterns, and optimize processes. For example, AI-powered systems can optimize route planning by considering factors such as traffic conditions, weather, and delivery priorities (Karimi and Walter 2015). This leads to faster and more reliable deliveries, reducing fuel consumption and operational costs. Additionally, AI can be used to automate customer service interactions, providing instant responses to common inquiries and freeing up human agents for more complex issues.

Technological advancements also contribute to improving the sustainability of postal operations (Baláž et al. 2023). Electric delivery vehicles, for instance, offer a greener alternative to traditional fuel-powered vehicles, reducing carbon emissions and operational costs. Advanced route optimization software can minimize the distance traveled and fuel consumption, further enhancing environmental sustainability. Additionally, the use of sustainable packaging materials and practices helps reduce the environmental impact of postal services. These initiatives not only align with global sustainability goals but also enhance the public image of postal service providers as responsible and forward-thinking organizations. The adoption of digital technologies has also transformed customer interactions and service delivery in the postal service industry. Online platforms and mobile applications allow customers to easily access postal services, track shipments, and manage deliveries. Digital communication tools, such as email and SMS notifications, keep customers informed about the status of their parcels. These advancements improve the customer experience, increasing convenience and satisfaction. Moreover, digital technologies enable postal service providers to offer value-added services, such as flexible delivery options and secure digital mailboxes.

This paper aims to explore the application of Cobb–Douglas production functions to assess the impact of IoT on the efficiency of postal services in Slovakia, with a focus on identifying how technological innovations can influence production processes and performance metrics.

2. Literature Review

Production functions are fundamental tools in microeconomics, used to describe the relationship between input factors and the output produced by a firm. Essentially, a production function specifies the maximum quantity of output that can be obtained from a given set of inputs, assuming efficient use of resources (Li et al. 2022). The primary inputs in production are typically labor, capital, and sometimes raw materials. Understanding

this relationship helps economists and business managers make informed decisions about resource allocation, production techniques, and overall operational efficiency.

Microeconomic theory emphasizes that production functions can vary depending on the nature of the production process and the technology used (Praveen et al. 2019). These functions are critical for analyzing the efficiency and productivity of firms, as they provide insights into how different combinations of inputs affect output levels. By examining production functions, economists can determine the marginal products of each input, which indicate the additional output generated by using an extra unit of a particular input while holding other inputs constant. This analysis is crucial for optimizing production processes and improving economic efficiency.

The Cobb–Douglas production function is one of the most widely used forms of production functions in microeconomics due to its simplicity and empirical robustness (Zhang et al. 2017). Developed by economist Paul Douglas and mathematician Charles Cobb in the 1920s, this function represents a specific form of the relationship between inputs and output where the output elasticity of each input is constant (Cobb and Douglas 1928). This means that the proportional change in output resulting from a proportional change in one of the inputs is always the same, regardless of the level of inputs used.

The Cobb–Douglas production function has several appealing properties. It assumes that returns to scale can be constant, increasing, or decreasing, depending on the specific context. If the sum of the output elasticities of labor and capital equals one, the function exhibits constant returns to scale, meaning that doubling all inputs will double the output. If the sum is greater than one, there are increasing returns to scale, while a sum less than one indicates decreasing returns to scale. This flexibility makes the Cobb–Douglas function a valuable tool for analyzing production processes in various industries.

Technological substitution refers to the process of replacing one type of input with another while maintaining or increasing the level of output (Thiam et al. 2001). In the context of production functions, this concept is crucial for understanding how technological advancements can improve efficiency and productivity (Heun et al. 2017). For example, a firm might replace labor with automated machinery, thereby increasing output while reducing labor costs, but on the other hand, it must acquire the highest quality and most efficient experts (Strenitzerova 2016). The ability to substitute between inputs allows firms to adapt to changing economic conditions and technological innovations.

The Cobb–Douglas production function accommodates technological substitution by allowing changes in the output elasticities of capital and labor. As technology evolves, the relative importance of different inputs can shift, leading to changes in these elasticities. This dynamic aspect of the Cobb–Douglas function makes it particularly useful for analyzing the impact of technological changes on production processes (Antras 2004). Companies can use this analysis to make strategic decisions about investments in new technologies and the optimal mix of inputs.

The IoT is a technological advancement that has profound implications for production processes across various industries. IoT involves the use of interconnected devices and sensors that collect and exchange data in real time. In the context of production, IoT can enhance efficiency, reduce costs, and improve overall productivity by providing valuable insights into the performance and condition of machinery, inventory levels, and other critical parameters.

For example, IoT sensors can monitor the operational status of equipment, predicting maintenance needs before breakdowns occur and thus minimizing downtime. Additionally, IoT-enabled devices can optimize supply chain management by providing real-time data on inventory levels, shipment status, and demand patterns. This real-time visibility allows firms to make more informed decisions, improve resource allocation, and respond swiftly to changes in market conditions. Integrating IoT into production functions represents a form of technological substitution that enhances the effectiveness of traditional inputs like labor and capital.

Empirical studies often use the Cobb–Douglas production function to quantify the impact of IoT on production efficiency (Li et al. 2019). By incorporating IoT-related variables into the production function, researchers can assess how the adoption of IoT technologies affects the output elasticities of capital and labor. For instance, an increase in capital productivity due to IoT investments might be reflected in a higher importance of capital, while improvements in labor efficiency through IoT-enabled automation could lead to changes in the contribution of labor (Gajdzik and Gawlik 2017).

These empirical applications provide valuable insights for policymakers and business leaders. By understanding the specific impacts of IoT on production processes, firms can make targeted investments in technology that yield the highest returns. Additionally, policymakers can design supportive frameworks that encourage the adoption of IoT, thereby boosting overall economic productivity and competitiveness. The integration of IoT into the Cobb–Douglas production function thus serves as a powerful tool for both strategic decision-making and economic analysis.

3. Methodology

The aim of this paper is to investigate the impact of technological advancements, specifically the integration of the IoT, on the efficiency and productivity of the postal service industry in Slovakia. By applying the Cobb–Douglas production function, this paper seeks to quantify how IoT adoption influences the relationship between labor, capital, and output within this sector. This research aims to provide empirical evidence on the effectiveness of IoT in enhancing operational performance, offering valuable insights for both policymakers and industry stakeholders. Ultimately, this paper endeavors to contribute to the broader understanding of technological substitution in production processes and to guide strategic decision-making in the context of digital transformation.

The hypotheses for this research are the following:

Hypothesis 1: *The integration of IoT increases the efficiency of capital utilization.*

Hypothesis 2: *IoT adoption positively affects labor productivity.*

3.1. Description of Data Sources

The data collection process for this research involved gathering comprehensive financial and operational data from six major postal service providers in Slovakia: Slovak Post, Packeta, DHL Express, DPD, TNT Express, and GLS. These companies were selected due to their significant presence in the Slovak postal market and their diverse operational strategies, which provide a robust basis for comparative analysis. The primary data sources include annual financial reports and publicly available records from the companies, which were accessed through the FinStat portal (Appendix A—Table A1). This portal aggregates financial statements and other relevant business data, ensuring the reliability and accuracy of the information used in this study.

