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Temperature and Firms' Performance: Outcomes, Mechanisms, and Coping Strategies

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Abstract

This paper examines the impact of weather conditions on firms' performance in Slovakia. By employing a unified framework that analyzes the outcomes, mechanisms, and coping strategies of firms across the entire economy, we contribute to a better understanding of the microeconomic foundations of weather's impact on economic development. Specifically, combining data on the universe of firms from 2013 to 2023 with temperature and precipitation data in a panel framework, we find that annual losses in sales, revenue, and profit associated with a 1°C increase in temperature are substantial in heat-sensitive industries, whereas firms in non-heat-sensitive industries are generally unaffected. The findings suggest that the main mechanism underlying these relationships is a decline in total factor productivity driven by rising temperatures. To cope with the adverse impact of temperature, firms in heat-sensitive industries primarily adopt cost-reduction strategies. Future projections suggest a decline in firms' performance, implying significant future economic losses for the economy.

JEL classification

D22, D24, Q54

Keywords

coping strategies, firms, mechanisms, temperature, Slovakia

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1. INTRODUCTION

Many studies document that higher temperatures slow down aggregate economic growth globally (Bilal and Känzig, 2024; Burke et al., 2015; Dell et al., 2009, 2012; Heal and Park, 2016; Henseler and Schumacher, 2019; Hsiang, 2010; Linsenmeier, 2023; Matthias and Wenz, 2020; Newell et al., 2021; Tol, 2024), with the effects being more pronounced in poorer economies (Acevedo et al., 2020; Dell et al., 2012; Letta and Tol, 2019; Matthias and Wenz, 2020; Tol, 2024) and in certain economic sectors, such as manufacturing, agriculture, and tourism (Deschênes and Greenstone, 2007; Otrachshenko and Nunes, 2022; Schlenker et al., 2006; Somanathan et al., 2021; Zhang et al., 2017, 2018).[1]

While the evidence on the macroeconomic effects of weather is rich and growing, less is known about the microeconomic mechanisms behind the effects of weather on economic development. This is unfortunate because macro-level models that employ historical data at the country or regional level fail to capture important dynamics and specific channels and responses at the microeconomic level (Piontek et al., 2025). In this direction, several studies document that weather adversely affects firms' total factor productivity (TFP) (Donadelli et al., 2017; Letta and Tol, 2019; Li et al., 2025; Ren et al., 2024; Zhang et al., 2018). However, evidence on the impact of weather on corporate performance outcomes, and particularly on firms' coping strategies, remains scarce. This paper contributes to this direction.

This paper examines the impact of temperature on firms' performance in Slovakia, a high-income economy in Central Europe. Using data on the universe of firms operating in Slovakia from 2013 to 2023, we analyze whether and how temperature affects firms' performance indicators, including sales, revenues, and profits. In addition, we suggest and test the mechanisms behind the impact of temperature and explore potential coping strategies of the Slovak firms. Finally, we provide predictions of firms' future performance under alternative scenarios for average temperature increase over the 21st century, including combating climate change, a fragmented world, and business-as-usual.

The findings suggest that the impact of temperature on firms' performance varies by season. In particular, we find that increases in spring and summer temperatures adversely

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[1] In addition, higher temperatures undermine human capital accumulation (Zivin et al., 2018), induce relocation of labor between sectors (Otrachshenko and Popova, 2022; Somanathan et al., 2021; Zhang et al., 2018; Zivin and Neidell, 2014), affect migration (Cai et al., 2016; Cattaneo and Peri, 2016; Deschênes and Moretti, 2009), crime (Cohen and Gonzalez, 2024; Otrachshenko et al., 2021; Ranson, 2014), and mortality (Deschênes and Greenstone, 2011; Deschênes and Moretti, 2009; Otrachshenko et al., 2017).

affect sales, revenues, and profits, whereas increases in winter and autumn temperatures have no such impact. The impacts of temperature on performance are substantially stronger for firms operating in heat-sensitive industries. The primary mechanism behind these results is changes in total factor productivity in those industries, with cost reduction as the key coping strategy. The findings remain stable across a battery of robustness checks.

This paper provides several distinct contributions to the literature. First, by employing a unified framework that analyzes the outcomes, mechanisms, and coping strategies of firms across the entire economy, we contribute to a better understanding of the microeconomic foundations of weather's impact on economic development. In addition, this approach helps to identify vulnerabilities and determine which aspects of firms' operations are most susceptible to weather impacts. Next, by disentangling firms into those operating in heat-sensitive and non-heat-sensitive industries, we document important differences and dynamics behind the impact of temperature on firms' performance. Since extreme weather events are becoming more frequent and severe, this is a timely contribution for countries with a high share of heat-sensitive industries, such as Slovakia, which are becoming increasingly prone to these events and their effects.

The remainder of the paper is organized as follows. In the next section, we review the literature and present our hypotheses. Section 3 presents the methodology, section 4 introduces background on the Slovak economy and climate, while section 5 describes the data used in the analysis. Then, we discuss our main findings, provide additional results, and conduct a battery of robustness checks. The final section concludes.

2. RELATED LITERATURE AND HYPOTHESES

Existing studies on the impact of weather on firm performance mainly focus on firms in the US (Addoum et al., 2020, 2023; Donadelli et al., 2017; Ren et al., 2024) and China (Chen et al., 2023; Chen and Yang, 2019; Tang et al., 2023; Zhang et al., 2018). In one such study, Addoum et al. (2023) find that profits of American publicly traded firms in about 40% of industries are sensitive to hot and cold temperatures, with consumer services, industrial production, and utilities being the most affected. The effects depend on seasons: warmer winters increase firm profits in metallurgy, mining, and transport sectors, while hotter summers decrease firm profits in construction, engineering, and utilities.[2] These findings are explained by increasing operational costs in most heat-sensitive industries, including construction, metallurgy, mining, utilities, transport, and

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[2] Hereinafter, we use weather and temperature interchangeably.

manufacturing, rather than by decreasing revenues.[3]

In cross-country studies, Pankratz et al. (2023) show that higher temperatures reduce firms' revenues and operating income and increase production costs, while Cevik and Miryugin (2023) suggest that higher temperatures reduce profitability, access to finance, and productivity of firms in developing countries. At the same time, higher temperatures increase the profitability of the energy and gas sectors, possibly due to increased energy demand (Anton, 2021), but reduce profit growth and stock returns for firms in the food industry due to higher drought risk (Hong et al., 2019). This suggests that the weather impacts on the firm's performance may depend on the industry in which the firm operates.

Hypothesis 1: *Higher temperatures are associated with worse firm performance, especially in heat-sensitive industries*.

Several firm-level mechanisms may explain changes in firm performance due to higher temperatures. One such mechanism is that higher temperatures worsen firm performance through reduced labor and capital productivity (Benincasa et al., 2024; Cai et al., 2018; Costa et al., 2024; Donadelli et al., 2017; Somanathan et al., 2021; Zhang et al., 2018). In particular, higher temperatures increase workers' absenteeism (Somanathan et al., 2021; Zivin and Neidell, 2014), reduce cognitive performance (Zivin et al., 2018), and reduce machine performance (Zhang et al., 2018). In addition, weather adversely affects firms' total factor productivity (TFP) (Donadelli et al., 2017; Letta and Tol, 2019; Li et al., 2025; Ren et al., 2024; Zhang et al., 2018). Finally, temperatures reduce firms' output, increase operational costs, and constrain investment, further contributing to reduced TFP and worsened firm performance (Addoum et al., 2023; Chen and Yang, 2019; Donadelli et al., 2017; Ren et al., 2024).

Hypothesis 2: *Higher temperatures worsen firm performance by lowering total factor productivity (TFP), labor productivity, and capital productivity*.

2.1. HOW DO FIRMS COPE WITH WEATHER IMPACTS?

Following existing studies, we may distinguish several behavioral responses (coping strategies) on the firm side that may result from negative weather impacts on firm performance. In practice, however, firms are likely to apply a mix of coping and mitigation

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[3] Zivin and Neidell (2014) suggest that "heat-sensitive" industries are those in which work is primarily performed outdoors or under high exposure to heat during the production process. These industries are agriculture, forestry, fishing, and hunting; mining; construction; transportation; utilities and manufacturing if production processes generate heat (p.4). The remaining industries are classified as the "non-heat-sensitive."

measures.

By increasing the firms' operational costs, extreme weather conditions may increase the risk of running out of liquidity (Benincasa et al., 2024; Brown et al., 2021; Cevik and Miryugin, 2023; Chen et al., 2023), the risk of default (Chen et al., 2024), and systemic risk (Tzouvanas et al., 2019). Thus, the first strategy is to improve a firm's financial resilience. In line with this strategy, Chen et al. (2023) show that when facing extreme rainfall, which is often unpredictable and leads to substantial physical and financial damage, firms in China increase cash holdings and become more conservative in borrowing, relying on long-term rather than short-term loans. Similarly, in a cross-country study, Benincasa et al. (2024) suggest that firms with weather-related losses are more financially constrained, more likely to apply for loans, and more likely to invest in long-term assets.[4] Given these implications from the previous literature, our first hypothesis regarding the firms' coping strategies is as follows:

Hypothesis 3a: *Firms increase cash on hand, loans, and accrued expenses to cope with higher temperatures.*

Another strategy may include firm-level changes in technological processes and development expenses (Adhvaryu et al., 2020; Zhao and Parhizgari, 2024). For instance, investments in energy-saving technologies may improve productivity during high temperatures (Adhvaryu et al., 2020). Thus, we hypothesize that:

Hypothesis 3b: *Firms increase development expenses to cope with higher temperatures.*

In addition, temperature shocks are associated with a higher cost of capital (Balvers et al., 2017), labor (Pankratz et al., 2023), and energy (Pechan and Eisenack, 2014; Ponticelli et al., 2023). Thus, firms may consider reducing operational costs as an additional coping strategy (Addoum et al., 2023), suggesting the following hypothesis:

Hypothesis 3c: *Firms reduce costs to cope with higher temperatures.*

Firms may also apply several alternative strategies. For instance, they may diversify supply sources and reorient exports. In line with this, Castro-Vincenzi et al. (2024) suggest that changes in the structure of supply chains can be an effective strategy to cope with extreme weather risks, although it may increase input costs. In addition, Pelli and Tschopp (2017) suggest that following hurricanes that reduce the opportunity costs of export reorientation, firms' physical capital tends to be reallocated towards exports in industries that have higher comparative advantages. Since larger firms may

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[4] Alternatively, higher temperatures may also induce firms to avoid paying taxes as a way to increase cash holdings and mitigate the negative impacts of weather (Tang et al., 2023).

have better access to finance and be more prepared to cope with increasing operational costs, increasing temperatures may also lead to higher market concentration (Ponticelli et al., 2023). Finally, to cope with the consequences of increasing temperatures, firms may also change their geographic location, although the feasibility of relocating their activities may be limited and depend on the industrial structure (Linnenluecke et al., 2011). Due to data availability, we do not test whether firms use export reorientation or relocation as coping strategies in response to weather impacts. However, given the country's industrial structure and relatively small geographic area, these strategies are unlikely to be the primary ones that Slovak firms use.

