



## Apple revenue forecast - 2022

### Analysis goal

The purpose of the following paper is to provide an estimate as accurate as possible about the values that the company's revenues will assume *Apple* over the next twelve months, with the intention of understanding what growth will be generated in the following year.

### Dataset description

For the construction of the model, we first searched for and identified three macroeconomic variables that could influence the trend in demand for the goods sold by *Apple*. Subsequently, such variables were treated individually as *univariate time series*, predicting probabilistically (with a degree of confidence equal to 95%) the values of these variables for the year 2022<sup>1</sup>. Finally, to forecast revenues from sales for the year 2022, a multiple linear regression technique was opted for.

The macroeconomic variables identified for this analysis are the following:

#### - CPI\_net\_food\_energy[fig1]:

this is inflation measured by the consumer price index (CPI) and is defined as the change in the prices of a basket of goods and services that are typically purchased by specific groups of families. In this specific case, the chosen CPI index considers a basket of goods net of food and energy products (OECD source: <https://data.oecd.org/price/inflation-cpi.htm>). This variable was chosen as it is considered one of the main factors in the variation of the demand for goods, above all in the consumer electronics market. It is plausible to assume that periods of high inflation correspond to periods of lower sales and related revenues for *Apple*.

Valori trimestrali dell'indice CPI USA (Q1'91 - Q4'21)

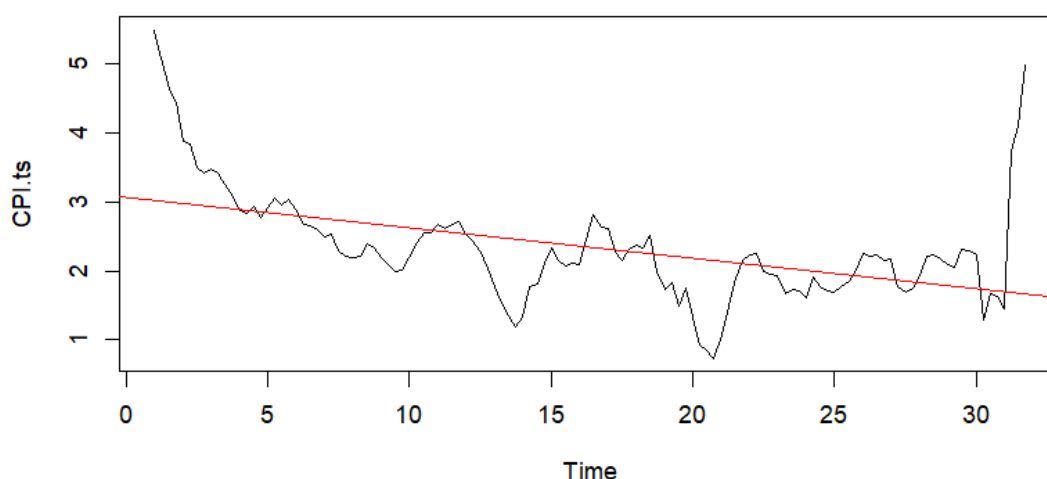


Figure 1 – Historical series trend of quarterly values of the US CPI index

<sup>1</sup>For this analytical work, we placed ourselves as subjects/observers on 12/31/2021, before the war events triggered by the Russian Federation at the end of February 2022 and the blockage of global supply chains caused by the Shanghai lockdown in April 2022.

#### - Financial\_rate\_consumer\_loans[fig2]:

it is the index of the financial rate on personal loans at commercial banks, 24-month period. The choice of this variable because, to date, more and more electronic products and *hi-tech* they can and are purchased through consumer loans. In periods in which there are increases in interest rates on personal loans, there is supposed to be a more attenuated adoption of this instrument for the purchase of consumer electronics goods (source FRED:<https://fred.stlouisfed.org/series/TERMCBPER24NS#> ).