The postal service providers analyzed in this paper each play a vital role in the logistics and postal sectors in Slovakia. Slovak Post, the national postal operator, offers a wide range of services, including mail delivery, parcel shipping, and financial services, maintaining a broad network across the country. Packeta, a rapidly growing logistics company, specializes in e-commerce solutions and efficient parcel delivery services. DHL Express and DPD, both global logistics giants, provide extensive international and domestic shipping services. TNT Express, now part of FedEx, focuses on express delivery services, while GLS offers comprehensive logistics and parcel delivery solutions. Analyzing these diverse companies allows for a comprehensive assessment of how different operational models and scales influence the impact of IoT integration on efficiency.

This paper covers a period from 2017 to 2021, a span of five years during which the adoption of IoT technologies has accelerated significantly. This period allows for the observation of both pre- and post-IoT integration effects within the companies' operations.

Data points include non-current assets representing capital input, personnel expenses representing labor input, and revenues representing output. By examining these variables over this extended timeframe, this study aims to capture the evolving impact of technological advancements on the postal service industry, providing a dynamic view of how IoT integration affects productivity and efficiency over time.

3.2. Variables

The three primary variables are used to analyze the efficiency and productivity of the selected postal service providers: capital, labor, and output. The non-current assets of the companies, which include long-term investments such as property, equipment, and technology infrastructure, represent capital. These assets are essential for sustaining and expanding operational capabilities. Labor is quantified through personnel expenses, encompassing wages, salaries, and other employee-related costs. This variable reflects the human resources required to operate and manage postal services effectively. The revenues generated from the companies' operational activities, providing a direct indicator of their productivity and market performance, measure output.

To facilitate a more rigorous analysis, the data for these variables were transformed into logarithmic form (Appendix A—Table A2). This transformation serves several purposes: it helps normalize the data, reducing the impact of extreme values and skewed distributions, and it simplifies the interpretation of the regression coefficients by converting multiplicative relationships into additive ones. In the context of the Cobb–Douglas production function, using logarithmic values allows for the estimation of elasticities, which indicate the percentage change in output resulting from a one percent change in either capital or labor (Kleyn et al. 2017). This approach provides clearer insights into the relative importance of each input in the production process.

The logarithmic transformation of the data involved calculating the natural logarithms of the values for capital, labor, and output for each company across the five-year period from 2017 to 2021. By doing so, this study ensures that the regression analysis yields more accurate and interpretable results. This transformation is particularly useful in handling the wide range of values present in the financial data of different companies, ensuring that the analysis is robust and comparable across the various postal service providers.

3.3. Cobb–Douglas Production Function

The Cobb–Douglas production function is a fundamental model used in microeconomics to represent the relationship between inputs and outputs in a production process. Mathematically, it is expressed as

$$Y = A \cdot K^{\alpha} \cdot L^{\beta}, \quad (1)$$

where Y represents the total output, A is a constant representing total factor productivity, K is the input of capital, L is the input of labor, and α and β are the output elasticities of capital and labor, respectively (Cobb and Douglas 1928). These elasticities measure the responsiveness of output to changes in the respective inputs, indicating the percentage change in output resulting from a one percent change in either capital or labor.

The Cobb–Douglas production function operates under several key assumptions that make it particularly useful for empirical analysis. One of the primary assumptions is that the function can exhibit different returns to scale. If $\alpha + \beta = 1$, the function demonstrates constant returns to scale, meaning that doubling all inputs will result in a doubling of output. If $\alpha + \beta > 1$, there are increasing returns to scale, indicating that output increases more than proportionally to the increase in inputs. Conversely, if $\alpha + \beta < 1$, it signifies decreasing returns to scale, where output increases less than proportionally to the increase in inputs. These properties allow the Cobb–Douglas function to flexibly model different production scenarios across various industries.

The flexibility of the Cobb–Douglas production function also extends to its ability to incorporate technological substitution. Technological substitution refers to the process of

replacing one type of input with another while maintaining or increasing the level of output (Costa et al. 2015). As technology evolves, the relative importance of different inputs can shift, leading to changes in the elasticities α and β . This dynamic aspect makes the Cobb–Douglas function particularly useful for analyzing the impact of technological changes on production processes. For instance, the integration of the IoT into postal services can optimize the use of both labor and capital by providing real-time data and automation, thereby shifting the production function's parameters to reflect these efficiencies. By applying the Cobb–Douglas production function, this study aims to quantify the impact of IoT adoption on the productivity of these companies, offering insights into how technological advancements can drive efficiency in the postal service industry.

3.4. Regression Analysis

Regression analysis is utilized to estimate the coefficients of the Cobb–Douglas production function, aiming to quantify the impact of capital and labor on output for the selected postal service providers (Arkes 2023). The least squares method is employed for this purpose, which is a standard approach in econometrics for fitting a regression line to a set of data points (Biddle 2011). This method works by minimizing the sum of the squared differences between the observed values and the values predicted by the model, thereby finding the optimal coefficients that best represent the relationship between the dependent variable (output) and the independent variables (capital and labor).

The regression analysis is conducted using Microsoft Excel, a widely accessible and powerful tool for statistical analysis. Excel's regression analysis capabilities are utilized to transform the Cobb–Douglas production function into its linear logarithmic form, simplifying the estimation of coefficients. This transformation involves taking the natural logarithm of the production function, which linearizes the equation and allows for the application of linear regression techniques. Excel's built-in functions for linear regression are then used to estimate the elasticities of capital and labor, providing a clear understanding of their contributions to the overall production output.

Using Excel for this analysis offers several advantages, including ease of use, accessibility, and the ability to handle large datasets efficiently. Excel's data analysis toolpak includes a regression tool that simplifies the process of performing least squares regression. By inputting the logarithmic transformed data for capital, labor, and output, the regression tool calculates the coefficients, standard errors, t-statistics, and p -values, which are essential for interpreting the results. This approach ensures that the analysis is straightforward and reproducible, making it an ideal choice for conducting the regression analysis required for this paper.

4. Results

4.1. Main Results from Regression Analysis

The regression analysis conducted in this study provided insightful results regarding the impact of capital and labor on the output of the six selected postal service providers in Slovakia: Slovak Post, Packeta, DHL Express, DPD, TNT Express, and GLS. Using the Cobb–Douglas production function, the analysis revealed the elasticities of capital and labor for each company, offering a clear picture of how these inputs contribute to the overall production process.