3. EMPIRICAL STRATEGY

To examine the impact of temperature on firms' performance, we follow the econometric approach suggested by Hsiang (2010) and Dell et al. (2012, 2014):

$$\begin{aligned} Performance_{j,i,r,t} = \beta_0 + \beta'_{\mathbf{1,s}} * \mathbf{Temp_{s,r,t}} + \alpha'_{\mathbf{s}} * \mathbf{Prec_{s,r,t}} + \gamma_j + \phi_t + \\ + \boldsymbol{\Theta}'_{\mathbf{1}} * \mathbf{Ind_r} * t + \boldsymbol{\Theta}'_{\mathbf{2}}\mathbf{Ind_r} * t^2 + \boldsymbol{\Phi}'_{\mathbf{1}} * \mathbf{Region_r} * t + \\ + \boldsymbol{\Phi}'_{\mathbf{2}}\mathbf{Region_r} * t^2 + u_{j,i,r,t} \end{aligned} \tag{1}$$

where subscripts *j, i, r*, and *t* stand for a firm, industry, region, and year, respectively, while the superscript *s* stands for seasons, such as winter, spring, summer, and autumn. *Performance* denotes a set of firms' performance indicators such as the natural logarithm of sales, revenue, and profit.

Temp and **Prec** are vectors of weather variables such as the average winter, spring, summer, and autumn temperature (in °C) and their precipitation levels (in *mm*), respectively. To compute the average winter temperature, the temperature of December in a period *(t-1)* and of January and February in a period *t* are taken.[5] Spring is the average of March, April, and May's temperature in a period *t*; summer is the average of June, July, and August's temperature in a period *t*; and autumn is the average of September, October, and November's temperature in a period *t*.

Using a panel dataset framework, we also control for firm and year fixed effects, γ and ϕ, respectively. The firm fixed effects stand for time-invariant unobserved characteristics that may affect a firm's performance and its choice of a specific region for operations. The year fixed effects account for the introduction of new reforms and/or regulations at the national level that are common across the 8 regions during the study period.

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[5] For a detailed discussion, see Hsiang (2010)

Region is a vector of 8 regional dummy variables and equals one for a region *r* (i.e., Bratislava region, Banská Bystrica, Nitra, Košice, Prešov, Trenčín, Trnava, and Žilina) and 0 otherwise. t and t^2 stand for linear and squared time trends, respectively. The interaction term between regional dummies and both time-trend controls for any region-specific non-linear trends that affect firms' performance and might be correlated with weather. These might be trends in industrial location choices, regional economic development, infrastructural development, government spending and subsidies, and private investments. Also, Dell et al. (2014) point out that including fixed effects and interaction terms (in our case, linear and quadratic trends with regional and industry dummies) into the analysis disentangles the effects of temperature from possible omitted variable bias. β_0, $\beta_{1,s}$, α, Θ_1, Θ_2, Φ_1, and Φ_2 are parameters of the model to be estimated. u is a disturbance term. Robust standard errors are clustered at the district level.

3.1. MECHANISMS AND COPING STRATEGIES

To analyze the mechanisms underlying the relationship between firms' performance and temperature, we compute labor productivity, capital productivity, and total factor productivity (TFP). The first two measures show how efficiently labor and capital are allocated in production, whereas TFP stands for technological advances, managerial skills, and innovation.

Labor productivity is the natural logarithm of the ratio of the firm's revenue to labor costs, both in Euro currency units.[6] Capital productivity is the ratio of the firm's revenue to capital. It is worth mentioning that capital is also affected by temperature (Benincasa et al., 2024). To avoid this situation, capital is taken at the beginning of each period. Finally, to estimate firm-level total factor productivity (TFP), we follow Levinsohn and Petrin (2003):

$$y_{j,t} = \theta_0 + \theta_1 * k_{j,t} + \theta_2 * l_{j,t} + \theta_3 * int_{j,t} + \pi_j + e_{j,t} \tag{2}$$

where the subscripts *j* and *t* are explained in the previous section. *y, k, l* and *int* are the natural logarithm of the gross firm's revenue, capital, total personnel costs, and costs of intermediate materials utilized, respectively. All indicators are measured in Euros and are price-adjusted by the relevant industrial PPI. To account for other industrial disparities such as annual fluctuations in input prices, we also introduce industry-year

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[6] Alternatively, labor productivity can be measured as the natural logarithm of the ratio between the firm's revenue and the number of employees. Examples are Chen et al. (2025); Costa et al. (2024), among others. Unfortunately, we do not have the exact number of employees. Instead, we use firm total personnel costs in Euros.

fixed effects (Ren et al., 2024).

Then, we estimate the predicted value, ŷ, from Eq. 2 and compute the natural logarithm of firm-level total factor productivity as follows:

$$ln(TFP_{j,t}) = y_{j,t} - \hat{y}_{j,t} \tag{3}$$

To analyze firms' coping strategies, we estimate Eq. 1, using alternative dependent variables corresponding to different potential coping strategies. As discussed above, we test three sets of potential coping strategies: 1) the ones related to borrowing and using money for payments, including the use of cash on hand, short- and long-term bank loans, and short- and long-term accrued expenses; 2) the ones related to investment and development, such as capitalization of development costs (e.g., investment into enhancement of products or production lines), and 3) cost reduction.

4. BACKGROUND

Slovakia is a landlocked high-income economy in Central Europe, bordering Austria and the Czech Republic to the west, Hungary to the south, Ukraine to the east, and Poland to the north. Its size is approximately 49,000 km^2, with a population of approximately 5.4 million. In 2023, its real GDP per capita was 28,400 Euros, which is below the EU27 average of 38,100 Euros (Eurostat, 2025).[7] Geographic proximity to major EU markets, particularly Germany and Czechia, supports its export-oriented growth, and the United States also represents a notable trading partner (OECD, 2024).

Slovakia is highly industrialized, with the automotive industry playing a dominant role (European Labour Authority, 2025; Guzi and Fabo, 2021). 21% of all firms in Slovakia are in the construction sector, followed by wholesale and retail trade (16.9%) and services (15.7%) (European Labour Authority, 2025). As of 2022, manufacturing is the largest employer, accounting for 27.7% of the labor force. It is followed by wholesale and retail trade and vehicle repair (18.4%), construction (10.8%), and professional, scientific, and technical services (9.2%). In terms of total value added, services contribute around 65%, industry and construction 32%, and agriculture approximately 3%. Micro-enterprises dominate the economy, with 97% of firms employing up to 9 people (European Labour Authority, 2025). Small firms employ approximately 43% of the labor force and contribute about 23% of total value added. Foreign ownership is sig-

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[7] Slovakia is larger in size than the Netherlands and Switzerland, but smaller than Austria and the Czech Republic. Its population is ca. 3.3 and 1.6 times smaller than in the Netherlands and Switzerland, respectively. In 2023, its GDP ranked 36th out of 145 economies worldwide, but it was the fourth-poorest in the EU27.

nificant, especially in manufacturing, and is heavily concentrated in western Slovakia. This region, particularly the Bratislava (capital) area, is considerably more productive and wealthier than central and eastern Slovakia. Foreign investment and high-value manufacturing also cluster in the west (Guzi and Fabo, 2021; Vaňko and Novák, 2025).

The climate in Slovakia is temperate continental, with four distinct seasons and a low incidence of natural disasters. Winters (December to February) are typically cold, and temperatures often drop below 0°C, particularly in mountain regions. Summers (June to August) are generally warm, with average temperatures ranging from 20°C to 30°C, although heatwaves can result in higher extremes. Mild temperatures and moderate rainfall characterize spring and autumn.

Figure 1 displays the seasonal distribution of mean air temperatures in Slovakia over 2013–2023. As shown, winter exhibits a mass below 0–5°C, while summer concentrates between roughly 20–25°C with a longer warm tail. Spring and autumn overlap around the 10–17°C range. Precipitation is relatively evenly distributed throughout the year.

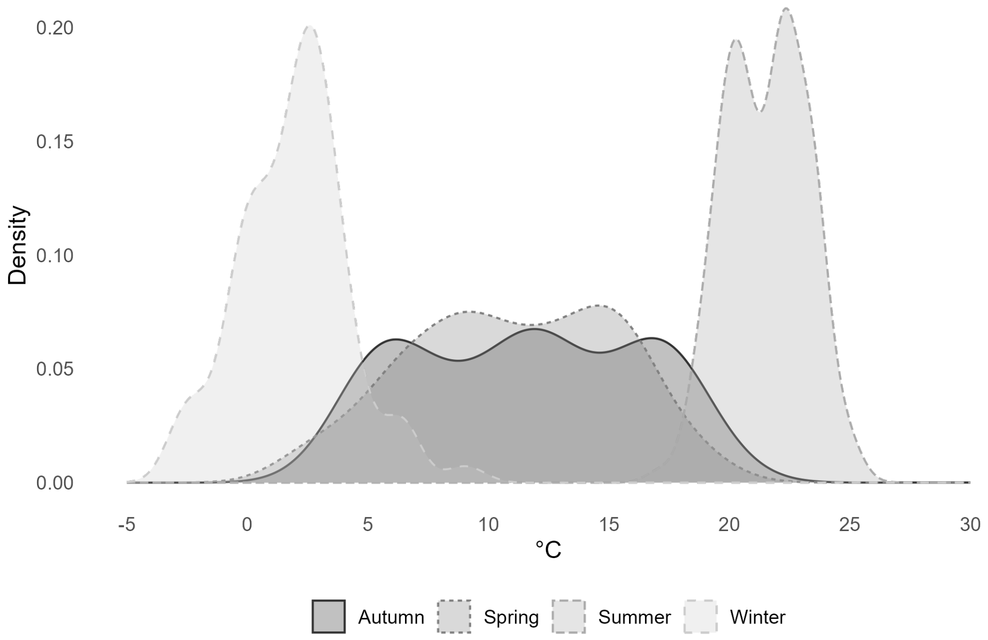

Figure 1: Seasonal Temperature Distribution in Slovakia.

Source: Authors' construction based on data from the Slovak Hydrometeorological Institute. *Notes:* The figure shows the mean seasonal temperature distribution in Slovakia during the 2013–2023 period.

