Summary of findings – scientific paper

Impact of inflation on the export value of flowers and plants in the top 10 countries

A study on monthly export data from 2009-2022

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Abstract
The objective of this research is to investigate the impact of inflation on the export value of flowers and plants in different countries within the European Union, the United States and Russia. Through a comprehensive literature review and data analysis using stepwise regression and cross-correlation techniques on the import value of flowers and plants in these 10 countries, potential factors influencing inflation rates in European countries have been identified.

Additionally, it has been explored that the interactions between inflation rate and import value differs between countries. The variations between countries leads to different conclusions. Finally, the optimal model for finding the time lag between import value fluctuations and the onset of inflation.

The results of the analysis suggests that the main factors that most likely are influencing inflation rates in the top 10 countries to be M2(Money supply), PPI (Producer Price Index) and energy inflation. A positive correlation has been found between the inflation rate and the import value of flowers or plants in most countries. Meanwhile the fluctuations in the import value of flowers and plants have no significant impact on the overall import value. Furthermore, it has been identified that the Vector Error Correction Model (VECM) is the most suitable method for studying the relationship between inflation rate and import value. It has been observed in this research that most top 10 countries exhibit a time lag ranging from four to six months between inflation and import value. Overall, this research contributes to the understanding of the dynamics between inflation and the export value of flowers and plants, providing valuable insights for stakeholders in the floral industry. However, further improvements can be made in terms of expanding the dataset, considering additional variables such as delivery time and prices of flowers and plants, and conducting further analysis on the specific reasons for the observed time lags.

Research questions
What is the impact of inflation on the export value of flowers and plants in different countries?

Several sub-questions were raised to better answer the research question:
1. What are the factors affecting the inflation rate of countries.
2. What is the interaction effect between inflation and the export value?
3. How does this influence vary by country (top 10)?
4. What is the most optimal model to find the time lag between the fluctuations of export value and the onset of inflation?

Data collection
Economic variables are analyzed to determine their impact on import value (which is the Dutch import value of flowers and plants for a certain country).

Table 1: Sources of economical data

Economic Variables	Source of Data
Import value of flowers and plants (Euros)	Provided by Floridata (monthly data 2009 – 2022)
Inflation rate	Trade economics
Disposable income	The World Bank & statistical agencies of various countries.
Food price	The World Bank & Official statistical agencies of various countries.
Core inflation	Trade economics
Energy price index	The World Bank & Official statistical agencies of various countries.
M2*	Trade economics
Public debt	Trade economics
Import value (Total)	Trade economics
PPI**	The World Bank
Disposable income	Trade economics
GDP per capita	Trade economics
Agriculture GDP	Trade economics

* Definition of how money is measured, that deviates from M1 and M3. M1 includes currency, money in checking accounts (demand deposits), and checks. M2 includes all M1, plus savings deposits, time deposits like certificates of deposit, and money market funds.

** PPI stands for Producer Price Index. It is a measure of the average change in prices received by domestic producers for their output over time. It is commonly used to reflect changes in production costs.

Table 2: Consulted websites to obtain economic data

Country/Data platform	Website
The World Bank	https://www.worldbank.org
Trade economics	https://trading economics.com
Germany	https://www.destatis.de/
France	https://www.insee.fr/en/accueil
United Kingdom	https://www.ons.gov.uk/
Poland	https://stat.gov.pl/en/
Italy	https://www.istat.it/en/
United States	https://www.bea.gov/ https://www.bls.gov/
Russian Federation	http://www.gks.ru/eng/
Belgium	https://statbel.fgov.be/en
Switzerland	https://www.bfs.admin.ch/bfs/en/home.html
Denmark	https://www.dst.dk/en
Sweden	https://www.scb.se/en/
Austria	https://www.statistik.at/web_en/
Spain	https://www.ine.es/en/welcome.shtml

The obtained monthly data is categorized based on variable types and recorded in chronological order in an Excel document. Table 1 displays the independent variables, such as inflation rate, food price, oil price, total import value, M2, and PPI, which are all monthly data. Disposable income and agriculture GDP are seasonal data. This report will not further investigate factors such as income, stock-to-use ratio of flowers and plants, the agriculture price level of flowers and plants, and agriculture production level of flowers and plants. Quarterly data will be derived from monthly data, by using linear interpolation (Meijering, 2002).