The main findings indicate that the elasticities of capital and labor vary significantly among the companies. For instance, Slovak Post exhibited a balanced contribution of both capital and labor to its output, suggesting efficient utilization of resources across its operations. In contrast, Packeta showed a higher elasticity for labor, highlighting the labor-intensive nature of its operations, possibly due to its focus on e-commerce logistics, which often requires significant human intervention for handling and delivery processes.

On the other hand, DHL Express and DPD demonstrated relatively high elasticities for capital, indicating that investments in technology and infrastructure play a critical role in their production processes. This is consistent with their global operational strategies

that emphasize automation and advanced logistics solutions. TNT Express and GLS, while also showing significant capital contributions, had distinct patterns reflecting their unique business models and market strategies. Overall, the results underscore the diverse approaches to production within the postal service industry and highlight the importance of aligning resource allocation with strategic objectives to enhance efficiency and productivity.

4.1.1. Slovak Post

The Slovak Post is a provider of postal services in Slovakia with a long-standing tradition and is currently the sole provider of universal postal service (Slovak Post 2023). This position allows the company to carry out a wide range of activities and provide services nationwide. In addition to traditional postal services such as the delivery of letters and parcels, it also offers modern services. Figure 1 presents the results of the regression analysis for Slovak Post.

SUMMARY OUTPUT for Slovak Post					RESIDUAL OUTPUT			
Regression Statistics					Observation	Predicted ln(Y)	Residuals	
Multiple R	0.97156917				1	19.63626896	0.011692831	
R Square	0.943946652				2	19.65497449	-0.013617226	
Adjusted R Square	0.887893304				3	19.66414853	0.004750586	
Standard Error	0.013486089				4	19.58818655	-0.004155018	
Observations	5				5	19.57793921	0.001328827	
ANOVA								
	df	SS	MS	F	Significance F			
Regression	2	0.00612559	0.003062795	16.84014761	0.056053348			
Residual	2	0.000363749	0.000181875					
Total	4	0.006489339						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	8.680582928	1.894241455	4.582616911	0.044466167	0.530319759	16.8308461	0.530319759	16.8308461
ln(K)	0.268608401	0.112186455	2.394303303	0.138978666	-0.214090958	0.75130776	-0.214090958	0.75130776
ln(L)	0.300275624	0.125018425	2.40185095	0.138279106	-0.237635245	0.838186492	-0.237635245	0.838186492

Figure 1. Regression analysis—Slovak Post.

Based on the regression results for Slovak Post, it can be assessed that the model estimates approximately 94.4% of the variability in output, with a correlation coefficient $R = 0.9716$. The ANOVA test showed that the model is statistically significant at the 0.056 significance level. The coefficients α and β obtained from this calculation provide information about the elasticity of output concerning capital and labor inputs. Practically, they indicate the percentage change in output if the given input increases by 1%, assuming the other input remains constant. Specifically, the estimated coefficient for $\ln(K)$ is 0.269 ($p = 0.139$), and for $\ln(L)$, it is 0.300 ($p = 0.138$).

The results also show that the residuals for all observed years are relatively small and close to zero, which is a good sign. This indicates that the model explains the data well and is suitable for analyzing the output of Slovak Post based on capital and labor inputs. However, it is important to consider that the p -values for the coefficients are higher than the standard significance level of 0.05, indicating that the coefficients are not statistically significant. This may be due to the limited number of observations available for analysis.

4.1.2. Packeta

Packeta is an international logistics company with a strong presence in Slovakia. With its competitive prices and efficient parcel delivery solutions, it is an important player in the postal services market. Packeta offers not only traditional parcel and letter shipping but also innovative services such as online shipment tracking and solutions for e-shops (Packeta 2023). It covers extensive geographical areas in its operations, enabling it to provide services nationwide. The regression analysis for Packeta is shown in Figure 2.

SUMMARY OUTPUT for Packeta					RESIDUAL OUTPUT			
Regression Statistics					Observation	Predicted ln(Y)	Residuals	
Multiple R	0.997900016				1	17.45733936	0.042660636	
R Square	0.995804441				2	16.83265336	-0.002653362	
Adjusted R Square	0.991608882				3	16.04946288	-0.039462876	
Standard Error	0.097973301				4	15.43919098	-0.089190978	
Observations	5				5	14.78135342	0.08864658	
ANOVA								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	2	4.556482465	2.278241232	237.3472614	0.004195559			
Residual	2	0.019197535	0.009598768					
Total	4	4.57568						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.854610695	1.259023736	0.67878839	0.56728661	-4.562531218	6.271752607	-4.562531218	6.271752607
ln(K)	-0.077096642	0.054731241	-1.408640495	0.294290612	-0.312586165	0.158392881	-0.312586165	0.158392881
ln(L)	1.142880074	0.13367811	8.549493079	0.013406541	0.56770959	1.718050558	0.56770959	1.718050558

Figure 2. Regression analysis—Packeta.

According to the regression analysis results for Packeta, the model has high accuracy, explaining approximately 99.6% of the variability in output. With a correlation coefficient $R = 0.998$, there is a strong linear relationship between the inputs and the output. The ANOVA test confirmed the statistical significance of the model with a p -value of 0.0042. The coefficients α and β obtained using this model provide details about the elasticity of output with respect to capital and labor inputs. The specific values are as follows: the coefficient for $\ln(K)$ is -0.077 with a p -value of 0.294, and the coefficient for $\ln(L)$ is 1.143 with a p -value of 0.0134. From these results, it can be concluded that the model is very accurate, as the residuals for all years are low. However, it should be noted that the coefficient for $\ln(K)$ is negative, and its p -value exceeds the common significance threshold of 0.05, indicating that this coefficient may not be statistically significant. This could be due to the limited number of observations, or it might suggest that capital input does not have a significant impact on Packeta’s output. Conversely, the coefficient for $\ln(L)$ is statistically significant and positive, indicating that output increases with an increase in labor input.

4.1.3. DHL Express

DHL Express is a global leader in logistics and express deliveries. Its operations extend to Slovakia, where it provides a wide range of postal and logistics services. In addition to delivering letters and parcels, DHL Express offers advanced solutions in warehousing and goods processing (DHL Express 2023). Its services are available regardless of geographical location, ensuring accessibility for all population groups in the country. The results of the regression analysis for DHL Express are shown in Figure 3.

