THE FINANCIAL SITUATION OF AGRIBUSINESSES IN RELATION TO CLIMATIC CONDITIONS: EVIDENCE FROM THE V4 COUNTRIES

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Abstract

The aim of the article is to provide a detailed statistical description and evaluation of the mutual relationship between the development of two types of agribusinesses' cash flows which represent the capacities of farms to save and self-finance in relation to changes in basic climatic parameters (i.e. temperature, precipitation). The calculations have been based on data obtained from the FADN (Farm Accountancy Data Network) and the CCKP (Climate Change Knowledge Portal). The figures on the V4 countries come from the period between 2004 and 2020. In terms of the net worth of agribusinesses and the values of their capital, V4 countries could be split into two groups. In Hungary and Poland, the development of temperature changes and the net worth or enterprise capital levels are moving in the same directions, while agribusinesses in Slovakia or Czechia, negative, but low correlation coefficients were measured. Regarding the relationship between cash flow and climatic conditions, we conclude that temperature changes are not happening to be a distinctive factor on the level of countries, but rather something that the whole Central European region has in common: the trend is suggesting the existence of a slight growing tendency and consequently pointing us to a direct relationship, but the nature of this relationship is rather weak and not indicative. The interaction of cash flow and of the development of precipitation levels is showing relatively more dynamics and fluctuations for all agro-businesses in the researched V4 countries. This results in a rising trend line where the yearly precipitation level is ranging from approximately 500 mm to 750 mm. Agro-businesses, mostly in Czechia and Slovakia, in the years when precipitation levels exceed 750 mm per year report relatively lower levels of cash flows.

Keywords: cash flow, FADN, agribusiness, climate change, V4 countries

JEL Classification: M21, Q14, Q13

Introduction and theoretical background

Cash flow statements and budgets are in general one of the main parts of agribusinesses' business economic management. In his study, originally focused on the Green Paradox, Österle (2016) states, among other conclusions, that the taxation of cash flow and the increase of this taxation are one of the effective tools for dealing with climate change. Chukwuezie et al. (2016) bring the macro view where they conclude that on the global level (i.e. regarding the stock of global financial assets) the discounted global cash flow is higher when modulated to the pre-industrial level of climatic parameters. The cash flow of entities is in general an important part of the global cash flow; that is why we assume it interesting to look at the mutual development of cash flows of agribusinesses and basic climatology parameters to assess whether there are any signs of co-dependency between such variables.

Hong et al. (2020) is among the many authors who claim that given the already proved macroeconomic impact of climate change, asset prices should be prone particularly also to the exposure of their cash flows to various climate risks, and research on this particular relationship (climate change parameters – cash flow fluctuations) regards as one of the very important ones in the whole climate finance research area. Nevertheless, the topic is not entirely new, but for climate economists this has been a topic since the 1980s, e.g. in (Montross et al., 1997; Lee et al., 1987; Ziauddin and Liang, 1986; Poling and Safley, 1986).

More than 40 years later, Brahmana and Kontesa (2023) studied the impact of temperature anomalies on cash holdings. The study worked with a sample of fishery companies based in 27 countries in the timespan from 2013 to 2019. The results indicate a positive relationship between cash holdings and temperature anomalies. Authors also pointed out that companies tend to possess higher amounts of cash in response to higher temperature anomalies.

However, it is essential to add that although cash flow and cash holdings have a couple of important common features, there are significant disparities between them. Cash flow is an annual range, and derived from adjusted annual profits, while cash holdings are characterized as a cumulative cash balance on the balance sheet. Financially deprived enterprises are less likely to enter capital markets, so it is apparent that holding cash could be in favor of their investment needs (either current or the future ones) (Chan et al., 2013).

Addoum et al. (2021) documented the impacts of temperature exposures on the actual earnings of enterprises in 59 different industries, while putting emphasis on the cash flow channel (in the form of operating cash flow). They argued that this could allow for the better understanding of the real economic impacts and effects of climate change on enterprises. Sensitivity to extreme temperature (either extreme heat or extreme cold) was measured in 24 out of 59 industries.

However, their hypothesis that temperature extremes will have significant effects on profitability in agricultural and related industries was not supported by sufficient evidence. On the other hand, they also stated that the reason for this result may lie in their focus solely on publicly traded firms, so the researched sample included only a few companies directly involved in farming and agricultural production. Their inclusion could bring different results.

Addoum et al. (2021) also concluded that there are no significant relations in industries such as agricultural product producers, producers of packaged meet and food, or staples and food retailing. Also, they were able to find significant extreme temperature effects among firms in the beverages and hotels and catering industries.

They also state that the earning effects they describe were prevalently revenue driven rather than a cost channel, suggesting that they may be more consumer demand driven than agricultural crop yields.

Huang et al. (2018) directly studied the impacts of climate-related risk on financial situations and choices made by publicly listed firms around the world through the Global Climate Risk index. They were able to prove that the likelihood of loss from major catastrophic climate events, such as storms, floods, heat waves, etc. need to be associated with lower and more volatile earnings and cash flow. Their findings are in agreement with policies that try to moderate these negative effects. They also concluded that enterprises located in countries characterized by more severe weather conditions are more prone to posses more cash to build financial slack and thereby some kind of organizational resilience to threats resulting from climate change. Those enterprises also tend to have less short-term debt and more long-term debt, and to have lower probability to be able to distribute cash dividends.