Slovakia faces increasing risks from climate change, including higher average temperatures, more frequent extreme precipitation events, floods, and droughts (OECD, 2024). This implies that heat stress is emerging as a growing obstacle to economic activities, and its impacts are likely to be uneven across sectors. Outdoor-oriented and heat-sensitive industries—such as agriculture and forestry, construction, development and civil engineering, energy and mining, and transportation, waste management, and logistics—which account for approximately 40% of the Slovak economy's value added, are likely to be particularly affected. These industries have limited capacity to shift operations indoors and often employ less-skilled labor (Guzi and Fabo, 2021). In contrast, industries with a highly skilled labor force are better positioned to adapt to adverse events.

5. DATA

Data on temperature (in °C) and precipitation (mm) used in our analysis come from the Slovak Hydrometeorological Institute (SHI). We use data from weather stations in Slovakia, including Bratislava, Hurbanovo, Košice, and Kamenica nad Cirochou from December 2012 to December 2023. Using monthly mean temperature and precipitation data, we calculate seasonal averages and use them in the analysis. Then, for each firm, we use weather data from the nearest station. We also have information regarding the annual number of days with a mean daily temperature above 30°C. This information is used in Section 6.6 in additional results and checks.

The firm-level data used in our analysis is an unbalanced panel drawn from the Finstat (2024) database during the 2013-2023 period. The database includes registration and financial data on Slovak and foreign firms operating in Slovakia during the studied period. After excluding non-governmental organizations (NGOs), which are non-profit entities, the final sample comprises approximately 2.5 million observations, or about 250,000 firms per year. In the analysis, we use information on sales, revenues, profits, total assets and liabilities, labor, capital, and intermediate materials' costs, firms' age and size, as well as cash on hand, bank loans, accrued expenses, and capitalized development costs. The variable descriptions and summary statistics are provided in Table 1.

To clean balance sheet data for the analysis, following Chen et al. (2023), we first removed firms that report negative values on performance indicators, including sales, revenues, total assets, total costs, firms' age, labor, capital, and intermediate materials' costs. Depending on the specific indicator, such firms constitute between 0.1% and 0.8% of our whole data set. Second, there are cases where firms report zero sales in a given period and have missing information on the total revenue and revenue from other sources. Following accounting that total revenue equals sales plus revenue from other sources, we substitute missing values with zero, conditional on firms not having dissolved in previous and current periods.

Table 1: Descriptive Statistics

Variables	(1) Description	(2) Nr.	(3) Mean	(4) Std. Dev.	(5) Min.	(6) Max.
ln(Sales)	the natural logarithm of firms' sales.	2,465,095	8.912	4.766	0	23.104
ln(Revenue)	the natural logarithm of firms' revenue.	2,464,374	9.137	4.641	0	23.104
ln(Profit)	the natural logarithm of firms' profit.	1,460,159	8.066	2.924	0	20.645
Dummy Profit	=1 if firms' profit $\geq$ 0, and 0 otherwise.	2,380,400	0.613	0.487	0	1
Heat Sens. Industries	=1 for heat-sensitive industries, and 0 otherwise.	2,465,095	0.277	0.448	0	1
ln(Labor Prod.)	the natural logarithm of the ratio between total revenue and labor costs.	2,460,592	1.231	1.480	0	15.544
ln(Capital Prod.)	the natural logarithm of the ratio between total revenue and capital at the beginning of a period.	2,464,542	0.898	1.380	0	15.910
ln(TFP)	the natural logarithm of firm-level total factor productivity.	2,454,000	0	2.865	-15.588	16.788
Cash	=1 for cash on hand and 0 otherwise.	2,445,553	0.953	0.211	0	1
Bank Loans:	=1 for bank loans and 0 otherwise.	-	-	-	-	-
Long-term	-	2,463,578	0.072	0.258	0	1
Short-term	-	2,458,734	0.158	0.365	0	1
Accrued Expenses:	=1 for accrued expenses and 0 otherwise.	-	-	-	-	-
Long-term	-	2,463,895	0.005	0.071	0	1
Short-term	-	2,461,737	0.030	0.170	0	1
Cap. Development:	=1 for capitalized development costs and 0 otherwise.	2,435,477	0.001	0.033	0	1
ln(Costs)	the natural logarithm of firm costs.	2,359,836	10.184	3.203	0	23.084
ln(Age)	the natural logarithm of firm age.	2,465,032	1.908	0.896	0	4.615
Nr. of Employees:	4 categories for the number of employees in a firm.	-	-	-	0	1
1 Employee	-	2,466,826	0.428	0.495	0	1
10–19 Employees	-	2,466,826	0.033	0.180	0	1
100+ Employees	-	2,466,826	0.270	0.444	0	1
No Information	-	2,466,826	0.268	0.443	0	1
ln(Liabilities)	the natural logarithm of the total liabilities of a firm.	1,203,149	10.902	2.265	0	25.438
ln(Total Assets)	the natural logarithm of the total assets of a firm.	2,429,858	10.750	2.316	0	25.486

Source: Authors' construction. *Notes*: All variables in natural logarithms are computed as $\ln(X+1)$ to handle zero values. Cap. Development and Std. Dev. stand for capitalized development costs and standard deviations, respectively.

6. ESTIMATION RESULTS

In this section, we first examine the impact of temperature on the performance of firms in all industries in the Slovak economy. Then, we disentangle firms into those operating in non-heat-sensitive industries and those operating in heat-sensitive industries, and test the mechanisms behind those impacts. Next, we discuss firms' coping strategies in handling temperature impacts, including heterogeneity in those strategies between old and young firms. We also compute future projections on the impact of temperature on firms' performance in Slovakia. Finally, we provide additional results and a battery of robustness checks.

6.1. MAIN RESULTS

In Table 2, we present the impact of temperature on sales (column 1), revenue (column 2), profit (column 3), and the likelihood of earning a positive profit (column 4).[8] As shown, a 1°C increase in the spring temperature reduces sales by 3.78 percentage points (p.p.) and revenues by 3.45 p.p. We also find that a 1°C rise in summer temperature reduces profits by 2.91 p.p., while there is no impact on the likelihood of earning a positive profit.

Table 2: The Impact of Temperature on Firms' Performance, All Industries

Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum. Profit
Winter	-0.0013	-0.0020	0.0141	0.0005
	(0.010)	(0.009)	(0.009)	(0.002)
Spring	-0.0378***	-0.0345***	-0.0204*	-0.0027
	(0.011)	(0.010)	(0.011)	(0.002)
Summer	-0.0002	-0.0023	-0.0291***	0.0006
	(0.016)	(0.017)	(0.007)	(0.002)
Autumn	0.0062	0.0121	-0.0126	0.0071*
	(0.029)	(0.027)	(0.027)	(0.004)
Observations	2,465,095	2,464,374	1,460,159	2,380,400
R-squared	0.003	0.004	0.018	0.004

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends.

We then disentangle firms into those operating in non-heat-sensitive and heat-sensitive

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[8] Hereinafter, in regressions with profit as an outcome variable (column 3 in Tables 2 and 3), firms with negative profits are excluded from the estimation.

industries. Following Zivin and Neidell (2014), we define heat-sensitive sectors as those directly and indirectly exposed to heat, including agriculture and forestry, construction, development and civil engineering, energy and mining, education, transportation and logistics, and waste management. The remaining industries are classified as non-heat-sensitive. As shown in Table 3, we find a remarkable difference between these two groups. Cumulatively, when temperature rises by 1°C during spring and summer, firms' sales in heat-sensitive industries drop on average by 15.15 p.p., revenues drop by 14.28 p.p., profits by 12.21 p.p., and the likelihood of earning a positive profit by 2.06 p.p. (Panel B), while no substantial impacts are observed in non-heat-sensitive industries (Panel A).[9]

Regarding firm profits, we find that non-heat-sensitive industries are affected somewhat less than heat-sensitive industries (see column 3, Panels A and B in Table 3). A 1°C increase in summer temperature reduces profits by 2 p.p. in non-heat-sensitive industries. In heat-sensitive industries, the impacts of spring and summer temperatures on profits are more pronounced, resulting in a cumulative 12.21 p.p. reduction. At the same time, an increase in winter temperature may increase firms' profits in heat-sensitive industries by 4.08 p.p. This improvement may result from employees' prolonged working hours and the mitigated adverse impact of cold temperatures during winter.

Interestingly, the likelihood of earning a positive profit in heat-sensitive industries decreases by 2.06 p.p. during spring and summer, while it rebounds by 1.65 p.p. during autumn (see column 4, Panel B in Table 3). In non-heat-sensitive industries, temperature has no statistically significant effects on the likelihood of earning a positive profit (see column 4, Panel A in Table 3).

Overall, we find substantial differences in the temperature impacts on non-heat-sensitive and heat-sensitive industries. In the case of profit, this difference is approximately six-fold (2.08 p.p. vs. 12.21 p.p.). That is, the impact of temperature is more pronounced in heat-sensitive industries. These findings support Hypothesis 1 and are consistent with the existing literature, suggesting that temperature increases during warm seasons may reduce firms' performance. In the next section, we explore possible mechanisms behind these effects in detail.

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[9] To compute the cumulative (total) impact of spring and summer, for each indicator, we sum up the estimated coefficients on the spring and summer temperatures for heat-sensitive industries from Table 3: -0.1515=-0.0826-0.0689 (column 1, Panel B), -0.1428=-0.0803-0.0625 (column 2, Panel B), -0.1221=-0.0757-0.0464 (column 3, Panel B), -0.0206=-0.0136-0.0070 (column 4, Panel B).

Table 3: The Impact of Temperature on Firms' Performance by Groups

A: Non-heat-sensitive industries

Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum.Profit
Winter	-0.0083	-0.0091	0.0026	0.0002
	(0.011)	(0.010)	(0.011)	(0.002)
Spring	-0.0213*	-0.0175	0.0018	0.0023
	(0.011)	(0.011)	(0.011)	(0.002)
Summer	0.0300	0.0246	-0.0208**	0.0036
	(0.023)	(0.024)	(0.009)	(0.002)
Autumn	0.0010	0.0075	-0.0204	0.0030
	(0.024)	(0.022)	(0.024)	(0.004)
Observations	1,781,827	1,781,342	1,050,848	1,721,223
R-squared	0.003	0.004	0.018	0.004

B: Heat-sensitive industries

Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum.Profit
Winter	0.0129	0.0131	0.0408***	0.0013
	(0.017)	(0.013)	(0.014)	(0.004)
Spring	-0.0826***	-0.0803***	-0.0757***	-0.0136***
	(0.022)	(0.022)	(0.020)	(0.004)
Summer	-0.0689***	-0.0625***	-0.0464***	-0.0070**
	(0.018)	(0.018)	(0.015)	(0.003)
Autumn	0.0246	0.0287	0.0107	0.0165**
	(0.055)	(0.053)	(0.041)	(0.007)
Observations	683,268	683,032	409,311	659,177
R-squared	0.003	0.004	0.019	0.004

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends. Heat-sensitive industries include agriculture and forestry, construction, development and civil engineering, energy and mining, intermediary activities, waste management, education, transportation and logistics. The remaining industries are classified as non-heat-sensitive.