SUMMARY OUTPUT for DHL Express					RESIDUAL OUTPUT			
Regression Statistics					Observation	Predicted ln(Y)	Residuals	
Multiple R	0.657289222				1	17.73289999	-0.342899986	
R Square	0.432029121				2	18.16696918	0.113030817	
Adjusted R Square	-0.135941757				3	18.38493331	-0.214933308	
Standard Error	0.402445743				4	18.08323911	0.066760888	
Observations	5				5	17.91195841	0.378041589	
ANOVA								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	2	0.246394848	0.123197424	0.760653649	0.567970879			
Residual	2	0.323925152	0.161962576					
Total	4	0.57032						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	-8.061879143	35.43451638	-0.227514863	0.841165012	-160.5242978	144.4005395	-160.5242978	144.4005395
ln(K)	-0.875847816	0.8405334	-1.042014292	0.406814911	-4.492371144	2.740675512	-4.492371144	2.740675512
ln(L)	2.433100334	2.407995004	1.010425823	0.4186577	-7.927665943	12.79386661	-7.927665943	12.79386661

Figure 3. Regression analysis—DHL Express.

The regression analysis for DHL Express revealed that the model explains approximately 43.2% of the variability in output, with a correlation coefficient R of 0.6573. However,

this model did not pass the ANOVA test for statistical significance, with a p -value of 0.568, indicating that the model may not be suitable for interpreting these data. The values of the coefficients α and β suggest how output changes in response to a 1% change in capital or labor input, assuming other inputs remain constant. In this case, the coefficient for $\ln(K)$ is -0.876 ($p = 0.407$), and for $\ln(L)$, it is 2.433 ($p = 0.419$). The residuals for all observations are not negligible, suggesting that the model may not accurately explain the output for DHL Express. Additionally, the coefficients for $\ln(K)$ and $\ln(L)$ have p -values higher than 0.05, meaning these coefficients are not statistically significant.

4.1.4. DPD

DPD is a European courier company with a significant presence in Slovakia. It offers fast and reliable parcel delivery, both within Slovakia and internationally. DPD utilizes the latest technologies to provide its services as efficiently and accessibly as possible for all residents (DPD 2023). The regression analysis for DPD is presented in Figure 4.

SUMMARY OUTPUT for DPD						RESIDUAL OUTPUT			
Regression Statistics						Observation	Predicted $\ln(Y)$	Residuals	
Multiple R	0.996020409					1	17.96521169	0.034788305	
R Square	0.992056655					2	17.79874634	-0.048746342	
Adjusted R Square	0.98411331					3	17.27105593	0.00894407	
Standard Error	0.050246521					4	17.17131643	0.028683569	
Observations	5					5	17.0836696	-0.023669602	
ANOVA									
		df	SS	MS	F	Significance F			
Regression		2	0.630630574	0.315315287	124.8915458	0.007943345			
Residual		2	0.005049426	0.002524713					
Total		4	0.63568						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%	
Intercept	0.337895436	1.288536552	0.262231937	0.817681835	-5.206229877	5.88202075	-5.206229877	5.88202075	
$\ln(K)$	-0.012514994	0.037385701	-0.334753488	0.769658604	-0.173372682	0.148342694	-0.173372682	0.148342694	
$\ln(L)$	1.120615346	0.110090625	10.17902608	0.009513826	0.646933616	1.594297075	0.646933616	1.594297075	

Figure 4. Regression analysis—DPD.

In the case of DPD, the regression model successfully explains approximately 99.2% of the variability in output, with a correlation coefficient $R = 0.996$. The ANOVA test confirmed that the model is statistically significant ($p < 0.01$). The estimated coefficients suggest that the output would change by -0.0125% with a 1% increase in capital, assuming labor remains constant ($p = 0.77$). On the other hand, the output would increase by 1.12% with a 1% increase in labor, assuming capital remains constant ($p < 0.01$). Examining the residuals shows that for most observations, these values are close to zero, indicating a high accuracy of the model. However, it is important to emphasize that the p -value for the coefficient for $\ln(K)$ is greater than 0.05, indicating that the coefficient is not statistically significant and its interpretation might be uncertain.

4.1.5. TNT Express

TNT Express, now part of the FedEx group, is a significant global player in delivery and logistics, with a strong presence in Slovakia (TNT Express 2023). The company offers a wide range of services, including fast parcel delivery, express postal services, and comprehensive logistics solutions for businesses. The regression analysis for TNT Express is shown in Figure 5.

For TNT Express, the regression model can explain nearly 96.8% of the variability in output, with a correlation coefficient $R = 0.984$. The ANOVA test indicates that this model is statistically significant ($p < 0.05$). From the estimated coefficients α and β , it can be inferred that if capital increases by 1% while labor remains constant, the output changes by -3.21% ($p < 0.05$). When labor increases by 1% with constant capital, the output changes by -0.10% ($p = 0.65$). Looking at the residuals, it can be assessed that the values are generally small and close to zero, which means the model is quite accurate. However, it is important to

note that the coefficient for $\ln(L)$ is not statistically significant, as its p -value is higher than 0.05. This indicates that the effect of labor on output is uncertain according to this model.

SUMMARY OUTPUT for TNT Express					RESIDUAL OUTPUT			
Regression Statistics					Observation	Predicted $\ln(Y)$	Residuals	
Multiple R	0.984093607				1	17.86719364	0.002806358	
R Square	0.968440228				2	17.6911711	-0.001171101	
Adjusted R Square	0.936880456				3	17.67251156	-0.022511559	
Standard Error	0.038201098				4	17.55651098	0.043489023	
Observations	5				5	17.47261272	-0.022612721	
ANOVA								
	df	SS	MS	F	Significance F			
Regression	2	0.089561352	0.044780676	30.68590686	0.031559772			
Residual	2	0.002918648	0.001459324					
Total	4	0.09248						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	70.00628842	11.09274996	6.310994899	0.024199872	22.27803752	117.7345393	22.27803752	117.7345393
$\ln(K)$	-3.210232699	0.549855627	-5.838319263	0.02810659	-5.576070513	-0.844394885	-5.576070513	-0.844394885
$\ln(L)$	-0.103406044	0.197217994	-0.524323577	0.652370376	-0.951966582	0.745154494	-0.951966582	0.745154494

Figure 5. Regression analysis—TNT Express.

4.1.6. GLS

GLS is an international postal and logistics company with a strong presence in Slovakia. The company provides a wide range of postal and courier services, including parcel delivery and express shipments, as well as logistics solutions (GLS 2023). The regression analysis for GLS is presented in Figure 6.

SUMMARY OUTPUT for GLS					RESIDUAL OUTPUT			
Regression Statistics					Observation	Predicted $\ln(Y)$	Residuals	
Multiple R	0.988401961				1	17.93977286	-0.029772856	
R Square	0.976938436				2	17.7285091	0.0914909	
Adjusted R Square	0.953876873				3	17.44734702	-0.067347022	
Standard Error	0.090167198				4	17.16219819	-0.032198191	
Observations	5				5	16.91217283	0.037827169	
ANOVA								
	df	SS	MS	F	Significance F			
Regression	2	0.688819753	0.344409876	42.36219403	0.023061564			
Residual	2	0.016260247	0.008130124					
Total	4	0.70508						
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.054329503	1.93741698	0.028042236	0.980175042	-8.281702954	8.39036196	-8.281702954	8.39036196
$\ln(K)$	0.048170813	0.140868413	0.341956102	0.764973572	-0.557937048	0.654278674	-0.557937048	0.654278674
$\ln(L)$	1.13866849	0.219979076	5.176258186	0.035354864	0.192174921	2.08516206	0.192174921	2.08516206

Figure 6. Regression analysis—GLS.