Since there is a lack (or absence) of studies of this kind of enterprises in the European area, we decided to inspect the relationship between the basic climatic condition parameters and cash flow for agricultural enterprises in the Visegrad 4 countries – Slovakia, Czechia, Poland and Hungary (hereinafter referred to as the V4).

Material and methods

In the analysis we worked with 5 variables describing the financial situation (economic size, net worth, average farm capital, cash flows), 2 variables representing basic climatic conditions in the researched countries where agribusinesses carry out their business activities (mean annual temperature change, total sum of precipitation of identified period), and through the 3 additional variables we provide information on the number of agribusinesses represented in our data sample (minimum and maximum number of enterprises and the represented enterprises in the particular country).

Regarding the representativeness of the data sample, we refer to the methodology of the Farm Accountancy Data Network, whose data set we use as the only resource of the economic parameters used in this study. Ramsey and Hewitt (2005) state that data samples must meet 2 conditions: a) containing only farms which belong to the field of observation, and b) the included farms must represent an identical distribution presented by the farms in the field of observation. According to the FADN (2018) methodology guide, the fulfilment of the second condition is provided by the procedure used for the extraction of the farms from the field of observation, which classifies the farms according to 3 criteria – geographical district, type of farming and economic size (classification variables defined in the Regulation on the Typology of agricultural holdings (European Commission, 2008). For the details on the process of the stratification, i.e., extraction of the representative sample as well as further details about meeting the conditions of representativeness see Mari (2020).

Below we provide further information on each variable used in our analysis:

- *Economic size* of agri-enterprise (measured in thousands of euros of standard output (based on Community typology, abbreviation used: econ_size, method of calculation: total economic size in euros divided by 1,00 euros, which is equal to 1 ESU–European size unit defined as a fixed number of ECU of Farm Gross Margin based on the Commission Decision 90/36, data source: *Farm Accountancy Data Network*)

- *Net worth* (measured in euros, abbreviation used: net_worth, calculation: total assets of the agribusinesses minus total liabilities of the agribusinesses, data source: *Farm Accountancy Data Network*)
- *Average capital* of the agro-enterprise except land and quotas (measured in euros, abbreviation used: farm_cap, calculation: average value = arithmetic mean of the opening and closing values, the formula sums up the following: livestock, permanent crops, land improvements, buildings, machinery and equipment, circulating capital; the value of quotas and other prescribed rights are not included as they cannot always be separated from the value of land, it is calculated only if land capital is recorded independently from the value of buildings, data source: *Farm Accountancy Data Network*)
- *Cash flow 1* (measured in euros, abbreviation used: CF1, represents the enterprise's capacity for saving and self-financing, calculated as the following stream: receipts minus expenditure for the accounting year, with no operations on capital and on debts and loans, net receipts of agricultural activity and other receipts (plus the balance agro-enterprise subsidies and taxes, plus balance subsidies and taxes on investments), sales of products, other receipts and sales of livestock (minus all costs paid, minus purchases of livestock), receipts minus expenditure for the accounting year, net receipts of agricultural activity and other receipts (plus balance agro-enterprise subsidies and taxes, plus balance subsidies and taxes on investments), sales of products, other receipts and sales of livestock (minus all costs paid, minus purchases of livestock, plus agro-enterprise subsidies, minus agro-enterprise taxes, plus VAT balance, plus subsidies on investments, minus taxes on investments), data source: *Farm Accountancy Data Network*)
- *Cash flow 2* (measured in euros, abbreviation used: CF2, represents the enterprise's capacity for saving and self-financing, calculated as the following stream: receipts deprived of values of expenditure for the accounting year, net receipts of agricultural activity and other receipts (added balance farm subsidies and taxes, balance subsidies and taxes on investments, add balance of operations on capital, balance of operations on debts and loans), sales of products, other receipts and sales of livestock (deprived of all costs paid and purchases of livestock, added enterprise subsidies, minus enterprise taxes, added VAT balance, subsidies on investments, minus taxes on investments, plus sales of capital deprived of investments, plus closing valuation of debts deprived of opening valuation of debts), data source: *Farm Accountancy Data Network*)
- *Precipitation* (measured as a sum over an identified period in millimetres, abbreviation used: precipitation data source: Climate Change Knowledge Portal)
- *Mean annual temperature change* (measured in Celsius degrees, abbreviation used: temp_change, annual mean temperature anomalies, i.e., temperature change with respect to a baseline climatology, corresponding to the period 1951–1980, data are based on the publicly available GISTEMP data, the Global Surface Temperature Change data distributed by the National Aeronautics and Space Administration Goddard Institute for Space Studies (NASA-GISS), source of the data: *Climate Change Knowledge Portal*)
- *Minimum of the sample agribusinesses* (measured as the number of enterprises in the sample, minimum value, abbreviation used: sample_min, data source: Farm Accountancy Data Network)
- *Maximum of the sample agribusinesses* (measured as the number of enterprises in the sample, maximum value, abbreviation used: sample_max, data source: *Farm Accountancy Data Network*)

- Agribusinesses represented (measured as a sum of weighting coefficients of individual enterprises in the sample, abbreviation used: farm_rep, data source: Farm Accountancy Data Network)

Table 1: Descriptive statistics, data sample of V4 countries, timespan: 2004–2020, frequency: annual