The import value of flowers and plants is strongly affected by seasonality. To control for this seasonality effect, the seasonal decomposition function in SPSS is used. This is a data preprocessing method to extract seasonal factors from the import value of flowers and plants (Hyndman and Athanasopoulos, 2018).
Then the preprocessed import value was plotted in Excel as a corresponding curve, and the peak values are obtained directly from the data points shown on the chart. The inflation rate is also processed in the same way.

Modeling

Linear multiple regression analysis in SPSS examined the optimal model for explaining the import value of flowers and plants. The following variables are used.

Table 3: Variables used to examine the optimal model

Dependent variable	**Independent variables**
Top 10 country's import value of flowers and plants	Core inflation rate
	Disposable income
	Agriculture GDP
	Oil price
	M2
	Import value (total)
	Producer Price Index
	Disposable income

Sample sizes varies by country, due to variations in data availability and the specific kind of modeling factors. The distribution of sample sizes is as follows:
$n_{Germany}$:164 n_{France}: 164, $n_{United\ Kingdom}$: 164, n_{Italy}: 146, n_{Poland}:164, $n_{Denmark}$: 164, $n_{Belgium}$:164, $n_{Austria}$: 128, n_{Russia}: 158, $n_{United\ Srates}$: 164, n_{Sweden}: 161, $n_{Switzerland}$: 165, n_{Spain}: 164. The data was analyzed using the statistical software SPSS version 25.0.

The null hypothesis Ho is $\beta1 = \beta2 = \beta3 = \beta4 = \beta5 = \beta6 = \beta7 = \beta8 = 0$

The formula of the linear multiple regression and AIC value are described as follows (Ngo and La Puente, 2012; Symonds and Moussalli, 2011):

$$Y_{timp} = \beta_0 + \beta_1 X_{t1} + \beta_2 X_{t2} + \beta_3 X_{t3} + \beta_4 X_{t4} + \beta_5 X_{t5} + \beta_6 X_{t6} + \beta_7 X_{t7} + \beta_8 X_{t8} + \varepsilon \quad (1)$$

Where β_0 is the intercept, β_1-β_8 are the regression coefficients, and ε is the error term.

Additionally, diagnostic measures, such as variance inflation factor (VIF) or correlation matrices, may be used to assess potential multicollinearity among the independent variables. The results of these tests will provide insights into the individual impact of each variable on the import value and help evaluate the appropriateness of the variable settings in the regression model. Then, the inflation rate at time t with the inflation rates will be replaced by those at time t-1, t-2, and t-3, while keeping other variables unchanged, and conducting multiple regression analysis. AIC values will be calculated for each model and identify the time corresponding to the model with the lowest AIC value as the time lag between the fluctuations of import value and the onset of inflation (Ngo and La Puente, 2012; Symonds and Moussalli, 2011).

$$RSS = \Sigma(yi_{timp} - \widehat{y_{timp}})^2 \quad (2)$$

$$\mathrm{AIC} = n[\ln(\frac{\mathrm{RSS}}{n})] + 2k \quad (3)$$

Table 4: Overview of formula's symbols and their represented value

Symbol	Represented value
Y_{timp}	The value of import value at time t
β_0	Constant
$\beta_1\ \beta_2\beta_3\ \beta_4\beta_5\beta_6\beta_7\beta_8\beta_9$	Coefficient Regression
X_{t1}	The value of core inflation rate (CPI) at time t
X_{t2}	The value of disposable income at time t
X_{t3}	The value of agriculture GDP at time t
X_{t4}	The value of the oil price index at time t
X_{t5}	The value of M2 at time t
X_{t6}	The value of import value (Total)
X_{t7}	The value of PPI
X_{t8}	The value of disposable income
ε	Standard error
n	The number of samples
k	The number of variables