For GLS, the regression model explains approximately 97.7% of the variability in output, with a correlation coefficient R of 0.988. The model is statistically significant according to the ANOVA test ($p < 0.05$). The estimated coefficients indicate that with a 1% increase in capital, while labor remains constant, the output increases by approximately 0.048% ($p = 0.76$), which is statistically insignificant. If labor increases by 1% and capital remains constant, the output increases by 1.14% ($p < 0.05$). The residuals are close to zero and relatively small, indicating that the model is accurate. However, the coefficient for $\ln(K)$ is statistically insignificant (p -value > 0.05), meaning that the effect of capital on output is uncertain in this model.

4.2. Predicted vs. Actual Outputs

Estimating returns is a crucial part of the analysis. In practice, the values of the coefficients α and β are used to estimate returns. Using these coefficients, it is possible to calculate the estimated returns for individual companies and years. When calculating estimated returns, it is important to realize that there are other factors that may influence the results. These factors can include management efficiency, technological innovations, changes in

market supply and demand, or various external circumstances such as legislative changes or macroeconomic conditions; the Cobb–Douglas function does not directly account for these factors. Returns can be estimated according to the following equation:

$$Y' = A \cdot K^{\alpha} \cdot L^{\beta}, \quad (2)$$

where Y' is the estimated output (returns), A is a constant corresponding to the level of technological efficiency, K is the capital, L is the labor, and α and β are the regression coefficients obtained from the analysis (Biddle 2011, Cobb and Douglas 1928).

In this case, the value of A is the antilog of the intercept in the regression equation, K is the amount of non-current assets, L is the level of personnel expenses, and the values for the coefficients α and β are provided for individual companies based on the regression results. The estimated returns for individual companies and years are shown in Table 1.

Table 1. Estimated returns for individual companies and years.

Company	Year	Actual Returns	Estimated Returns	Difference
Slovak Post	2021	341,194,000	337,227,710	3,966,290
	2020	338,948,000	343,595,100	−4,647,100
	2019	348,413,000	346,761,759	1,651,241
	2018	320,064,000	321,396,638	−1,332,638
	2017	318,543,000	318,119,993	423,007
Packeta	2021	39,777,235	38,108,529	1,668,706
	2020	20,420,874	20,325,418	95,456
	2019	8,998,933	9,377,460	−378,527
	2018	4,647,155	5,094,021	−446,866
	2017	2,866,928	2,624,219	242,709
DHL Express	2021	35,808,143	50,888,992	−15,080,849
	2020	87,060,327	77,568,208	9,492,119
	2019	77,544,541	96,906,044	−19,361,503
	2018	76,027,595	71,496,348	4,531,247
	2017	87,485,110	59,656,646	27,828,464
DPD	2021	65,826,208	63,293,988	2,532,220
	2020	51,163,766	53,633,933	−2,470,167
	2019	32,107,982	31,614,113	493,869
	2018	29,610,324	28,566,127	1,044,197
	2017	25,744,127	26,312,276	−568,149
TNT Express	2021	57,748,742	56,772,749	975,993
	2020	48,109,052	48,481,458	−372,406
	2019	46,130,919	47,327,992	−1,197,073
	2018	44,033,149	41,950,541	2,082,608
	2017	37,697,094	39,057,028	−1,359,934
GLS	2021	59,725,749	61,766,217	−2,040,468
	2020	54,924,546	49,862,648	5,061,898
	2019	35,270,079	37,574,976	−2,304,897
	2018	27,553,650	28,319,161	−765,511
	2017	22,945,078	22,229,515	715,563

From Table 1, it is evident that there are differences between the estimated and actual returns for individual companies. For example, in the case of Slovak Post in 2020, the estimated returns exceeded the actual returns by more than EUR 4 million, while in 2021, the estimated returns were lower than the actual returns by nearly EUR 4 million. DHL Express in 2021 recorded actual returns lower by EUR 15 million compared to the estimated returns, whereas in 2020, the actual returns were higher by almost EUR 10 million.

The differences between actual and estimated returns can be attributed to various factors not directly included in the Cobb–Douglas function. To better understand the

dynamics of estimated and actual company returns, a graphical representation of the results is provided. The findings are shown in Figure 7.