6.2. MECHANISMS

As discussed in Section 2, previous literature suggests that weather may affect firms' performance due to multiple reasons, including decline in labor productivity and labor supply, worsening health conditions of employees, and diminishing firms' assets, including fixed assets, buildings, machinery, and equipment.[10] Thus, the likely mechanisms behind the impact of the weather on firms' performance are related to labor productivity, capital productivity, and total factor productivity at a firm level. In this section, we test these mechanisms. To the best of our knowledge, this is the first study to test all these mechanisms using the same framework for the whole economy.[11]

Table 4 presents the findings on the impact of temperature on labor productivity, capital productivity, and the firm-level total productivity in non-heat-sensitive and heat-sensitive industries. We find that in non-heat-sensitive industries, an increase in winter temperature is associated with improvements in labor productivity, whereas in heat-sensitive industries, neither labor nor capital productivity is associated with temperature. This suggests that we generally do not find support for Hypothesis 2 for labor and capital productivity.

Table 4: Mechanisms

	Non-heat-sensitive industries			Heat-sensitive industries		
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variables:	ln(Labor Prod.)	ln(Capital Prod.)	ln(TFP)	ln(Labor Prod.)	ln(Capital Prod.)	ln(TFP)
Winter	0.0116***	-0.0027	0.0025	-0.0016	-0.0049	0.0025
	(0.004)	(0.004)	(0.008)	(0.007)	(0.005)	(0.012)
Spring	-0.0062	0.0015	-0.0171*	0.0084	-0.0095	-0.0582***
	(0.005)	(0.004)	(0.009)	(0.007)	(0.006)	(0.015)
Summer	0.0011	0.0003	0.0084	-0.0096	-0.0006	-0.0591***
	(0.005)	(0.005)	(0.022)	(0.010)	(0.007)	(0.011)
Autumn	0.0131*	-0.0062	0.0027	0.0008	0.0115	0.0297
	(0.007)	(0.006)	(0.016)	(0.015)	(0.010)	(0.031)
Observations	1,778,539	1,781,449	1,773,891	682,053	683,093	680,109
R-squared	0.001	0.011	0.000	0.002	0.017	0.000

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Labor Prod. and Capital Prod. stand for labor productivity and capital productivity, respectively. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends. Heat-sensitive industries include agriculture and forestry, construction, development and civil engineering, energy and mining, intermediary activities, waste management, education, transportation and logistics. The remaining industries are classified as non-heat-sensitive.

Regarding the impact of temperature on the firm-level total factor productivity (TFP), the results differ between heat-sensitive and non-heat-sensitive industries. As shown in Table 4, total factor productivity is not affected in non-heat-sensitive industries. On the other hand, in heat-sensitive industries, a 1°C increase in spring and summer tempera-

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[10] For the impact of weather on labor productivity and labor supply, see Zivin and Neidell (2014) and Somanathan et al. (2021), on firms' assets - Benincasa et al. (2024), among others.

[11] Earlier studies typically focused on one mechanism at a time. Examples include Benincasa et al. (2024) (on the impact of weather on capital productivity in 41 countries), Chen et al. (2025) and Zhang et al. (2018) (on firm-level TFP in China), and Costa et al. (2024) (on labor productivity in OECD countries).

tures leads to reductions of 5.82 p.p. and 5.91 p.p. in TFP, respectively (see column 6). This finding supports Hypothesis 2 for firms operating in heat-sensitive industries.

To summarize, by examining the three mechanisms using the same framework, we find that firm performance is affected by temperature mainly through firm-level total factor productivity. Moreover, we show that the adverse impact is more pronounced in heat-sensitive industries. This is an alarming signal, particularly for economies with a notable share of heat-sensitive industries, such as Slovakia.

6.3. COPING STRATEGIES

How do firms respond to and cope with the adverse impacts of weather, in particular, higher temperatures? Given that firm-level total factor productivity is the main mechanism behind firms' performance and the weather relationship, potential coping strategies may arise from firms' financial and managerial decisions, as well as investments in technological advancement. As introduced in Section 2.1 and explained in Section 3.1, we test three sets of potential coping strategies: 1) the ones related to borrowing and using money for payments; 2) the ones related to investment and development, and 3) cost reduction. The results for non-heat- and heat-sensitive industries are presented in Table 5, Panels A and B, respectively.

The results on coping strategies are modest. First, unlike previous literature (Chen et al., 2023; Tang et al., 2023), we find no evidence that temperature affects the likelihood of holding cash, except for a small impact in autumn (0.27 p.p., column 1 in Table 5). In contrast to Chen et al. (2023) and Benincasa et al. (2024), we also find mostly no evidence of using short- and long-term bank loans as a coping strategy in non-heat- and heat-sensitive industries (see columns 2 and 3, panels A and B, in Table 5). One possible explanation for these differences in findings between our study and previous literature is that we analyze economy-wide firm-level data, i.e., we consider all firms, including those that did not apply for loans, those that applied but were not successful in securing a loan, and those that applied and were successful. Unlike approaches that use bank records to identify performing and non-performing loans, our approach helps avoid selection bias when estimating the impact of weather on borrowing.

We find some evidence that accrued expenses are used as a coping strategy, although the magnitude of this effect is quite small, rendering it economically negligible. As shown in Table 5, Panel A, the rise in winter temperature by 1°C decreases the likelihood of using short-term accrued expenses by 0.09 p.p. in non-heat sensitive industries. Interestingly, we find a positive impact of spring temperature. For instance, a 1°C rise in temperature during spring increases the likelihood that firms use short-term accrued expenses in

Table 5: Firms' Coping Strategies by Groups

A: Non-heat-sensitive industries

Dep. Variables (=0/1)	Cash	Bank Loans		Accrued Expenses		Capitalized Development	ln(Costs)
		Long-term	Short-term	Long-term	Short-term		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Winter	-0.0001	0.0004	-0.0015*	0.0001	-0.0009**	-0.00001	-0.0050
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.007)
Spring	0.0002	0.0012*	0.0016*	-0.0001	0.0014**	-0.00006	-0.0093
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.006)
Summer	-0.0001	-0.0010	0.0004	0.0000	-0.0001	0.00007	0.0012
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.011)
Autumn	0.0027**	0.0021*	0.0010	0.0002	-0.0009	-0.00019	-0.0219*
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.000)	(0.012)
Observations	1,768,628	1,780,721	1,777,513	1,780,961	1,779,386	1,781,744	1,704,097
R-squared	0.002	0.007	0.009	0.002	0.011	0.000	0.012

B: Heat-sensitive industries

Dep. Variables (=0/1)	Cash	Bank Loans		Accrued Expenses		Capitalized Development	ln(Costs)
		Long-term	Short-term	Long-term	Short-term		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Winter	-0.0007	-0.0007	0.0008	-0.0006**	-0.0003	-0.00007	0.0265***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.009)
Spring	0.0002	0.0019*	-0.0001	0.0008*	-0.0001	0.00011	-0.0377***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)	(0.000)	(0.011)
Summer	-0.0012	0.0014	-0.0023	-0.0003	0.0006	-0.00010	-0.0367***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)	(0.000)	(0.010)
Autumn	0.0021	-0.0010	-0.0013	-0.0002	-0.0015	-0.00035*	0.0025
	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)	(0.000)	(0.026)
Observations	676,925	682,857	681,221	682,934	682,351	683,240	655,739
R-squared	0.002	0.012	0.018	0.002	0.008	0.000	0.010

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends. Heat-sensitive industries include agriculture and forestry, construction, development and civil engineering, energy and mining, intermediary activities, waste management, education, transportation and logistics. The remaining industries are classified as non-heat-sensitive.

non-heat-sensitive industries by 0.14 p.p. In heat-sensitive industries, firms use long-term accrued expenses as a possible coping strategy. A 1°C rise in winter temperature decreases the likelihood of using long-term accrued expenses by 0.06 p.p. These results suggest that we find only limited support for our Hypothesis 3a in both heat-sensitive and non-heat-sensitive industries, with a negligible economic effect.

Another coping strategy that firms may use is capitalizing on development costs to improve production lines and to cope with and mitigate the adverse impact of temperature. As shown in Table 5, Panels A and B, the estimated coefficients on seasons are not statistically significant. Thus, we do not find support for Hypothesis 3b. There are several reasons why this strategy is not popular in response to the adverse impact of temperature. Among them are complexity due to exhaustive documentation and justification, and increased managerial risks after capitalization due to optimistic future expectations of firms' performance.[12]

Finally, we explore cost reduction as a firm's coping strategy. This strategy remains relatively overlooked in the literature, although it may be the only one available to firms in the short and medium run. As observed in Table 5, Panel B, column 7, firms in heat-sensitive industries abate costs when temperatures rise during spring and summer. A 1°C rise in spring and summer temperature abates firm costs by 3.77 p.p. and 3.67 p.p. in heat-sensitive industries, resulting in the total effect of spring and summer being 7.44 p.p. Importantly, a winter temperature increase boosts firms' performance in heat-sensitive industries (see Table 3, column 3), and firms also adjust their costs, increasing them by 2.65 p.p. This result suggests that the firms' cost side is a valuable coping strategy, supporting our Hypothesis 3c.

6.4. YOUNG VS. OLD FIRMS

Compared to older firms, younger firms are more innovative (McKelvie et al., 2017; Stam and Wennberg, 2009), fast-growing and productive (Dumont et al., 2016; Federico and Capelleras, 2015; Haltiwanger et al., 2013; Navaretti et al., 2014), although they may face stronger liquidity constraints (Bottazzi et al., 2014; Huynh and Petrunia, 2010; Oliveira and Fortunato, 2006; Weuschek, 2025) and institutional barriers (Calvino et al., 2016; Weuschek, 2025) than older firms. At the same time, younger firms can be more resilient and better prepared to weather impacts than older firms (Heinzel et al., 2025). This suggests that coping strategies in response to weather impacts may also differ between young and old firms in heat-sensitive and non-heat-sensitive industries. To understand whether this is the case, we analyze the coping strategies of young and old firms separately.[13]

The results for young and old firms in heat-sensitive industries are presented in Table 6. As shown, an increase in spring temperatures reduces all performance indicators of young firms and the likelihood of earning positive profits for old firms, whereas summer temperatures affect only old firms. In addition, an increase in winter temperatures is associated with higher profits of older firms. For young firms, there is no such effect. Warmer autumns are associated with a higher likelihood of earning positive profits by both young and old firms. Overall, these findings suggest that although the effects may differ by season, both young and old firms in heat-sensitive industries are affected.