Results

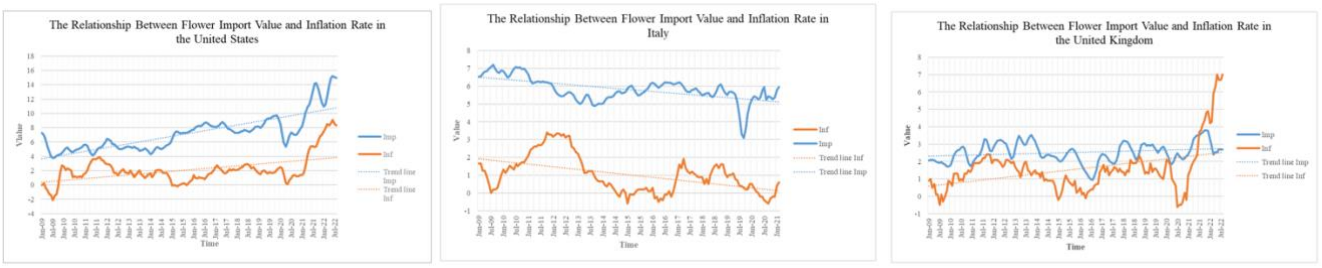
For which countries does inflation rate correlate with import value?

Regarding the top 10 countries in terms of import value for flowers, the countries with a Pearson correlation value larger than 0 are Germany (Sig=0.000<0.05), United Kingdom (Sig=0.000<0.05), France (Sig=0.029<0.05), Poland (Sig=0.000<0.05), Italy (Sig=0.000<0.05), United States (Sig=0.000<0.05), Belgium (Sig=0.001<0.05), and Denmark (Sig=0.000<0.05). The only country with a Pearson correlation value less than 0 is Russia (Sig=0.001<0.05). Switzerland (Sig=0.205>0.05) has no significant correlation between its inflation rate and flower import value.

Regarding the top 10 countries in terms of import value of plants, the countries with a Pearson Correlation value larger than 0 are Germany (Sig=0.016<0.05), France (Sig=0.000<0.05), Poland (Sig=0.000<0.05), Belgium

(Sig=0.001<0.05), Switzerland (Sig=0.006<0.05), Spain (Sig=0.000<0.05). The country with a Pearson correlation value less than 0 is the United Kingdom (Sig=0.002<0.05). Sweden (Sig=0.541>0.05), Austria (Sig=0.790>0.05) Italy (Sig=0.322>0.05), have no significant correlation between their inflation rate and import value of plants.

Top 3 with the highest correlations for flowers: United States, Italy, United Kingdom



Top 3 with the highest correlations for plants: Poland, Spain, France

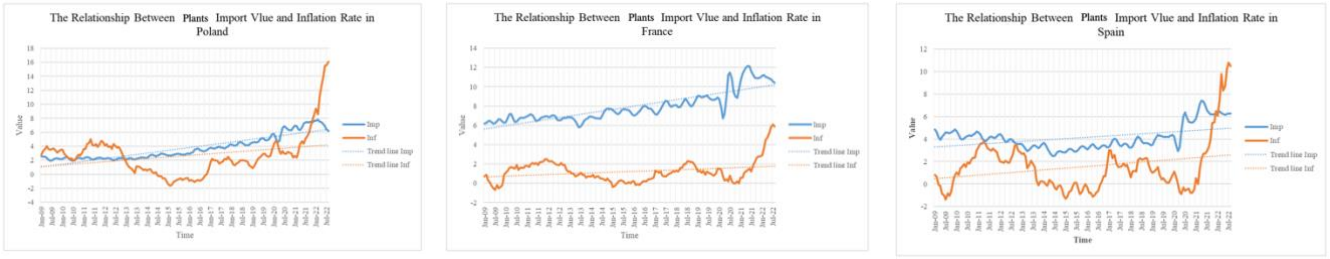


Figure 1: Correlation charts: top 3 separately for flowers and plants

What is the time lag in months between the fluctuation of import value and the onset of the inflation rate?