Variable	Mean	SD	Min.	Perc.25	Perc.75	Max.
country: Czechia						
Economic size (thousand €)	254.52	33.68	215.6	234.5	274.1	356.5
Net worth (€)	548508.47	80852	436051	493598	599058	686271
Average capital (€)	632300.06	84214.54	516182	563192	699217	782118
CF1 - Cash Flow 1 (€)	64881.53	15373.93	37104	55228	77711	88325
CF2 - Cash Flow 2 (€)	96757.29	101997.65	10688	22796	216888	277231
Precipitation (sum over identified period in mm)	690.69	75.95	567.52	644.41	735.54	868.6
Mean annual temperature change (Celsius degrees)	1.63	0.72	0.44	0.97	2.19	2.67
Sample agribusinesses (min)	1000	0	1000	1000	1000	1000
Sample agribusinesses (max)	2000	0	2000	2000	2000	2000
Agribusinesses represented (nb)	16508.41	1430.31	13899	15713	18007	18161
country: Hungary						
Economic size (thousand €)	51.33	6.51	39.4	46.9	56.1	61.8
Net worth (€)	135515.82	33629.89	81366	104059	163040	185872
Average capital (€)	124998.41	20327.79	86520	112675	137738	155762
CF1 - Cash Flow 1 (€)	21747.59	6309.19	8952	18533	25239	31936
CF2 - Cash Flow 2 (€)	5974.41	9643.43	-9026	-2604	14321	17587
Precipitation (sum over identified period in mm)	628.71	95.26	426.56	591.21	668.29	864.96
Mean annual temperature change (Celsius degrees)	1.55	0.7	0.27	0.92	2.1	2.58
Sample agribusinesses (min)	1294.12	469.67	1000	1000	2000	2000
Sample agribusinesses (max)	2294.12	469.67	2000	2000	3000	3000

Agribusinesses represented (nb)	105877.65	5462.92	94240	102448	110696	111878
country: Poland						
Economic size (thousand €)	26.22	5.28	18.7	20.6	31.6	32.7
Net worth (€)	132974.12	43516.08	61445	92371	163183	182654
Average capital (€)	79580.47	11987.93	55305	72053	87614	95129
CF1 - Cash Flow 1 (€)	12598.18	2231.6	7791	11869	14248	15687
CF2 - Cash Flow 2 (€)	8683.53	2495.96	1236	7850	10171	11314
Precipitation (sum over identified period in mm)	615.02	77.06	504.13	554.53	665.93	794.6
Mean annual temperature change (Celsius degrees)	1.56	0.75	0.4	0.84	2.15	2.65
Sample agribusinesses (min)	10000	0	10000	10000	10000	10000
Sample agribusinesses (max)	20000	0	20000	20000	20000	20000
Agribusinesses represented (nb)	736780.06	7179.99	725572	733856	739289	749204
country: Slovakia						
Economic size (thousand €)	395.01	56.94	308.9	343.4	448	463.9
Net worth (€)	864419.65	318203.99	609340	665842	878264	1608270
Average capital (€)	1060289.82	261977.7	752601	921144	1246762	1665371
CF1 - Cash Flow 1 (€)	63984.65	23942.78	23605	49970	73776	120703
CF2 - Cash Flow 2 (€)	-12817.65	34674.06	-85407	-25936	1169	54276
Precipitation (sum over identified period in mm)	801.89	114.91	614.09	718.75	854.34	1126.71
Mean annual temperature change (Celsius degrees)	1.52	0.72	0.43	0.86	2.14	2.58
Sample agribusinesses (min)	500	0	500	500	500	500
Sample agribusinesses (max)	1000	0	1000	1000	1000	1000
Agribusinesses represented (nb)	3942.76	312.73	3531	3697	4152	4579

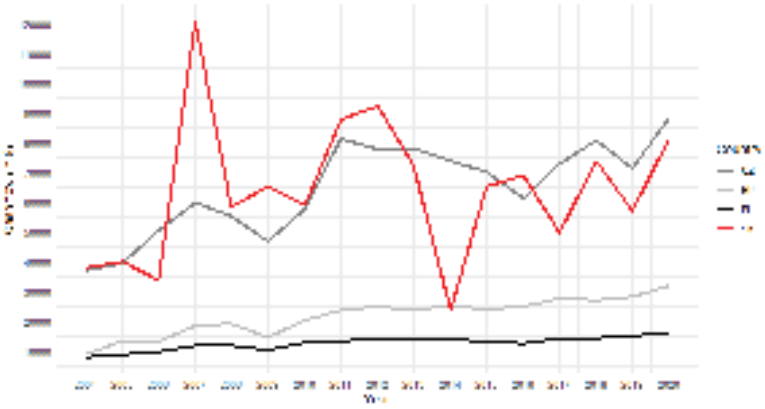
Source: own calculations based on FADN and CCKP data.
Legend: SD–standard deviation, Min.–minimum value, Max.–maximum value, Perc.–percentile, nb–number

Table 1 shows the basic statistical description (included mean, standard deviation, minimum, percentiles, and maximum values) of all the variables used for each researched country separately, while considering the timespan length of 17 years (2004-2020). The sample of agribusinesses we used in the analysis varies from 500 to 1000 businesses in Slovakia, 1000 to 2000 in Czechia, 1000 to 3000 in Hungary to 10 000 to 20 000 agribusinesses in Poland. All this is in proportion with the size of the agricultural sector in the selected countries, as it is visible from the numbers of agribusinesses represented. The country with the highest overall number of agribusinesses is Poland (mean value: 736 781), followed by Hungary with 105 878 agribusinesses, 165 509 in Czechia and 3 943 in Slovakia.