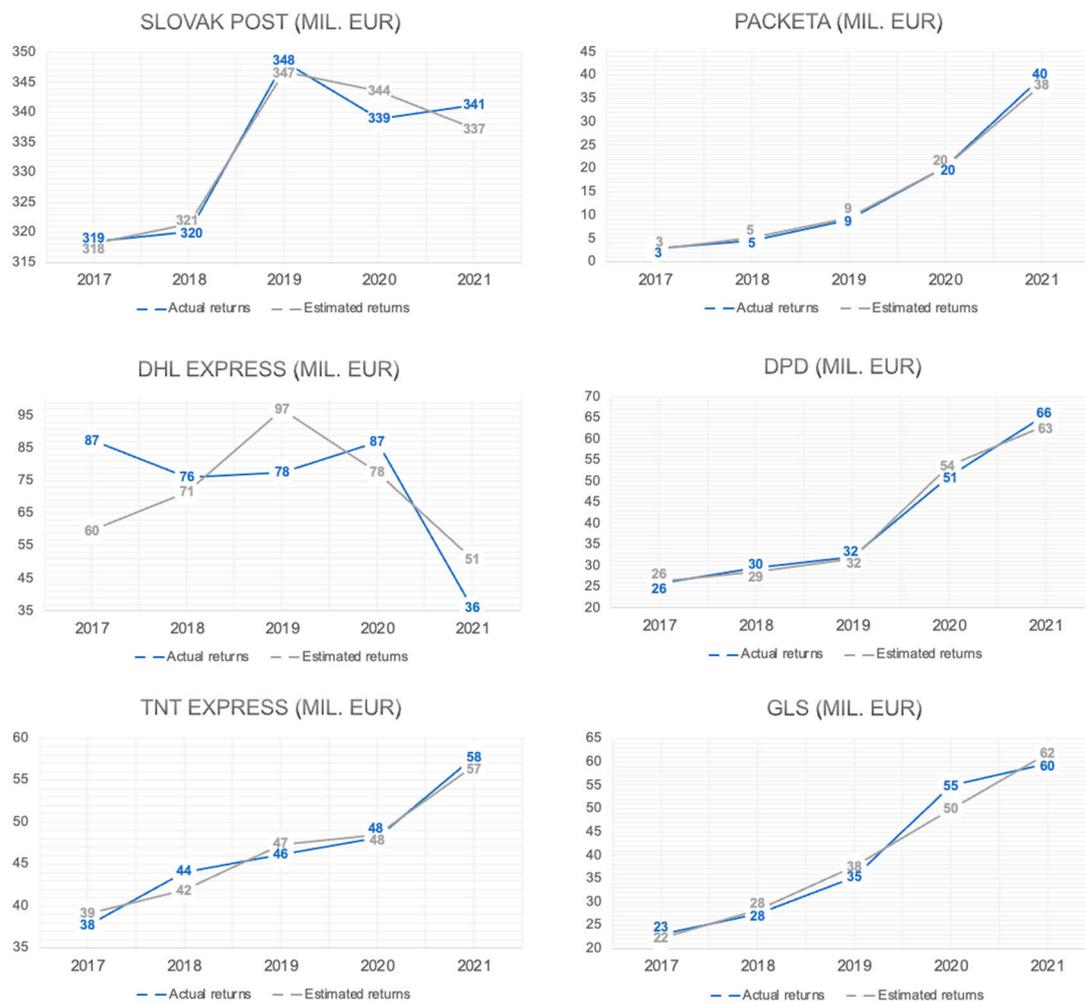


Figure 7. Graphical representation of actual and estimated returns of the analyzed companies.

Based on the data in Figure 7, Slovak Post exhibits consistent development with minimal deviations between actual and estimated returns. Its actual and estimated returns were relatively close to each other from 2017 to 2021, with estimated returns slightly exceeding actual returns in 2020. Packeta experienced a significant increase in actual returns from 2017 to 2021. Although estimated returns were slightly lower, a growth trend was still observed. For DHL Express, estimated returns were higher than actual returns in 2017 and 2021, while the opposite was true for 2018 and 2020. DPD showed slight deviations between actual and estimated returns, but overall, the growth trend was consistent. TNT Express exhibited returns with slightly variable deviations between actual and estimated returns. However, overall, actual returns were very close to the estimated values. GLS demonstrated a consistent upward trend with slightly variable deviations between actual and estimated returns. In 2017 and 2020, actual returns were higher than estimated, whereas in 2018, 2019, and 2021, the opposite was true.

4.3. Percentage Deviation

Text percentage deviation is an important metric that allows quantifying the difference between estimated and actual returns. It is a relative expression of deviation that enables comparison of estimation accuracy across different datasets or models. To calculate it, one must first subtract the estimated value from the actual value. The resulting difference is

then divided by the actual value, and the result is multiplied by 100. An overview of the percentage deviations for the analyzed companies from 2017 to 2021 is shown in Figure 8.

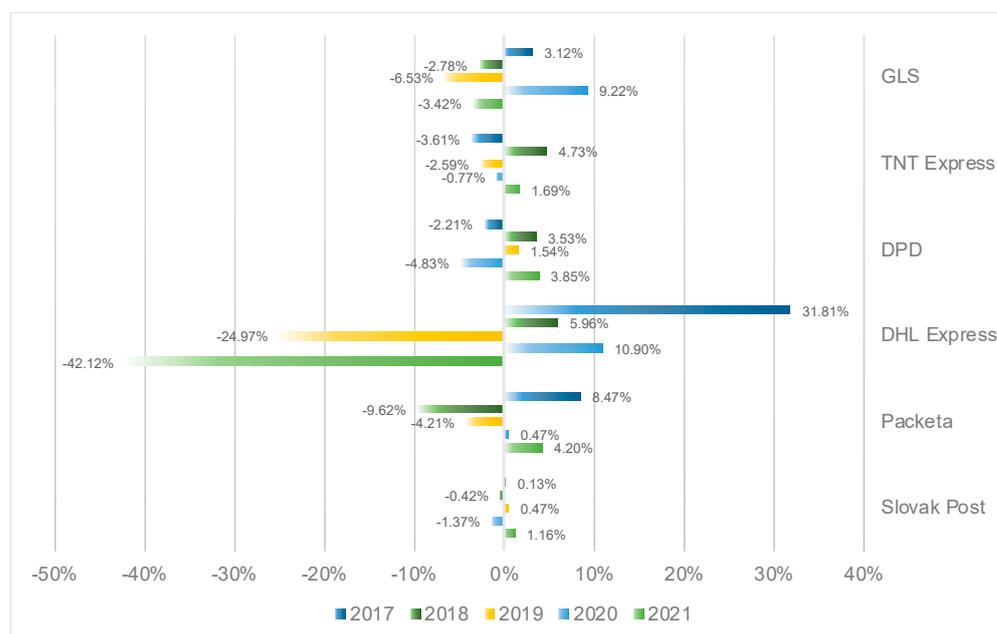


Figure 8. Percentage deviation for the analyzed companies.

The graphical representation shows the percentage deviations for the companies during the period from 2017 to 2021. Slovak Post recorded deviations each year, with the largest positive difference being 1.16% in 2021, while the largest negative difference was -1.37% in 2020. Thus, the actual output fluctuated around the expected output with small deviations. Packeta showed large fluctuations in percentage deviations, with the actual value in 2019 being even 4.21% lower than expected. Conversely, in 2021, the actual value was 4.20% higher than expected. On the other hand, DHL Express experienced positive deviations from 2017 to 2020, but in 2021 it reached a significant negative deviation of -42.12% . This indicates that the actual output was higher than predicted in the past, but this was not the case in 2021. DPD had mixed results, with positive deviations in 2018, 2019, and 2021 but negative ones in the other years. TNT Express had small to no deviations, indicating consistent output compared to the expected. The largest positive difference was 4.73% in 2018, and the largest negative was -3.61% in 2017. Finally, GLS experienced deviations in all years, with the largest positive difference being 9.22% in 2020, but in 2021, the actual value was 3.42% lower than expected.

4.4. Technological Efficiency

Comparing the results of the analysis with the theory of technical and technological substitution allows for a better understanding of the dynamics of using various technologies in postal processes and services. Technical substitution describes how companies can replace one technology with another to increase efficiency and reduce costs. Technological substitution addresses how technological progress can change dynamics. Figure 9 shows a comparison of the level of technological efficiency.