To investigate the time lag in months between the inflation rate and import value of flowers/plants and identify its causes, cross-correlation analysis was conducted between the import value and M2, energy inflation, and PPI for each top 10 country. The "x" in the table represents variables that are not investigated in this report or variables that do not exhibit a significant correlation with the independent variable.

Table 5: Time lag in months for factors correlating with import value

	M2		Energy inflation		PPI		Inflation rate	
	Flowers	Plants	Flowers	Plants	Flowers	Plants	Flowers	Plants
Germany	0	17	4	5	4	5	5	6
United Kingdom	0	2	7	38	7	26	4/5	24
France	0	0	8	2	8	6	8	6
Poland	0	0	0	2/3	3	2/3	4	5
Italy	2	x	10	x	13	x	18	x
United States	0	x	0	x	0	x	0	x
Russia	x	x	29	x	x	x	11/12	x
Belgium	0	0	9	9	6	5	6	5
Switzerland	0	x	0	x	4	x	12	x
Denmark	x	0	x	12	x	5	x	6
Spain	x	0	x	14	x	10	x	10

Time lag flowers

Denmark and Spain were found to have no significant correlation between its flower import value and inflation rate. The time lag of the impact of the inflation rate on the import value of flowers is 0 months for the United States, 5 months for Germany, 4 or 5 months for the United Kingdom, 8 months for France, 4 months for Poland, 18 months for Italy, 11/12 months for Russia, 6 months for Belgium and 12 months for Switzerland.

Time lag plants

Italy, Sweden, and Austria were found to have no significant correlation between their plant import value and inflation rate. The time lag of the impact of the inflation rate on the import value of plants is 6 months for Germany, France and Denmark, 24 months for the United Kingdom, 5 months for Poland and Belgium and 10 months for Spain.

What is the optimal model explaining the variation of the import value of flowers and plants?

Flowers

According to the results of a stepwise regression analysis the countries' models differ in their ability to explain variation in flower import value.

The regression model for Poland has the highest R-square value, up to 0.919, followed by the United States with an R-square value of 0.827. Germany (0.774), United Kingdom (0.730), Italy (0.750), and Denmark (0.709) also have quite high R-square values, indicating their ability to explain the variation in flower import value are 77.4%, 73.0%, 75.0%, 70.9% respectively. The models for France and the Russia have relatively low R-square values. The model for France can only explain 66.2% of the variation in flower import value, while the model for the Russia can only explain 61.0% of the variation in flower import value. Belgium has the lowest R-square value, with only 0.531, indicating its limited ability to explain the variation in the import value of flowers.

The coefficients of the model reflect the model goodness-of-fit regarding flower import value.

Country	R	R Square	Adjusted R Square	Std. The error in the Estimate
Germany	,884	,781	,774	3318665,88154097
United Kingdom	,859	,738	,730	255697,39713967
France	,821	,675	,662	2532173,73089302
Poland	,959	,920	,919	843346,91404344
Italy	,872	,760	,750	707929,14972770
United States	,911	,830	,827	1059415,16941799
Russian Federation	,782	,612	,610	1683452,57798524
Belgium	,733	,537	,531	689896,22848499
Switzerland	-	-	-	-
Denmark	,846	,716	,709	727745,92193125

Plants

The regression model for Poland shows the best fit to the data, with adjusted R^2 up to 0.971. Similarly, France (R^2=0.875) also demonstrates a good fit to the data, and it is followed by Switzerland, Spain, and Belgium in sequence, who's adjusted R^2 is 0.799, 0.767, and 0.692. Germany (R^2=0.357) and the United Kingdom (R^2=0.272) are the two countries that have the lowest adjusted R^2.

The coefficients of the model reflect the model goodness-of-fit regarding plant import value.