From the point of view of economics, the highest mean value when it comes to the economic sizes of agribusinesses is reached in Slovakia (395.01), followed by Czechia (254,52), the lowest mean value of economic sizes is reached in Hungary and Poland. The mean economic size of enterprises is five times smaller in Hungary than in Czechia and eight times smaller in Hungary than in Slovakia. In the case of Poland the gap is even more visible, where the mean economic size of Polish agribusinesses was approximately ten times smaller than that of Czech agribusinesses and fifteen times smaller than that of Slovak ones.

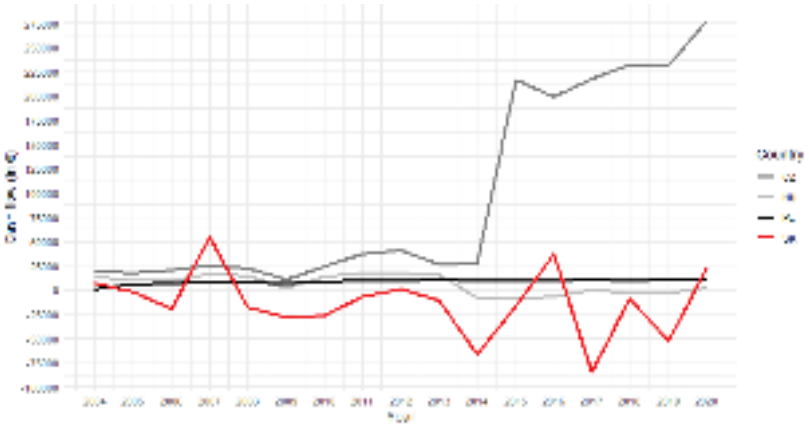
The total standard gross margin is the highest in the case of Slovak agribusinesses. It is also visible through the observed net worth of V4 agribusinesses. The biggest mean positive gap between total assets and total liabilities in the researched period was measured in Slovak agribusinesses (864 420 €), followed by Czech enterprises (548 508 €). Hungarian and Polish agribusinesses are more distinctive with smaller differences between their assets and liabilities values (mean values from 92 371 € in Poland to maximum 185 872 € in Hungary). When looking specifically only at how much capital agribusinesses operate with (gap between opening and closing values of various types of capital such as machines, buildings, equipment, land improvement, livestock or permanent crops), it is again Slovakia with the highest mean values over the researched period (1 060 290 €), whilst the Hungarian or Polish agribusinesses' average values of capital do not exceed 155 762 € (in Hungary), or 95 129 € (in Poland).

Figure 1 Development of Cash Flow (CF1) in V4 countries, timespan: 2004–2020



Source: own processing based on FADN data

Figure 2 Development of Cash Flow (CF2) in V4 countries, timespan: 2004–2020



Source: own processing based on FADN data

As Blyth et al. (2007) stated, climate policy uncertainty alone can significantly also affect the cash flow of companies and of various project investments. Uncertainty in cash flow very often leads to more uncertainty and risk, spreading and affecting the business sphere. In this paper we are working with the cash flows reported by the Farm Accountancy Data Network. The mean values of cash flow in the V4 are the highest in the agribusinesses in Slovakia (mean value: 63 985 €) and Czechia (mean value: 64 882 €). The lowest cash flow in agribusinesses is in Poland, where the mean cash flow value is 12 598 €.

Between the Cash Flow (CF1) and Cash Flow (CF2) there is only a methodical difference. Cash Flow 2 also includes operations on capital, debts, and loans. Those parts are not included in the Cash Flow 1 indicator. This is visible also in the values of Cash Flow 2 where there are apparent differences. This kind of cash flow is the highest in the case of Czech enterprises (mean value: 96 757 €), and much lower values are present in Hungary (mean value: 5 974 €) and Poland (mean value: 8 684 €). Slovakian agribusinesses are the only ones which report negative cash flow (mean value: -12 818 €) (when operations on capital, debts and loans are present in the analysis).

As it is also visible from Figure 1 and 2, the development and the dynamics of the cash flow 1 and 2 over the years from 2004 to 2020 differ. Fluctuations in the development of the cash flow 1 are mostly visible for Slovak and Czech agribusinesses with peaks in 2007 and 2012 and with a rapid downfall in 2014. On the contrary, Polish and Hungarian agribusinesses reported more stable financial flows over the researched years. Hungarian agribusinesses typically show stable growth over the years and their cash flow value evolved from approximately 6 000 € in 2004 to more than 31 000 € in 2020. Polish enterprises show stabilized cash flow values as well.