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[12] For a detailed discussion regarding capitalizing development costs, see AccountingInsights (2025); CFI (2025).

[13] Following Calvino et al. (2025) and McGregor (2021), we define young firms as those aged 5 years or younger.

Table 6: Young vs. Old Firms in Heat-Sensitive Industries

	Young				Old			
Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum. Profit	(5) ln(Sales)	(6) ln(Revenue)	(7) ln(Profit)	(8) Dum. Profit
Winter	0.0163	0.0063	-0.0072	0.0019	0.0121	0.0164	0.0455***	0.0017
	(0.033)	(0.031)	(0.028)	(0.004)	(0.020)	(0.014)	(0.016)	(0.005)
Spring	-0.1707***	-0.1672***	-0.0914***	-0.0139***	-0.0348	-0.0324*	-0.0506*	-0.0130***
	(0.047)	(0.044)	(0.028)	(0.005)	(0.021)	(0.019)	(0.027)	(0.005)
Summer	-0.0458	-0.0263	-0.0424*	0.0051	-0.0604***	-0.0647***	-0.0450**	-0.0136***
	(0.038)	(0.038)	(0.025)	(0.005)	(0.018)	(0.021)	(0.020)	(0.004)
Autumn	0.0316	0.0153	0.0125	0.0290**	0.0479	0.0639**	0.0435	0.0146**
	(0.089)	(0.099)	(0.046)	(0.011)	(0.036)	(0.029)	(0.047)	(0.007)
Observations	256,065	255,892	150,713	244,768	427,203	427,140	258,598	414,409
R-squared	0.081	0.091	0.052	0.008	0.011	0.010	0.019	0.003

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends.

Panels A (non-heat-sensitive industries) and B (heat-sensitive industries) in Table 7 present the results of the analysis of coping strategies for young and old firms. As shown in this table, in non-heat-sensitive industries, the likelihood of using cash on hand among old firms increases by 0.28 p.p. and 0.41 p.p. due to summer and autumn temperature rise, respectively. We also find that young and old firms use long-term bank loans when affected by seasonal weather. For instance, a 1°C rise in temperature during spring increases the likelihood that old firms use long-term loans by 0.22 p.p., while young firms increase the likelihood of using long-term loans by 0.32 p.p. in response to the rising temperature in autumn. However, we don't find differences in the use of short-term loans between young and old firms in Table 5, Panel A.

Regarding accrued expenses, our results show that only young firms use this strategy in response to temperature changes (see column 9, Panel A of Table 7). A 1°C rise in temperature during winter leads to a 0.14 p.p. drop in the use of short-term accrued expenses, while a 1°C rise in temperature during spring leads to a 0.22 p.p. increase in the use of this strategy by young firms in non-heat-sensitive industries.

We find no evidence that temperature affects the likelihood of using the capitalized development cost strategy by young and old firms in non-heat-sensitive industries (columns 11-12, Panel A in Table 7). Indirectly, this finding suggests that temperature changes do not hinder innovation among firms.

Next, our results suggest that old firms in non-heat-sensitive industries adjust their costs as temperatures rise. For instance, a 1°C rise in temperature during spring and autumn reduces the costs of old firms by 3.35 p.p. and 4.85 p.p., respectively. At the same time, the costs of young firms in non-heat-sensitive industries remain unaffected.

Table 7: Firms' Coping Strategies – Young vs. Old Firms

A: Non-heat-sensitive industries

Dep. Variables (=0/1)	Cash		Bank Loans				Accrued Expenses				Capitalized Development		ln(Costs)	
			Long-term		Short-term		Long-term		Short-term					
	(1) Young	(2) Old	(3) Young	(4) Old	(5) Young	(6) Old	(7) Young	(8) Old	(9) Young	(10) Old	(11) Young	(12) Old	(13) Young	(14) Old
Winter	-0.0001	0.0006	0.0005	-0.0009	-0.0011	-0.0018*	0.0002	0.0002	-0.0014**	-0.0004	0.0000	-0.0001	-0.0028	-0.0107
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.006)	(0.015)
Spring	0.0001	-0.0006	0.0006	0.0022**	0.0011	0.0028*	-0.0001	0.0001	0.0022**	-0.0004	-0.0001	0.0001	-0.0011	-0.0335**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.006)	(0.014)
Summer	-0.0012	0.0028**	-0.0013	-0.0003	0.0013	-0.0009	0.0000	0.0001	-0.0003	0.0005	0.0001	-0.0000	-0.0085	0.0298
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.012)	(0.020)
Autumn	0.0020	0.0041**	0.0032**	0.0022	0.0017	0.0040	0.0003	-0.0000	-0.0011	-0.0002	-0.0001	-0.0002	-0.0008	-0.0485**
	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)	(0.000)	(0.016)	(0.023)
Observations	1,132,114	636,514	1,140,760	639,961	1,138,119	639,394	1,140,969	639,992	1,139,607	639,779	1,141,613	640,131	1,098,555	605,542
R-squared	0.003	0.002	0.002	0.026	0.001	0.038	0.003	0.001	0.012	0.006	0.000	0.000	0.029	0.086

B: Heat-sensitive industries

Dep. Variables (=0/1)	Cash		Bank Loans				Accrued Expenses				Capitalized Development		ln(Costs)	
			Long-term		Short-term		Long-term		Short-term					
	(1) Young	(2) Old	(3) Young	(4) Old	(5) Young	(6) Old	(7) Young	(8) Old	(9) Young	(10) Old	(11) Young	(12) Old	(13) Young	(14) Old
Winter	-0.0007	-0.0006	-0.0009	0.0011	0.0004	0.0028	-0.0010**	0.0004	-0.0003	0.0001	-0.0001	0.0000	0.0324***	0.0114
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.008)	(0.019)
Spring	0.0006	-0.0012	0.0017	0.0011	0.0004	0.0000	0.0010*	0.0001	-0.0000	-0.0006	0.0001	-0.0000	-0.0250**	-0.0659***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.012)	(0.022)
Summer	-0.0024**	0.0010	0.0016	-0.0002	-0.0012	-0.0035	-0.0002	-0.0007	0.0009	0.0005	-0.0001	-0.0002	-0.0356***	-0.0362
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.010)	(0.024)
Autumn	0.0014	0.0046*	0.0011	-0.0020	0.0008	-0.0013	-0.0009	0.0014	0.0001	-0.0027	-0.0002	-0.0003*	0.0349	-0.0397
	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.006)	(0.001)	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)	(0.021)	(0.043)
Observations	422,853	254,072	426,860	255,997	425,548	255,673	426,915	256,019	426,417	255,934	427,178	256,062	411,959	243,780
R-squared	0.003	0.001	0.005	0.033	0.003	0.059	0.003	0.002	0.010	0.005	0.001	0.001	0.030	0.093

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends. Heat-sensitive industries include agriculture and forestry, construction, development and civil engineering, energy and mining, intermediary activities, waste management, education, transportation and logistics. The remaining industries are classified as non-heat-sensitive.

In heat-sensitive industries, young firms use cash-on-hand and long-term accrued-expenses strategies when affected by summer and winter temperatures (see columns 1 and 7, Panel B, Table 7). We also find that both older and younger firms in heat-sensitive industries do not use a capitalized development-cost strategy.

At the same time, we find evidence related to the firms' cost side. The costs increase by 3.24 p.p. for young firms when winter temperature rises by 1°C. This finding is consistent with the results on profit in Table 3, Panel B, column 3. It indicates that when winter temperatures rise, young firms adopt a cost-side strategy to maximize profits. In addition, young firms in heat-sensitive industries also reduce costs when heated by warm springs and hot summers. A 1°C increase in temperature during spring and summer reduces costs by 2.5 p.p. and 3.56 p.p., respectively. Old firms are also affected by warm temperatures, resulting in a 6.59 p.p. reduction in costs in spring. However, summer temperature has no statistically significant effect on the costs of old firms.

Overall, the findings suggest that coping strategies in response to rising temperatures may vary not only between firms in heat-sensitive and non-heat-sensitive industries, but also between young and old firms within those industries. Such differences may be related to competition, access to financial instruments, risk management, and resource availability (Crespo Cuaresma et al., 2014; Fidrmuc and Hainz, 2010; Iman et al., 2022; Nazarov and Obydenkova, 2020), and should be taken into account in the design of effective policies to improve firms' climate resilience.[14]

On the other hand, we show that both young and old firms are affected by increasing temperatures. This implies that even though young firms may be more innovative, their technologies or specialized management skills do not make them more resilient to the impacts of heat than old firms. In addition, we find that, in response to rising temperatures, cost reduction is a primary coping strategy for both young and old firms in heat-sensitive industries. This motivates future research to understand the reasons behind these results and to examine additional coping strategies that may help firms in these industries become more resistant and better prepared to the impacts of climate and weather changes.

6.5. FUTURE PROJECTIONS

In this section, we compute future economic projections for different scenarios. For this purpose, we combine findings from our study with future temperature projections for the 2040-2100 period in Slovakia, using end-of-century monthly weather projections

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[14] For examples of policy instruments to increase firms' resilience, see Bradley (2024); WEF (2024).

from the Copernicus Climate Change Service.[15] Temperature projections are generated by the Coupled Model Intercomparison Project (CMIP6), which is based on the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (IPCC, 2023). The dataset provides precipitation and near-surface air temperature data for Europe, allowing us to align future climate projections in Slovakia.

The projections are based on the Shared Socioeconomic Pathways (SSPs) and the Representative Concentration Pathways (RCPs), encompassing a wide range of potential global warming scenarios. Specifically, SSP1, SSP2, and SSP5 describe future economic development in terms of socioeconomic and demographic components. In particular, SSP1 is characterized by reasonable sustainable development, reduced inequalities, rapid technological change toward lower carbon-emission intensity, and high land productivity. SSP2 stands for moderate and uneven economic growth across countries and regions, a growing population, and moderate technological change in the energy sector. Finally, SSP5 represents the absence of climate policies, slower population growth, high energy demand from fossil fuels, and low investment in the green sector (O'Neill et al., 2014). RCPs quantify future greenhouse gas concentrations and the resulting radiative forcing, capturing the expected temperature increases driven by climate-related emissions.

To compute future economic development in Slovakia, we consider three RCPs to reflect different emissions trajectories by 2100: (i) SSP1-RCP2.6, representing a very low emissions scenario with global warming limited to below 2°C; (ii) SSP2-RCP4.5, a low to moderate emissions scenario with warming between 2°C and 4°C; and (iii) SSP5-RCP8.5, a high emissions scenario with projected warming of 4.3°C or higher. The differences among the selected RCPs become more pronounced after the mid-21st century, primarily due to differences among SSPs and the climate system's delayed response to changes in atmospheric greenhouse gas concentrations.