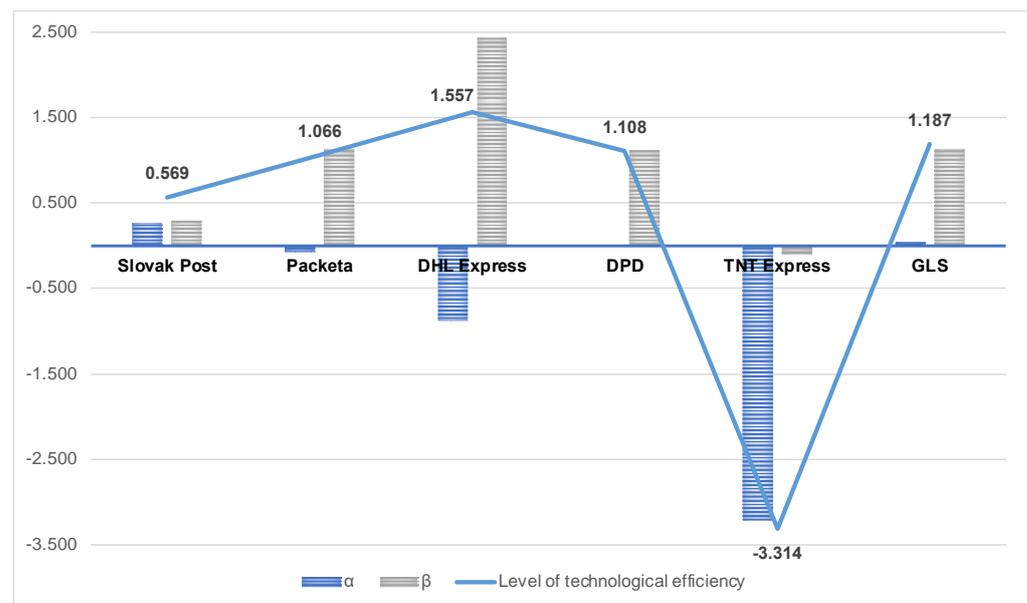


Figure 9. Level of technological efficiency of the analyzed companies.

For Slovak Post, the coefficients α (0.27) and β (0.30) indicate that if the amount of capital or labor increases by 1 percent, the expected output will increase by approximately 0.27 and 0.30 percent, respectively. This suggests that Slovak Post has the potential to increase its efficiency through technological advancements and process improvements. Packeta has a negative coefficient for capital (-0.08) and a high coefficient for labor (1.14). This could mean that the company could benefit from greater use of technologies to increase efficiency. DHL Express, with a negative coefficient for capital (-0.88) and a high coefficient for labor (2.43), might have the potential to increase its efficiency through better utilization of capital and technologies. DPD, with coefficients of 0.01 for capital and 1.12 for labor, shows a strong dependence on labor. Efficiency could be increased through better use of capital and technologies. TNT Express, with negative coefficients for capital (-3.21) and labor (-0.10), might have the opportunity to increase its efficiency by revising its work processes and capital utilization. Finally, GLS, with coefficients of 0.05 for capital and 1.14 for labor, shows a strong dependence on labor. This company could benefit from better use of technologies to increase efficiency.

4.5. Hypotheses Testing

Hypothesis 1: *The integration of IoT significantly increases the efficiency of capital utilization.*

The analysis of capital elasticity resulted in a mean value of -0.64 , with a t-statistic of -1.19 and a p -value of 0.29. Since the p -value is greater than the 0.05 threshold, the null hypothesis cannot be rejected. This indicates that IoT integration has not led to statistically significant improvements in capital utilization across the Slovak postal service sector during the analyzed period. These findings suggest that the immediate benefits of IoT may not yet be fully realized in terms of capital efficiency. It is possible that investments in IoT infrastructure, such as sensors, software, or automated systems, have not matured enough to demonstrate returns in enhanced capital productivity. Therefore, while IoT adoption may have begun, its impact on capital utilization might not be evident in the short term, as these investments could be laying the foundation for future gains rather than producing immediate efficiency improvements.

It should also be considered that the relationship between IoT and capital utilization may vary depending on factors such as the type of IoT investments, the scale of operations, and the speed at which companies integrate these technologies into their processes. While

no direct correlation between IoT and increased capital efficiency was observed, it does not exclude the possibility of longer-term effects. Future studies may reveal a stronger connection as companies further implement and scale IoT applications. Extending the time frame of analysis or examining how specific IoT investments—such as real-time tracking systems or automated parcel handling—affect capital over time may provide a clearer picture, especially as these technologies become more embedded in daily operations.

Hypothesis 2: *IoT adoption positively impacts labor productivity.*

In contrast to the capital findings, the analysis of labor elasticity strongly supports the hypothesis that IoT adoption positively impacts labor productivity. The mean labor elasticity was calculated to be 1.01, with a t-statistic of 2.82 and a p -value of 0.037, leading to the rejection of the null hypothesis. These results confirm that IoT significantly enhances labor productivity. IoT technologies appear to contribute to improved workforce efficiency by automating routine tasks, enabling real-time data sharing, and improving workflow management. This allows employees to focus on higher-value activities. For instance, IoT-enabled systems may reduce the time spent on manual processes, such as parcel sorting, while also minimizing errors through real-time tracking and optimized delivery routes.

The significant positive impact on labor productivity indicates that IoT adoption can continue to drive improvements in the efficiency of the postal service sector. As IoT solutions become more widespread, they are likely to further enhance labor performance by reducing repetitive manual tasks and increasing operational accuracy. This aligns with broader industry trends, where automation and digital tools are transforming labor dynamics, leading to higher service quality and more reliable operations. The strong positive elasticity highlights IoT's role in amplifying labor efficiency, not just by reducing labor intensity but by making it more productive. These findings emphasize the potential for further gains in labor productivity as IoT technologies are optimized and expanded across the sector.

5. Discussion

The findings of this paper provide valuable insights into the impact of technological advancements, specifically the integration of IoT, on the efficiency and productivity of the postal service industry in Slovakia. By applying the Cobb–Douglas production function, it has been possible to quantify the effects of capital and labor on the output of six major postal service providers, offering a comprehensive understanding of how these inputs contribute to overall production processes.

The regression analysis revealed significant variations in the elasticities of capital and labor across different companies. For instance, Slovak Post displayed balanced contributions from both capital and labor, indicating an efficient utilization of resources across its operations. This suggests that Slovak Post has successfully integrated technological advancements into its traditional postal services, maintaining a high level of efficiency.

On the other hand, Packeta, a logistics company focused on e-commerce, showed a higher elasticity for labor. This reflects the labor-intensive nature of its operations, where human intervention plays a crucial role in handling and delivering parcels. The significant positive elasticity of labor underscores the importance of workforce efficiency and the potential benefits of further automation and technological integration.

DHL Express and DPD exhibited relatively high elasticities for capital, aligning with their global strategies that emphasize automation and advanced logistics solutions. This indicates that investments in technology and infrastructure are critical drivers of productivity for these companies. The significant impact of capital suggests that these firms have effectively leveraged IoT technologies to optimize their logistics and operational processes, resulting in enhanced efficiency and output.

The concept of technological substitution, as captured by the Cobb–Douglas production function, highlights the potential for replacing labor with technology to maintain or

increase output levels. The negative coefficient for capital in some companies, such as TNT Express, suggests areas where capital investments may not be yielding the expected returns. This could point to inefficiencies in capital utilization or the need for more targeted technological innovations.