Cash flow 2, which takes into account the debts and loans and overall operations on capital, reported relatively strong fluctuations and dynamic development since the year 2014, especially for Czech and Slovak agribusinesses. However, Hungarian and Polish enterprise cash flows remain relatively stable, but with very low values, which could, when reported for that long period of time as it is in this case,

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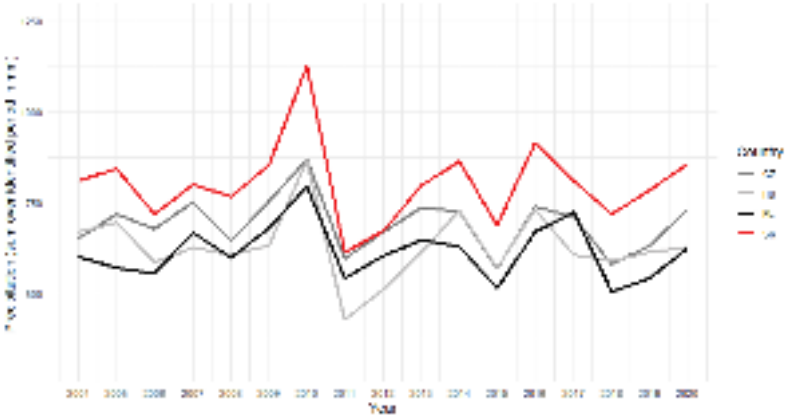
signalize relatively serious financial problems. The overall financial situation signalizes more stable development, bigger enterprises, when it comes to economics size, with higher net worth values and high but not that much stable values of cash flow for Czech and Slovakian agribusinesses.

The development of the climatic conditions we are describing with the two basic parameters–sum of precipitation over the identified period and the mean annual temperature change, are the most frequently and commonly used ones in the research area. Figure 3 and 4 show the development of both parameters between 2004 and 2020. The V4 countries are not only culturally but also geographically relatively similar, which should be also a good basis for the statement about similarities between the countries from the climatic point of view.

The country with the highest levels of precipitation measured per calendar year (see Figure 3 and Table 1 for more) for the whole researched period is Slovakia (mean value for the whole period is 801.89 mm, while in Poland precipitation is only 615.02 mm per year. Fluctuations for each country seem similar for the whole Central European region (Figure 3) with a peak in 2010, as the wettest year from the researched period. Year 2011 was the draughtiest for Hungary and Slovakia, and also as one of the draughtiest ones for Poland or Czechia.

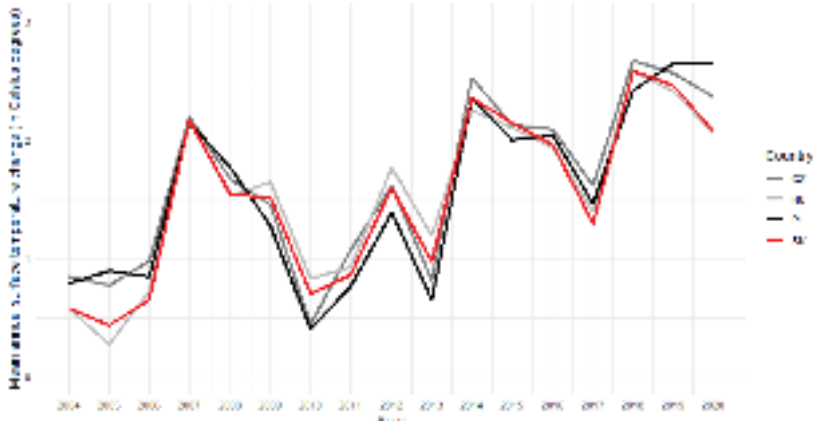
Figure 3 Development of precipitation level in V4 countries, timespan: 2004–2020



Source: own processing based on CCKP data

The developments in temperature changes in the V4 countries report extraordinarily strong and evident similarities across the whole researched period, with the most visible disparities in 2005 and 2020, where in both cases Poland is the country with the highest mean annal temperature changes, followed by Czechia, Slovakia, and Hungary. Development is full of fluctuations and there is also a visible stable growth trend in the observed temperature changes, e.g. in Poland the maximum mean annual temperature change in 2005 was 0.4 Celsius degrees, while in 2020 it was the mean annual value of 2.64 Celsius degrees.

Figure 4 Development of temperature changes in V4 countries, timespan: 2004–2020



Source: own processing based on CCKP data

Therefore, we can conclude that temperature changes are not happening to be a distinctive factor regarding the researched countries, but something that the whole Central European region has in common.

The aim of this study, which is prevalently a detailed statistical description and the evaluation of mutual relationships between the development of the two types of agribusinesses cash flows, is reached through descriptive statistics, the visualization of dynamic trend lines for the mutual relationship of the selected climatic variables and the selected economic variables and correlation analysis (Pearson, Spearman and Kendall correlation coefficients, analysis were conducted on the scaled data) for the 5 economic variables and 2 climatic condition parameters (all described in detail in the section above), for each of the researched countries separately.

Results and discussion

Trend lines

Visualizations of the mutual relationship between the cash flow of type 1 and the development of basic climatic parameters in the form of the sum of precipitation over an identified period and mean annual temperature changes are conducted trough the basic line plots with trend lines (shown in Figures 5 and 6). As we stated above, we do not register any major disparities in mean annual temperature changes. The joint trend line for all agribusinesses in the V4 countries is consequently suggesting the existence of a direct relationship between the variables, where higher mean annual surface temperature change results in higher values of cash flow type 1. However, the nature of this relationship is weak and not indicative (low coefficient of determination). We considered it more appropriate and accurate to visualize the trend line for each V4 country separately. As we mentioned in the data description section, in Figure 5 we can see a consistent prevalence of higher cash flow values for Slovak and Czech agribusinesses, analogously relatively lower cash flow values for Polish