Figure 2 presents the results for the future economic performance of the Slovak firms for the 2040-2100 period. The computation is conducted based on the estimated coefficients on spring and summer for sales in heat-sensitive industries from Table 3 (Panel B, column 1).[16] That is, the figure shows the total projected impact of a 1°C temperature rise during spring and summer on sales in heat-sensitive industries across different scenarios. To alleviate the main exposition of our results, we compute all impacts for a 5-year step framework.

As shown in Figure 2, a pronounced temperature impact under the SSP5-RCP8.5 sce-

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[15] For a detailed discussion of future projections, see https://cds.climate.copernicus.eu

[16] The computation for revenue and profit variables is similar and is available upon request.

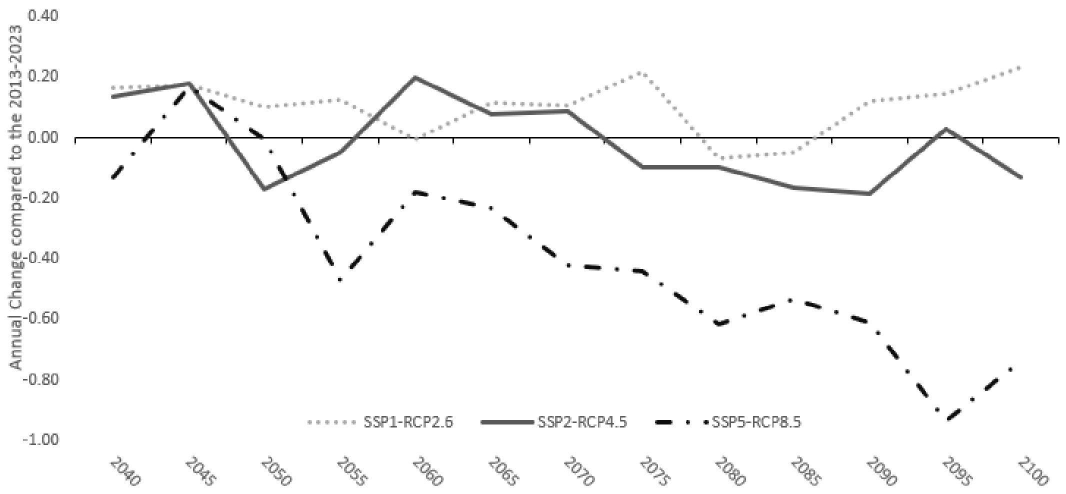

Figure 2: Projected Sales Trends by Scenario (2040–2100).

Source: Authors' calculation. The figure shows the total projected impact of a 1°C temperature rise during spring and summer on sales in heat-sensitive industries across different scenarios. The computation is based on the estimated coefficients from Table 3 (Panel B, column 1).

nario (a dash-dotted line) leads to significant economic losses, reaching up to 20 p.p. in 2050 relative to the study period. In 2055, the losses are twofold, with a rebound in 2060. This scenario shows a downward trend in the Slovak economy. In contrast, temperature has either a positive or no impact under the SSP1-RCP2.6 scenario (dotted line), underscoring the importance of enforcing climate policy in Slovakia and globally. Finally, the results under the SSP2-RCP4.5 (a black solid line) scenario lie between the previous two scenarios, indicating projected economic losses in a fragmented world. That is, when some countries introduce climate policies while others do not.

6.6. ADDITIONAL RESULTS AND CHECKS

In this section, we present additional results and address potential concerns, conducting a battery of robustness checks.

First, firms may have multiple establishments in several regions. However, we use pooled information from the balance sheets of all establishments provided by the headquarters. This implies that our results may reveal the effects of temperature on the performance of the firm's headquarters, whereas the effects on individual establishments are less clear. To alleviate this concern, we remove firms with multiple establishments from our analysis. As shown in Table 8, the estimated coefficients and corresponding significance levels are very similar to those in Table 3, Panel B. Thus, the results are robust to this sample modification. This is an expected result, since more than 80% of firms in Slovakia are single establishments.

Table 8: Firms with Multiple Establishments are Excluded

Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum. Profit
Winter	0.0179	0.0197	0.0390**	0.0005
	(0.020)	(0.015)	(0.015)	(0.004)
Spring	-0.0924***	-0.0900***	-0.0696***	-0.0138***
	(0.025)	(0.024)	(0.021)	(0.004)
Summer	-0.0715***	-0.0646***	-0.0477***	-0.0074*
	(0.021)	(0.020)	(0.015)	(0.004)
Autumn	0.0385	0.0353	0.0066	0.0136*
	(0.061)	(0.059)	(0.046)	(0.008)
Observations	590,778	590,564	350,750	568,026
R-squared	0.003	0.004	0.020	0.004

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends.

Second, as discussed in section 4, a substantial share of firms in Slovakia are micro-enterprises. As of 2023, about 60% of Slovak firms have one employee (i.e., “solopreneurs"). To show that those firms do not drive our results for heat-sensitive industries, we exclude them from our analysis. In Table 9, the estimated coefficients are not different from those in Table 3, Panel B. This indicates that our results hold for all firms in heat-sensitive industries regardless of their size.

Third, a potential concern is that our results may be driven by firms operating in specific industries within the heat-sensitive group. To show that this is not the case, we conduct an additional robustness check by removing one industry from the sample at a time while keeping all others. Figure 3 shows the results for sales, revenue, profit, and the likelihood of earning a positive profit. As shown, the estimated coefficients remain negative and similar to those in the baseline (Table 3, Panel B), alleviating concerns about industry-driven results.

An alternative way to analyze the impact of seasonal temperatures on firms' performance is to use deviations from historical means rather than the temperatures themselves. To do so, we compute temperature deviations for each season relative to its historical mean since 1961. For instance, to compute seasonal temperature deviations in 2013, we use seasonal temperature means based on the 1961-2012 period; for 2014, based on 1961-2013, and so on. The results are presented in Table 10. As shown in this table, the estimated coefficients are statistically the same as in Table 3, Panel B, alleviating potential concerns regarding the model specification.

Table 9: Small Firms are Excluded

Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum. Profit
Winter	0.0134	0.0151	0.0258	0.0045
	(0.023)	(0.019)	(0.020)	(0.005)
Spring	-0.0632**	-0.0674**	-0.0497**	-0.0148***
	(0.027)	(0.026)	(0.024)	(0.004)
Summer	-0.0695***	-0.0637***	-0.0638***	-0.0111**
	(0.024)	(0.020)	(0.023)	(0.005)
Autumn	0.0300	0.0287	-0.0058	0.0200**
	(0.071)	(0.069)	(0.046)	(0.010)
Observations	392,016	391,897	239,347	377,720
R-squared	0.007	0.009	0.019	0.005

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends.

Another potential concern is that the interaction between seasonal temperature and seasonal precipitation may amplify the impact of temperature. To address this, Eq. 1 is estimated with interaction terms. As shown in Table 11, the estimated coefficients on temperature are statistically the same as in Table 3, Panel B.[17] Moreover, the interaction terms are either not statistically significant or have a negligible magnitude, suggesting that the baseline model specification is adequate.

Next, the literature suggests that chronic and acute climate risks should be considered separately in a single framework (Piontek et al., 2025). The chronic risks represent long-term climate impacts (e.g., the impact of historical mean temperature on labor productivity, agricultural productivity, or health conditions), while the acute risks represent extreme event impacts (e.g., high-damage extremes in a particular location and period, such as extreme hot days, heat waves, storms, etc.). To respond to this question, we additionally introduce the number of extremely hot days (above 30°C) within a year into Eq. 1. The results are presented in Table 12. As shown, the estimated coefficients and their signs are similar. However, for profit (column 3), the estimated coefficients on spring and summer temperatures become less significant, while the coefficient on the number of days above 30°C is statistically significant. This may occur because chronic and acute risks overlap, as the summer variable and the number of hot days are measured in the same season. Thus, it is sufficient to consider only seasonal temperatures.

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[17] One exception is winter's temperature impact on profit and the summer's temperature impact on the likelihood of earning a positive profit, where the estimates remain similar in magnitude and sign to those in Table 3, Panel B, but become statistically insignificant.

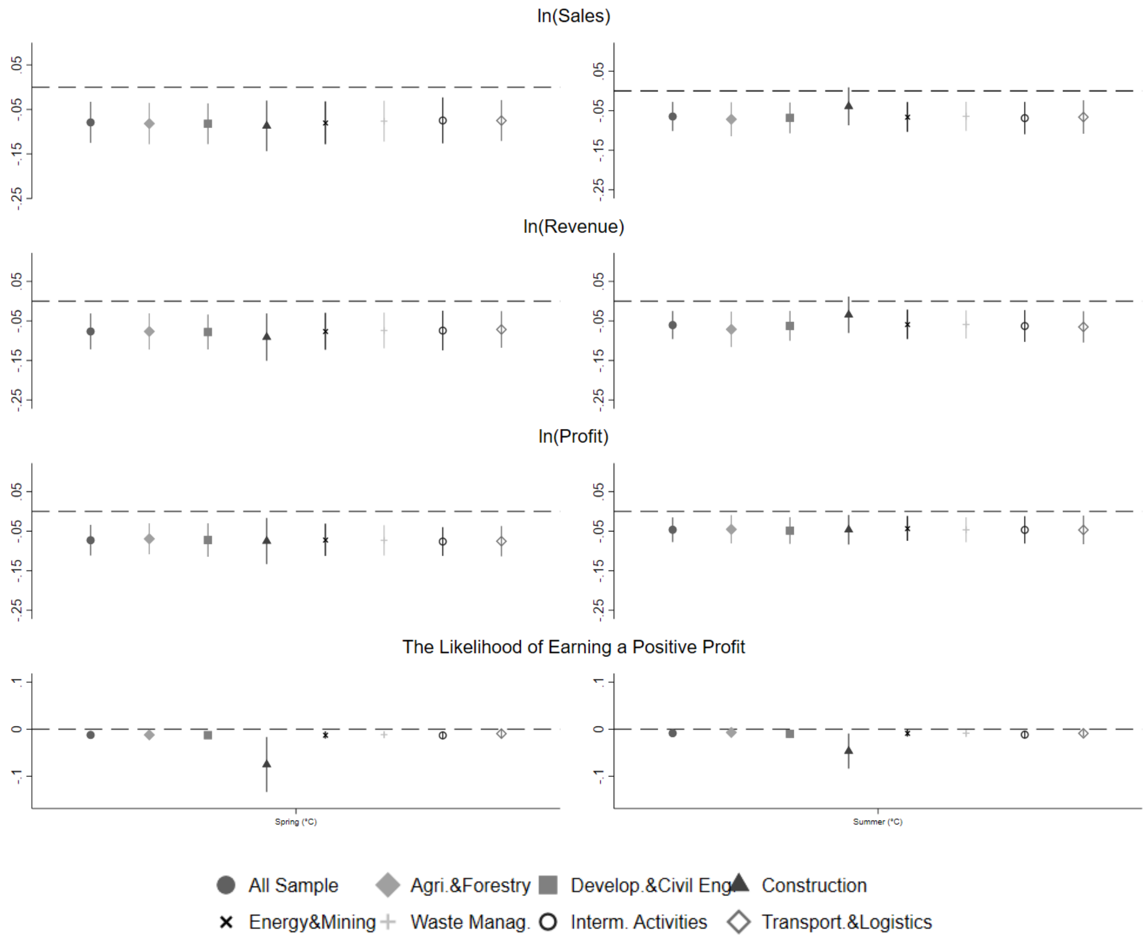

Figure 3: The Impact of Temperature in Heat-sensitive Industries

Source: Authors' construction. *Notes:* The figure shows the impact of temperature on sales, revenues, profit, and the likelihood of earning a positive profit in heat-sensitive industries after removing one industry from the sample at a time. "All sample" results correspond to the results from Table 3, Panel B.