For companies like GLS, which showed strong dependence on labor, there is a clear opportunity to enhance efficiency through better utilization of technology. The positive and significant elasticity for labor indicates that while the current workforce is effective, there is room for technological advancements to further boost productivity. Integrating more IoT solutions could streamline operations, reduce manual errors, and optimize resource allocation.

Despite the valuable findings, this paper faces several limitations that warrant careful consideration. One of the primary concerns is the relatively high p -values associated with some capital coefficients, particularly in companies like Slovak Post. These high p -values suggest that not all relationships between capital and output are statistically significant, which may be due to the limited number of observations analyzed over the five-year period from 2017 to 2021. Additionally, the Cobb–Douglas production function used in this study did not account for external factors such as fluctuations in market conditions, regulatory changes, or broader macroeconomic influences. These unaccounted factors may have impacted the efficiency and productivity of the postal service providers, introducing potential variability in the results.

Another limitation stems from the reliance on financial and operational data obtained from company reports and public records, which could introduce biases or inaccuracies. Although the FinStat portal was used to ensure the reliability of the data, differences in reporting standards and accounting practices among the postal service providers may affect the consistency of the dataset. These discrepancies could skew the findings, particularly in how capital and labor productivity are assessed across companies. In the future, expanding the dataset and incorporating additional economic and regulatory variables would help provide a more holistic understanding of the factors influencing postal service efficiency.

Nonetheless, this study significantly contributes to the theoretical understanding of how IoT adoption impacts operational efficiency in the Slovak postal sector. The application of the Cobb–Douglas production function highlights the diverse effects of IoT on both capital and labor productivity, with broader implications for resource allocation strategies in the context of technological substitution. The methodologies and insights from this research can also be applied to other sectors and regions, allowing for cross-sectoral and international comparisons of IoT's impact on productivity. Such analyses would help address the limitations posed by this study's narrow timeframe, ultimately broadening the scope of understanding regarding the integration of IoT technologies across industries.

6. Conclusions

This paper provides a comprehensive analysis of the impact of technological advancements, particularly the IoT, on the efficiency and productivity of the postal service industry in Slovakia. By applying the Cobb–Douglas production function, we have quantified the contributions of capital and labor inputs to the output of six major postal service providers over a five-year period. The regression analysis revealed significant variations in the elasticities of capital and labor across different companies, reflecting diverse operational strategies and levels of technological adoption. The findings indicate that companies such as DHL Express and DPD, which have higher capital elasticities, benefit significantly from investments in advanced logistics technologies and infrastructure. Conversely, firms like Packeta, with higher labor elasticities, highlight the importance of workforce efficiency and suggest potential gains from increased automation and technological integration. These results underscore the critical role of strategic resource allocation and the adoption of IoT technologies in enhancing productivity and competitiveness within the postal service sector.

Despite the valuable insights provided, this paper acknowledges several limitations, including the limited number of observations and potential external factors not accounted

for in the analysis. Future research should consider expanding the dataset and incorporating broader economic and regulatory variables to provide a more holistic understanding of the dynamics at play. Overall, this paper emphasizes the importance of continuous technological innovation and strategic investments to optimize the performance of postal service providers, offering practical implications for policymakers and industry stakeholders.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

The individual values in EUR for all analyzed years and companies are listed in Table A1.

Table A1. Data on companies for the period 2017–2021 in EUR (Finstat 2023a, 2023b, 2023c, 2023d, 2023e, 2023f).

Year	Indicator	Slovak Post	Packeta	DHL Express	DPD	TNT Express	GLS
2021	Non-current assets	275,380,000	5,166,715	2,142,385	24,338,343	6,877,771	18,198,954
	Personnel expenses	197,501,000	5,772,589	7,679,866	8,188,716	5,803,525	3,266,850
	Revenue from main operations	341,194,000	39,777,235	35,808,143	65,826,208	57,748,742	59,725,749
2020	Non-current assets	292,145,000	2,031,519	2,278,204	21,345,900	7,191,045	7,868,430
	Personnel expenses	199,372,000	3,127,292	9,336,851	7,053,391	6,702,058	2,804,670
	Revenue from main operations	338,948,000	20,420,874	87,060,327	51,163,766	48,109,052	54,924,546
2019	Non-current assets	316,065,000	1,890,756	1,244,547	23,176,067	7,274,052	5,286,809
	Personnel expenses	191,584,000	1,581,651	8,230,165	4,405,005	5,923,786	2,224,718
	Revenue from main operations	348,413,000	8,998,933	77,544,541	32,107,982	46,130,919	35,270,079
2018	Non-current assets	261,571,000	27,128	1,439,717	3,540,683	7,583,994	5,222,199
	Personnel expenses	176,203,000	696,432	7,654,259	3,940,427	5,206,766	1,736,359
	Revenue from main operations	320,064,000	4,647,155	76,027,595	29,610,324	44,033,149	27,553,650
2017	Non-current assets	262,507,000	16,266	1,657,717	3,032,264	7,783,114	5,292,795
	Personnel expenses	169,748,000	376,570	7,475,335	3,655,445	4,648,415	1,402,968
	Revenue from main operations	318,543,000	2,866,928	87,485,110	25,744,127	37,697,094	22,945,078

The resulting logarithmic values rounded to two decimal places are listed in the columns $\ln(K)$, $\ln(L)$, and $\ln(Y)$ in Table A2.

Table A2. Natural logarithms of capital, labor, and output values for the analyzed companies.

Company	Year	ln(K)	ln(L)	ln(Y)
Slovak Post	2021	19.43	19.10	19.65
	2020	19.49	19.11	19.64
	2019	19.57	19.07	19.67
	2018	19.38	18.99	19.58
	2017	19.39	18.95	19.58
Packeta	2021	15.46	15.57	17.50
	2020	14.52	14.96	16.83
	2019	14.45	14.27	16.01
	2018	10.21	13.45	15.35
	2017	9.70	12.84	14.87
DHL Express	2021	14.58	15.85	17.39
	2020	14.64	16.05	18.28
	2019	14.03	15.92	18.17
	2018	14.18	15.85	18.15
	2017	14.32	15.83	18.29
DPD	2021	17.01	15.92	18.00
	2020	16.88	15.77	17.75
	2019	16.96	15.30	17.28
	2018	15.08	15.19	17.20
	2017	14.92	15.11	17.06
TNT Express	2021	15.74	15.57	17.87
	2020	15.79	15.72	17.69
	2019	15.80	15.59	17.65
	2018	15.84	15.47	17.60
	2017	15.87	15.35	17.45
GLS	2021	16.72	15.00	17.91
	2020	15.88	14.85	17.82
	2019	15.48	14.62	17.38
	2018	15.47	14.37	17.13
	2017	15.48	14.15	16.95

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