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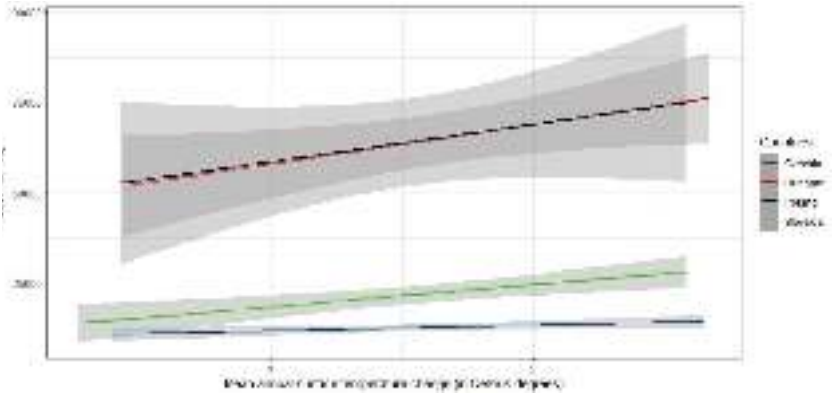
and Hungarian agribusinesses. Apart from the Czech agri-businesses, the agri-businesses in the remaining three V4 countries (Slovakia, Poland, and Hungary) show a positive trend in the relationship between the mean annual temperature change and cash flow values. The most visible, pronounced and almost identical is the common development of variables in Hungary and Poland. An existing, but a weaker positive trend is also observable in Slovak enterprises.

Figure 5 Relationship between the mean annual surface temperature change and cash flow (CF1) in V4 countries, timespan: 2004–2020, frequency: annual

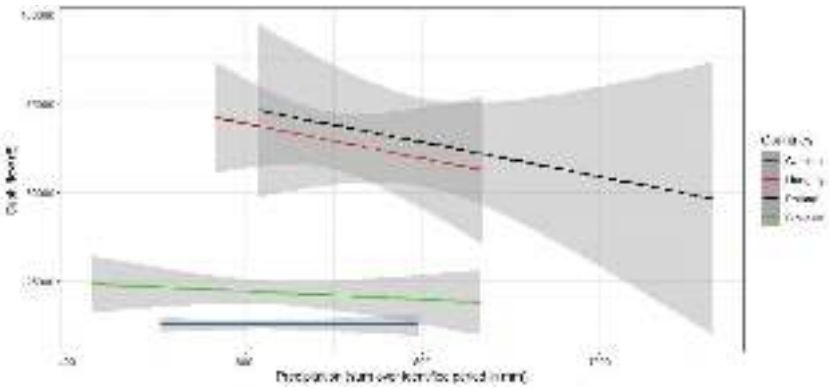


Source: own processing based on FADN and CCKP data

Figure 6 gave us glimpse into the nature of the relationship between the annual sums of precipitation and the development of cash flow type 1 throughout the period 2004-2020. This relationship is showing relatively more dynamics and fluctuations in all agro-business in the researched V4 countries, which results in a rising trend line for the situation where the yearly precipitation level is within the range of values from approximately 500 mm to 750 mm. Agribusinesses in Czechia or Slovakia operate in an environment with total precipitation not exceeding 900 mm per year and show relatively lower levels of cash flow compared to Polish and Hungarian agribusinesses. The development of their cash flow in relation to the precipitation levels compared again to the Polish and Hungarian counterparts is stable throughout the monitored period. Polish and Hungarian agribusinesses operate in an environment with higher annual precipitation totals and higher levels of cash flows, while the interrelationship of these variables shows a negative tendency.

Also, in case of the relationship cash flow–precipitation, the levels of cash flow are higher for Czech and Slovakian agribusinesses, as it is obvious also from the descriptive statistics (Table 1), which shows us that the first quartile (25% percentile) for Czech agribusinesses is 55 228 € (while the maximum level of precipitation over the researched timespan 2004–2020 is 88 325 €).

Figure 6: Relationship between the precipitation level and cash flow (CF1) in V4 countries, timespan: 2004–2020, frequency: annual



Source: own processing based on FADN and CCKP data

Modelling simple linear trendlines may not be sufficient for a proper and detailed description of the development of all researched variables. Therefore, the next section is devoted to the correlation analysis of mutual relationships of economic and climatic variables in each of the researched country separately.

Correlation analysis

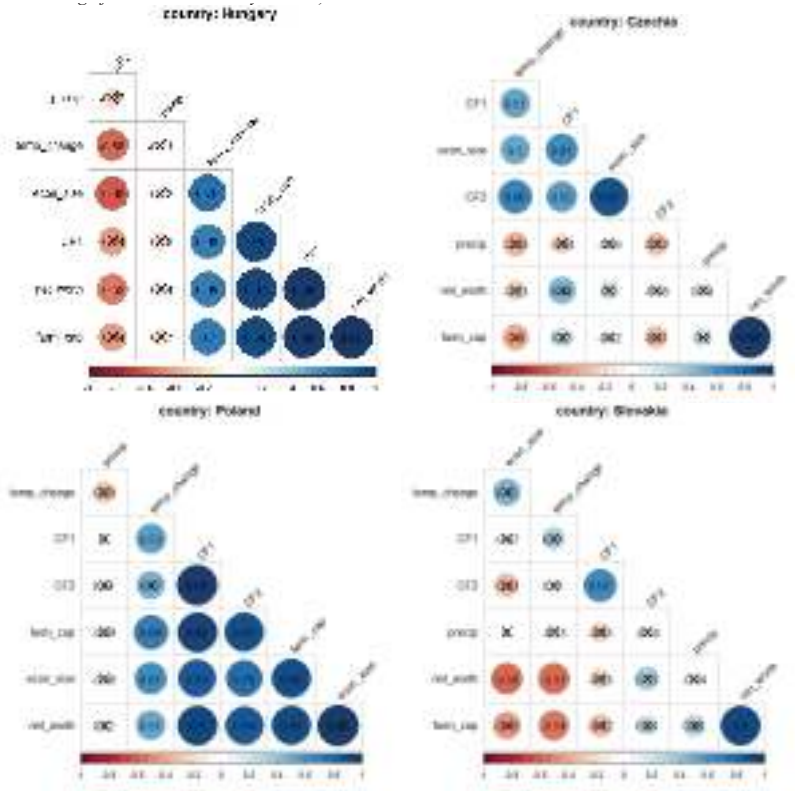
In the correlation analysis (Figure 7) we quantify the co-development of the mean temperature changes, as one of the most characteristic type of climatic parameter with the selected economic variables. Regarding the relationship between the temperature changes and cash flow type 1, for 3 out of 4 V4 countries there are spotted 2 moderate correlation coefficients within the range from 0.51 for Czechia and 0.68 for Hungary (the exception from moderation in correlation with temperature changes are the Slovakian agribusinesses with a low correlation coefficient 0.31, which is, according to the Pearson correlation test, not statistically significant).