Country	R	R Square	Adjusted R Square	Std. The error in the Estimate
Germany	,610	,373	,357	2671792,78957256
France	,937	,878	,875	1655255,75917402
United Kingdom	,535	,286	,272	244541,62274815
Italy	-	-	-	-
Poland	,986	,972	,971	584131,88839905
Belgium	,834	,696	,692	901461,01271858
Switzerland	,896	,803	,799	549400,09120141
Sweden	-	-	-	-
Austria	-	-	-	-
Spain	,880	,774	,767	505086,41714518

Conclusion

The main factors influencing the inflation rate in the top 10 countries in terms of the import value of flowers and plants are M2, energy inflation, and PPI (Produced Price Index). The relationship between the inflation rate and the import value of flowers and plants can be categorized into three types: positive correlation, negative correlation and no correlation. Among the top 10 countries examined in this study, most countries show a positive correlation between inflation rate and import value. These differences in correlation between countries may be related to factors such as the country's inflation threshold, the scale of imports in the flowers and plants trade, natural conditions, population size and the maturity of the national floral industry.

The VECM (Vector Error Correction Model) is theoretically the best modeling method. The time lag between inflation and the impact on the import value of flowers and plants in most countries is between four to six months. The PPI may be one of the reasons causing the lag in inflation. Core inflation and M2 have a positive correlation with the import value of flowers and plants. Food inflation and disposable income have a negative effect on the import value of flowers and plants. For countries with a strong domestic production industry in flowers or plants, the PPI has a positive impact on import value. However, using agriculture GDP as a model for studying the changes in flower imports is not ideal. The import value of flowers in Russia is highly correlated with the overall import value of the country.

FLOWERS

The optimal model for:

- Germany contains the factors; core inflation, M2, PPI, total import value, and disposable income and the time lag is 5 months.
- United Kingdom: energy inflation, food inflation, M2, PPI, and total import value and the time lag is 4 or 5 months.
- France: core inflation, food inflation, M2, PPI, and total import value, and the time lag is 8 months.
- Poland: energy inflation, M2, and total import value and the time lag is 4 months.
- Italy: core inflation, energy inflation, M2, and PPI, and the time lag is 18 months.
- The United States: core inflation, disposable income, and agriculture GDP, and there is no time lag.
- Russia: total import value, and the time lag is 11 months.
- Belgium: food inflation, M2, and the time lag is 6 months.
- Denmark: core inflation, food inflation, M2, PPI, and total import value, and the time lag is 12 months.

PLANTS

The optimal model for:

- Germany contains the factors energy inflation, M2, total import value disposable income, and the time lag is 6 months.
- France: energy inflation, food inflation, disposable income, and agriculture GDP, and the time lag is 6 months.
- United Kingdom: PPI, total import value, and agriculture GDP, and the time lag is 24 months.
- Poland: core inflation, energy inflation, food inflation, PPI, and total import value, and the time lag is 5 months.
- Belgium: core inflation, PPI, and the time lag is 6 months.
- Switzerland: core inflation, food inflation, and PPI, and the time lag is 6 months.
- Spain: energy inflation, M2, total import value, agriculture GDP, and the time lag is 10 months.

Discussion and recommendation

Further study could investigate the interactions between the factors affecting inflation and their impact on inflation dynamics. The focus should be on examining differences in the causes of inflation and the impact on flowers and plants' import value between developing and developed countries. This implies that certain variables such as delivery time of flowers/plants and their prices need to be considered when modeling. Future research should also consider the variations in trade volume and industry maturity when selecting model factors. Analyzing the time lag between inflation rate and import value: In most cases, the impact of inflation rate on the import value of flowers and plants exhibits a concentrated time lag of three to six months. Further research should delve into the specific reasons for these time lags and investigate whether similar patterns exist in other countries. Using the VECM model in the future studies is expected to obtain more satisfactory results. Overtime effects of inflation (highs and lows) may have different impacts on import value.

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