However, more research is required in this direction since our analysis is based on a moderate number of periods.[18]

Next, to demonstrate that our findings are not artifacts of the data, we perform a counterfactual (placebo) analysis. For this purpose, we randomly select temperatures from each seasonal distribution for every firm in our sample during the 2013-2023 period and repeat this exercise 1,000 times. If our analysis is a data artifact, then the estimated coefficients on each season from a placebo analysis would overlap with our estimates in Table 3 (column 1). In addition, the large share of these placebo estimates will be statistically significant.[19] As shown in Figures A1 and A2 in the appendix, most of the placebo

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[18] For a detailed discussion, see the recent report by the Network for Greening the Financial System (NGFS) (Piontek et al., 2025).

[19] For the sake of space, our placebo analysis discussion is built on the significance of coefficients for sales and TFP (corresponding to the baseline results in Table 3, column 1, and Table 4, column 4, respec-

Table 10: Deviations from the Long-term Trends

Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum. Profit
Winter Temp. Dev.	0.0128	0.0130	0.0405***	0.0012
	(0.017)	(0.013)	(0.014)	(0.004)
Spring Temp. Dev.	-0.0823***	-0.0800***	-0.0754***	-0.0134***
	(0.022)	(0.021)	(0.020)	(0.004)
Summer Temp. Dev.	-0.0679***	-0.0616***	-0.0463***	-0.0068**
	(0.018)	(0.018)	(0.015)	(0.003)
Autumn Temp. Dev.	0.0252	0.0293	0.0124	0.0163**
	(0.055)	(0.053)	(0.041)	(0.007)
Observations	683,268	683,032	409,311	659,177
R-squared	0.003	0.004	0.019	0.004

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Winter Temp. Dev., Spring Temp. Dev., Summer Temp. Dev., and Autumn Temp. Dev. denote the seasonal temperature deviations from their respective historical means since 1961. For instance, to compute seasonal deviations for temperature in 2013, seasonal temperature means are based on the 1961-2012 period; for 2014, based on 1961-2013, and so on. Each model also includes seasonal precipitation deviations (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends.

estimates are around zero and only 6% of them are statistically significant, indicating that our results are not the data feature and adequately capture the studied effects.

We also assess whether our results change when additional control variables are included. For instance, a firm's high performance in the current period may lead to its high performance in the next year. To account for this, we introduce lagged dependent variables into Eq. 1. We also include additional explanatory variables, such as the natural logarithm of firms' age, categories for the number of employees, and the natural logarithms of liabilities and total assets. However, these additional variables may themselves be highly correlated with temperature, and thus, the results of such specifications should be interpreted with caution. As suggested by Dell et al. (2014), adding controls that are themselves influenced by the weather may lead to biased estimates. In our case, the lags of the dependent variables depend on the previous period's weather, which is highly correlated with the current period's weather. The firm-specific extra variables also correlate with the current temperature.

Table A1 in the appendix presents the results for alternative specifications. As shown, the signs of the estimates are the same as in our baseline specification in Table 3, Panel B (columns 1-4). The confidence intervals of the estimates in Table 3 (Panel B) and A1 also overlap for most specifications. If we compute the total impact for spring and

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tively). The results for other dependent variables are available upon request.

Table 11: Interaction Terms between Temperature and Precipitation

Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum. Profit
Winter Temp.	0.0067	0.0108	0.0374	-0.0012
	(0.022)	(0.020)	(0.023)	(0.005)
Spring Temp.	-0.0799***	-0.0875***	-0.0790**	-0.0129**
	(0.024)	(0.027)	(0.032)	(0.005)
Summer Temp.	-0.0759***	-0.0729***	-0.0629***	-0.0015
	(0.025)	(0.023)	(0.021)	(0.004)
Autumn Temp.	0.0379	0.0384	0.1145**	-0.0032
	(0.063)	(0.058)	(0.057)	(0.009)
Winter Prec.	-0.0005	-0.0002	0.0003	0.0002
	(0.001)	(0.001)	(0.001)	(0.000)
Spring Prec.	-0.0009	-0.0037	-0.0038	-0.0000
	(0.007)	(0.007)	(0.006)	(0.001)
Summer Prec.	0.0000	-0.0007	0.0043	0.0021**
	(0.006)	(0.006)	(0.005)	(0.001)
Autumn Prec.	0.0047	0.0041	0.0240**	-0.0039**
	(0.008)	(0.008)	(0.010)	(0.002)
Winter Temp.×Prec.	0.0003	0.0003	0.0007	0.0000
	(0.001)	(0.001)	(0.001)	(0.000)
Spring Temp.×Prec.	-0.0001	0.0002	0.0002	-0.0000
	(0.001)	(0.001)	(0.001)	(0.000)
Summer Temp.×Prec.	0.0000	0.0001	-0.0002	-0.0001**
	(0.000)	(0.000)	(0.000)	(0.000)
Autumn Temp.×Prec.	-0.0004	-0.0003	-0.0019**	0.0004***
	(0.001)	(0.001)	(0.001)	(0.000)
Observations	683,268	683,032	409,311	659,177
R-squared	0.003	0.004	0.019	0.004

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Winter Temp., Spring Temp., Summer Temp., Autumn Temp., Winter Prec., Spring Prec., Summer Prec., and Autumn Prec. denote the seasonal temperature (in °C) and seasonal precipitation (in mm), respectively. Winter Temp.×Prec., Spring Temp.×Prec., Summer Temp.×Prec., and Autumn Temp.×Prec. are interaction terms between corresponding seasonal temperature and seasonal precipitation. Each model also includes firm and year fixed effects, and region- and industry-specific linear and quadratic time trends.

summer based on the significance of the estimates in Table A1, we find that the total impact is underestimated compared with the estimates in Table 3 (Panel B).

7. CONCLUSION

This study provides an in-depth contribution towards understanding the impact of temperature on firms' performance. Using the universe of firm-level data from Slovakia between 2013 and 2023, we present evidence that rising temperatures hurt firm perfor-

Table 12: Chronic vs. Acute Risks

Dep. Variables:	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum. Profit
Winter	-0.0040	-0.0031	0.0142	0.0015
	(0.021)	(0.017)	(0.016)	(0.004)
Spring	-0.0584**	-0.0570**	-0.0387*	-0.0139***
	(0.025)	(0.025)	(0.022)	(0.004)
Summer	-0.0489**	-0.0432**	-0.0139	-0.0072*
	(0.019)	(0.019)	(0.016)	(0.004)
Autumn	0.0063	0.0111	-0.0154	0.0167**
	(0.056)	(0.055)	(0.043)	(0.008)
Days above 30°C	-0.0028*	-0.0027*	-0.0044***	0.0000
	(0.002)	(0.002)	(0.001)	(0.000)
Observations	683,268	683,032	409,311	659,177
R-squared	0.003	0.004	0.019	0.004

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends.

mance. Specifically, we show that even a 1°C increase—particularly during spring and summer—leads to significant declines in sales, revenues, and profits. These effects are particularly severe in heat-sensitive industries, including manufacturing, agriculture, construction, and transportation.

Our analysis goes beyond measuring the direct impacts. We find that total factor productivity (TFP) is the main channel through which higher temperatures affect firms. In comparison, changes in labor and capital productivity contribute less. In addition, we examine how firms adapt. The findings suggest that firms in heat-sensitive industries tend to rely primarily on cost-reduction strategies to mitigate losses. This may indicate more limited access to financial instruments and a reliance on short-term, reactive measures.

Our findings emphasize the need for targeted policy instruments and support mechanisms that account for industry-specific exposure to higher temperatures and firm-level constraints. Economic losses will likely increase as climate risks intensify, particularly in vulnerable sectors. Our projections indicate that if no action is taken and climate follows the high emissions scenario with projected warming of 4.3°C or higher (RCP8.5), Slovak firms will face a significant adverse impact due to the temperature rise. Therefore, strengthening firms' adaptive capacity is essential to ensuring economic resilience during ongoing climate change.

This paper contributes to the growing literature on climate change impacts at the firm level. To the best of our knowledge, this is the first study to examine firms' reactions across the entire economy. Our findings emphasize the importance of integrating weather-related risks into firm strategy, financial planning, and economic policy design.

Our study opens several avenues for future research. First, our findings emphasize the importance of designing and enforcing climate adaptation strategies at the firm level, particularly in economies with a high share of heat-sensitive industries, which are increasingly prone to climate risks. A better understanding of why and how different coping strategies can be used is essential for the sustainable development of such economies. In addition, our findings indicate that young and old firms may differ in their use of coping strategies. A deeper understanding of these differences and their underlying causes may help design more tailored policy measures for future (small) business development and strengthen the climate resilience of existing firms. Finally, an additional analysis is needed to understand the role of confounded chronic and acute climate risks in firms' performance. This can be addressed in future research, when a longer time span of firm-level data becomes available for analysis.

A. APPENDIX

Table A1: Results with Additional Explanatory Variables.