Including the balance of operations of the loans and debts in cash flow type 2 caused severe fluctuations in the flows, where according to correlation coefficients, there is moderate correlation with the temperature changes for Czechia (coefficient: 0.66), not statistically significant correlation for Poland and no correlation for the development of the observed variables in Slovakia. Hungarian agribusinesses report developments in cash flow 2 which evolves in contradiction with the developments in mean annual temperature changes (moderate negative correlation coefficient -0.58).

Regarding the economic size of agribusinesses in V4 countries high correlation is spotted for Hungarian enterprises (coefficient: 0.75), moderate correlation for the Polish (coefficient: 0.61) and Czech enterprises (coefficient: 0.5), and statistically insignificant correlation for Slovak enterprises. In terms of the net worth of agribusinesses and values of their capital, V4 countries could be split into two groups, where in Hungary and Poland the development of temperature changes and net worth or enterprise capital levels are moving in the same direction, while for

agribusinesses in Slovakia or Czechia, there were low negative correlations measured (Slovakia), or low correlation coefficients for Czech enterprises.

Figure 7: Correlation plots for observed variables in timespan 2004-2020 (level of significance for Pearson correlation test a = 0.05, correlations which are not statistically significant are marked by crosses)



Source: own processing based on FADN and CCKP data

Quantifying the joint co-development of annual precipitation level and of the financial variables, such as economic size, net worth, agribusiness capital, or agribusiness' cash flow streams through a correlation analysis shows no statistically significant correlation coefficients in none of the countries for any of the above listed economic parameters.

Differences between the V4 countries are also present in the mutual co-development of economic parameters. An inversely proportional development in the economic size of agribusinesses and their relationship with the net worth and amount of enterprise capital is present exclusively in Slovakia (in the form of low and moderate negative correlation). For Hungarian and Polish agribusinesses there is

evidence of a very tight and proportional co-development of economics sizes of holdings and their net worth (in both cases high correlation coefficients, for Poland 0.96 and for Hungary 0.91); however, no statistically significant relationship between the variables was found in the case of Czech enterprises. The tightness of the co-development of the economic size of agribusinesses and of the amount of possessed capital is also typically in strong correlation (for Poland the value is 0.88 and for Hungary 0.89). In the case of Czech and Slovakian agribusinesses there was no statistically significant relationship observed. Therefore, in this case there also are visible discrepancies between the two groups, one including Polish and Hungarian agribusinesses, and the second one consisting of Slovak and Czech ones.

It is also essential to mention that in Poland, Czechia and Slovakia, we can see a proportional development in both types of cash flow reported by FADN. High correlation is present in Polish enterprises, and moderate correlation in the Slovakian and Czech ones. A statistically insignificant relationship was found solely in Hungarian agribusinesses, signalizing that operations on debts and loans is the key factor, which makes a difference resulting in strong or no relationship for both type of cash flows in these two groups of countries. The existence of no relationship for Hungarian agribusinesses could have an impact on the positive co-development of cash flow type 1 with economic size, net worth or the amount of capital and a negative type of co-evolvement of cash flow type 2 with the above-mentioned economic variables (i.e. economic size, net worth, and amount of capital).

Conclusions

Considering the trend lines for four Central European countries in the timespan of 17 years (2004–2020), the results are suggesting the existence of a slightly growing shape of the trend line and consequently pointing us to a direct relationship between temperature and cash flow, where higher mean annual surface temperature changes result in higher values of cash flow type 1. However, the nature of this relationship could be considered rather weak and not indicative. The drawing up of a separate trendline for each country brings us to the conclusions that except for Czech agribusinesses, the agribusinesses in the remaining three V4 countries (Slovakia, Poland and Hungary) show a positive trend in the relationship between the mean annual temperature change and their reported cash flow values. The most visible, pronounced and almost identical is the common development of variables in Hungary and Poland. An existing, but a weaker positive trend is also present in Slovak enterprises. There are also visible and prevalent higher values of cash flow in Slovak and Czech agribusinesses and analogically relatively lower cash flow values are present in Polish and Hungarian agribusinesses.

The relationship between precipitation and cash flow is showing more dynamics and fluctuations in all agribusinesses in the researched countries. Agribusinesses in Czechia or Slovakia operate in an environment with total precipitation not exceeding 900 mm per year and report lower levels of cash flow compared to Polish and Hungarian agribusinesses. The development of their cash flow in relation to the precipitation levels compared to the Polish and Hungarian counterparts was stable throughout the monitored period. Polish and Hungarian agribusinesses operate in an environment with higher annual precipitation totals and higher levels of cash flow, while the interrelationship of these variables shows a negative tendency.

Regarding the correlation matrices, the following results were observed for the two main objects of research: for all V4 countries, for the relationship between

mean annual temperature change and cash flow values (type 1), moderate correlation coefficient within the range from 0.51 for Czechia to the strongest 0.68 in Hungary were spotted (in the rest of the V4 countries we were unable to prove the existence of such relationships). An interesting observation emerged from the correlation analysis when the balance of operations of the loans and debts were included into cash flow type 2. The inclusion of the two variables caused severe fluctuations in the flows, where according to the correlation coefficients, there was a moderate correlation with the temperature changes for Czechia (coefficient: 0.66) and no correlation for the development of both variables in Slovakia and Poland. Hungarian agribusinesses report a development in cash flow 2 which evolves in contradiction with the development in mean annual temperature changes.

The existence of evidence of a statistically significant co-development of the researched variables is in agreement with the results of the studies in the area but conducted on the data samples from the diverse types (geographically, by the focus of their agricultural activities, etc.) of countries around the world. An object of further research could be the reasons for the observed difference in interactions with climatic parameters for cash flows with and without operations on debts and loans.

Bibliography

1. Addoum, J. M., Ng, D. T., & Ortiz-Bobea, A. (2021). Temperature shocks and industry earnings news. Available at SSRN 3480695. DOI: http://dx.doi.org/10.2139/ssrn.3480695
2. Blyth, W., Bradley, R., Bunn, D., Clarke, C., Wilson, T., & Yang, M. (2007). Investment risks under uncertain climate change policy. Energy policy, 35(11), pp. 5766–5773. DOI: https://doi.org/10.1016/j.enpol.2007.05.030
3. Brahmana, R. K., & Kontesa, M. (2023). Sea surface temperature anomalies and cash holdings: Evidence from fisheries companies. Marine Policy, 148, p. 105452. DOI: https://doi.org/10.1016/j.marpol.2022.105452
4. FADN (2018). Farm Accounting Data Network. An A to Z of methodology. Version 02/07/2018. Available on https://ec.europa.eu/agriculture/rica/pdf/site_en.pdf
5. Hong, H., Karolyi, G. A., & Scheinkman, J. A. (2020). Climate finance. The Review of Financial Studies, 33(3), pp. 1011–1023. DOI: https://doi.org/10.1093/rfs/hhz146
6. Huang, H. H., Kerstein, J., & Wang, C. (2018). The impact of climate risk on firm performance and financing choices: An international comparison. Journal of International Business Studies, 49(5), pp. 633–656. DOI: https://doi.org/10.1057/s41267-017-0125-5
7. European Commission (2008). Commission Regulation (EC) No 1242/2008 of 8 December 2008 establishing a Community typology for agricultural holdings OJ L 335, 13.12.2008
8. Chan, H. W., Lu, Y., & Zhang, H. F. (2013). The effect of financial constraints, investment policy, product market competition and corporate governance on the value of cash holdings. Accounting & Finance, 53(2), pp. 339–366. DOI: https://doi.org/10.1111/j.1467-629X.2011.00463.x
9. Chukwuezie, O. C., Nwakuba, N. R., Nwaigwe, K. N., & Asoegwu, S. N. (2016). The impact of climate change on Nigerian agricultural sector and economy. In 37th Annual Conference and Annual General Meeting at Minna in October.

10. Lee, J. G., Ellis, J. R., & Lacewell, R. D. (1987). Evaluation of production and financial risk: a stochastic dominance approach. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 35(1), pp. 109–126. DOI: https://doi.org/10.1111/j.1744-7976.1987.tb02177.x
11. Mari, F. (2020). The representativeness of the Farm Accountancy Data Network (FADN): Some suggestions for its improvement: 2020 edition. Publications Office. https://data.europa.eu/doi/10.2785/06861
12. Montross, M. D., Montross, J. E., Bakker-Arkema, F. W., & Hines, R. E. (1997). Dryer performance enhancement through grain preheating. Transactions of the ASAE, 40(5), pp. 1391–1394. DOI: https://doi.org/10.13031/2013.21365
13. Österle, I. (2016). The Green Paradox and the importance of endogenous resource exploration. Australian Journal of Agricultural and Resource Economics, 60(1), pp. 60–78. DOI: https://doi.org/10.1111/1467-8489.12103
14. Poling, E. B., & Safley, C. D. (1986). Economics of changing from matted row to annual hill system strawberry production. HortScience, 21(6), pp. 1409–1411. DOI: https://doi.org/10.21273/HORTSCI.21.6.1409
15. Ramsey, C. A., & Hewitt, A. D. (2005). A methodology for assessing sample representativeness. Environmental Forensics, 6(1), 71-75. DOI: https://doi.org/10.1080/15275920590913877
16. Ziauddin, A. M., & Liang, T. (1986). A weather risk model for grain drying system design and management in a developing region. Transactions of the ASAE, 29(5), pp. 1434–1440. DOI: https://doi.org/10.13031/2013.30333

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