	(1) ln(Sales)	(2) ln(Revenue)	(3) ln(Profit)	(4) Dum. Profit	(5) ln(Sales)	(6) ln(Revenue)	(7) ln(Profit)	(8) Dum. Profit	(9) ln(Sales)	(10) ln(Revenue)	(11) ln(Profit)	(12) Dum. Profit	(13) ln(Sales)	(14) ln(Revenue)	(15) ln(Profit)	(16) Dum. Profit
Winter	0.0099	0.0103	0.0213	0.0022	0.0074	0.0074	0.0383***	0.0011	0.0109	0.0105	0.0389***	0.0012	-0.0032	0.0057	0.0274	0.0060
	(0.015)	(0.013)	(0.017)	(0.003)	(0.017)	(0.013)	(0.014)	(0.004)	(0.018)	(0.013)	(0.014)	(0.004)	(0.016)	(0.011)	(0.017)	(0.005)
Spring	-0.0455**	-0.0466**	-0.0437	-0.0105**	-0.0760***	-0.0735***	-0.0754***	-0.0134***	-0.0887***	-0.0854***	-0.0803***	-0.0136***	-0.0308*	-0.0294*	-0.0263	-0.0116**
	(0.018)	(0.019)	(0.029)	(0.004)	(0.021)	(0.021)	(0.020)	(0.004)	(0.021)	(0.020)	(0.020)	(0.004)	(0.018)	(0.016)	(0.018)	(0.006)
Summer	-0.0848***	-0.0815***	-0.0315	-0.0082**	-0.0616***	-0.0553***	-0.0452***	-0.0068**	-0.0561***	-0.0502**	-0.0422***	-0.0067*	-0.0352*	-0.0299	-0.0231	-0.0189***
	(0.019)	(0.019)	(0.020)	(0.004)	(0.018)	(0.017)	(0.015)	(0.003)	(0.020)	(0.020)	(0.014)	(0.003)	(0.020)	(0.019)	(0.018)	(0.005)
Autumn	0.0193	0.0252	0.0707	0.0093	0.0308	0.0344	0.0143	0.0167**	0.0020	0.0073	0.0091	0.0162**	-0.0225	-0.0119	0.0209	0.0063
	(0.035)	(0.034)	(0.050)	(0.007)	(0.048)	(0.046)	(0.041)	(0.007)	(0.062)	(0.059)	(0.045)	(0.007)	(0.038)	(0.032)	(0.038)	(0.008)
Lag of Dep. Var.	0.3412***	0.3195***	0.2407***	0.0628***	-	-	-	-	-	-	-	-	-	-	-	-
	(0.004)	(0.004)	(0.005)	(0.002)	-	-	-	-	-	-	-	-	-	-	-	-
Ln(age)	-	-	-	-	2.1238***	2.1898***	0.6446***	0.0574***	1.7602***	1.8497***	0.5546***	0.0521***	0.1127***	0.1778***	-0.1273***	-0.0284***
	-	-	-	-	(0.029)	(0.030)	(0.019)	(0.003)	(0.029)	(0.031)	(0.018)	(0.003)	(0.031)	(0.026)	(0.026)	(0.005)
Nr. of Employees:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
10–19 Employees	-	-	-	-	-	-	-	-	2.2605***	2.0582***	0.6832***	0.0576***	0.8630***	0.7274***	0.1368***	0.0060
	-	-	-	-	-	-	-	-	(0.047)	(0.023)	(0.005)	(0.029)	(0.024)	(0.020)	(0.006)	
100+ Employees	-	-	-	-	-	-	-	-	1.7296***	1.5822***	0.4865***	0.0308***	0.7007***	0.5926***	0.0933***	-0.0049
	-	-	-	-	-	-	-	-	(0.038)	(0.035)	(0.032)	(0.017)	(0.003)	(0.020)	(0.016)	(0.016)
(0.003)																
No Info on Size	-	-	-	-	-	-	-	-	-0.9177***	-0.8893***	-0.2426***	-0.0083***	-0.5902***	-0.5522***	-0.0921***	0.0086*
	-	-	-	-	-	-	-	-	(0.032)	(0.033)	(0.016)	(0.003)	(0.031)	(0.028)	(0.020)	(0.004)
ln(Liabilities)	-	-	-	-	-	-	-	-	-	-	-	-	0.8391***	0.7746***	0.6481***	0.0960***
	-	-	-	-	-	-	-	-	-	-	-	-	(0.013)	(0.012)	(0.009)	(0.002)
ln(Total Assets)	-	-	-	-	-	-	-	-	-	-	-	-	0.8300***	0.7666***	0.6504***	0.0969***
	-	-	-	-	-	-	-	-	-	-	-	-	(0.022)	(0.018)	(0.014)	(0.003)
Observations	572,259	572,033	263,774	546,325	683,246	683,010	409,299	659,157	683,246	683,010	409,299	659,157	335,318	335,259	215,162	333,729
R-squared	0.142	0.127	0.074	0.007	0.048	0.055	0.029	0.005	0.097	0.099	0.040	0.006	0.199	0.206	0.100	0.024

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Winter, spring, summer, and autumn denote average temperature in the respective season (in °C). Each model includes average precipitation in each season (in mm), firm and year fixed effects, and region- and industry-specific linear and quadratic time trends.

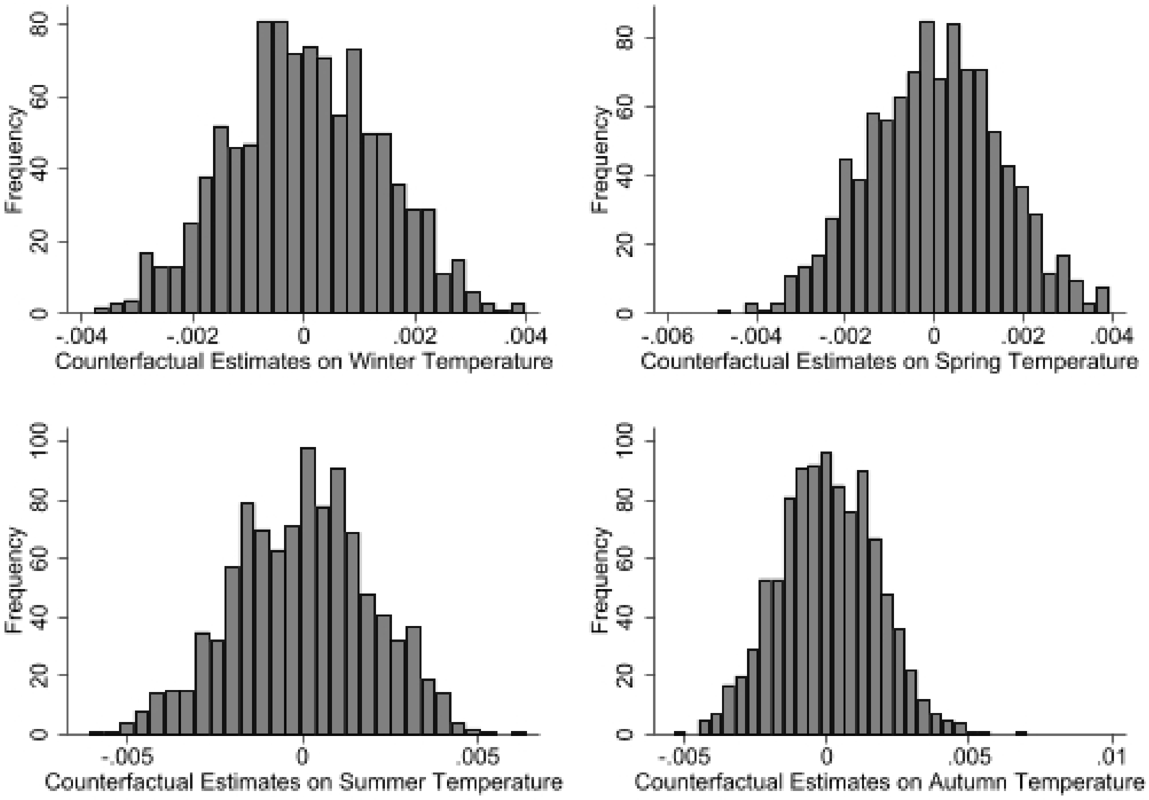

Figure A1: Placebo on Sales

Source: Authors' construction. *Notes:* The figure shows the estimated impact of temperature on sales in heat-sensitive industries using the counterfactual seasonal temperature distribution.

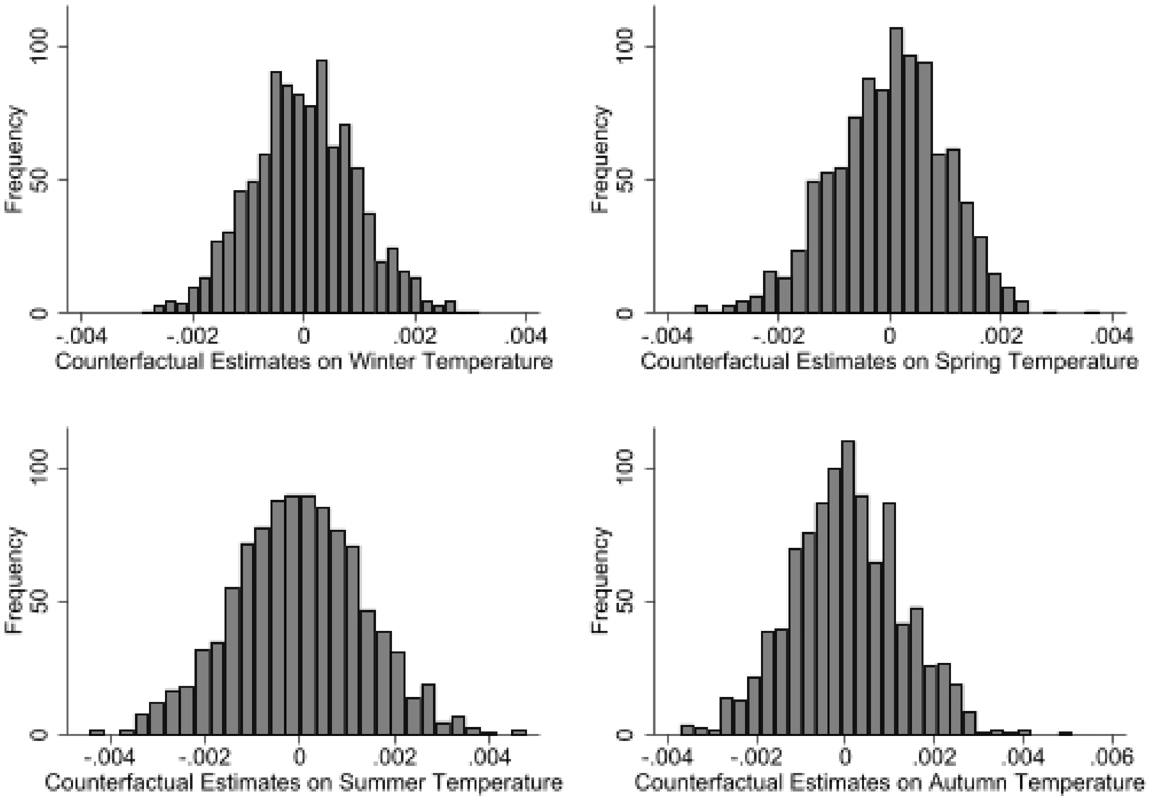

Figure A2: Placebo on TFP

Source: Authors' construction. *Notes:* The figure shows the estimated impact of temperature on TFP in heat-sensitive industries using the counterfactual seasonal temperature distribution.

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