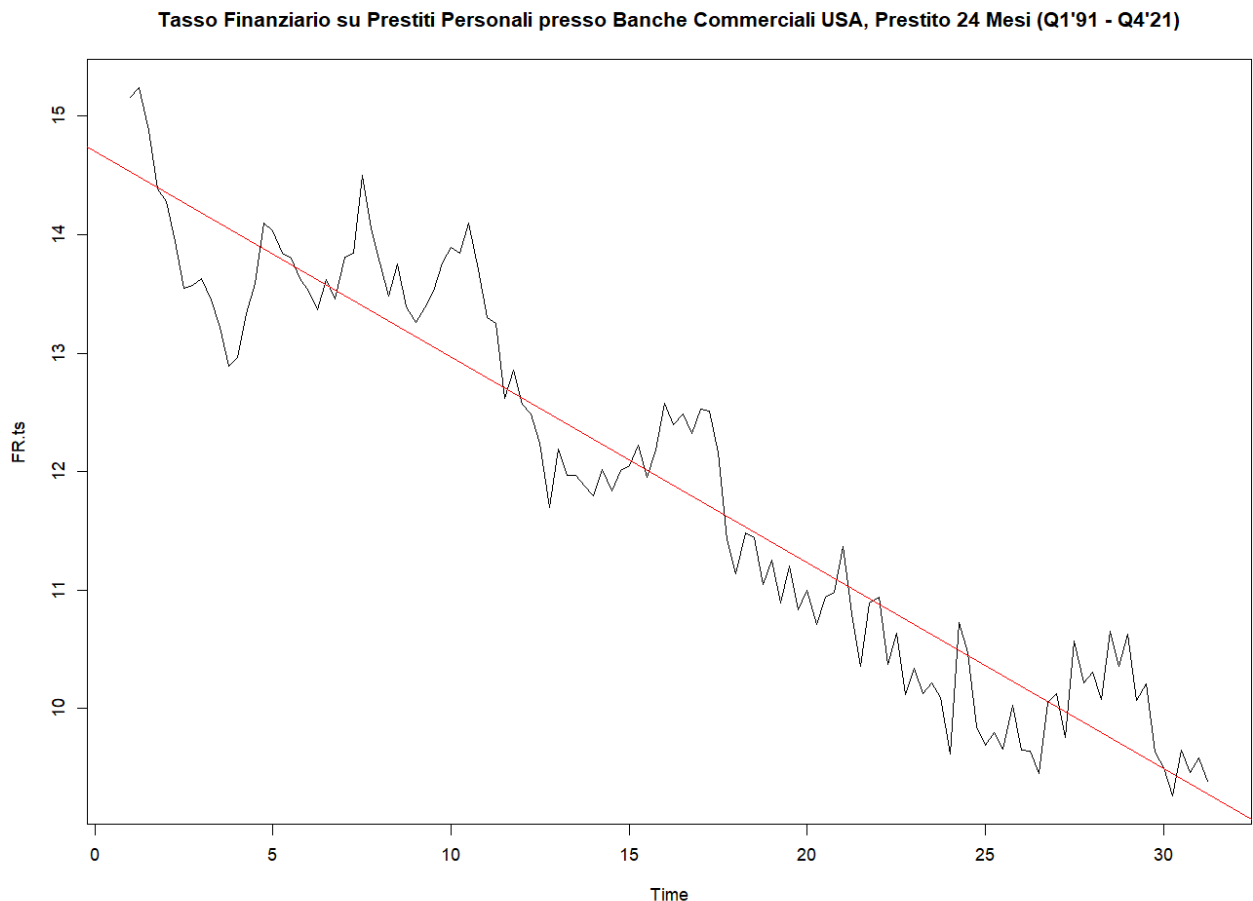


Figure 2 - Trend of the historical series of quarterly values of the financial rate on personal loans at US commercial banks

#### - USA\_Consumers\_Trust[fig.3]:

Based on a monthly survey prepared by the University of *Michigan*, is an index number constructed in such a way that higher values correspond to higher levels of consumer confidence. In periods in which the index measures upward spikes in confidence, the propensity to purchase goods such as those marketed by *Apple* assume increases (FED source:<https://fred.stlouisfed.org/series/UMCSENT> ).

## Valori trimestrali dell'indice di fiducia dei consumatori, USA (Q1'91 - Q4'2022)

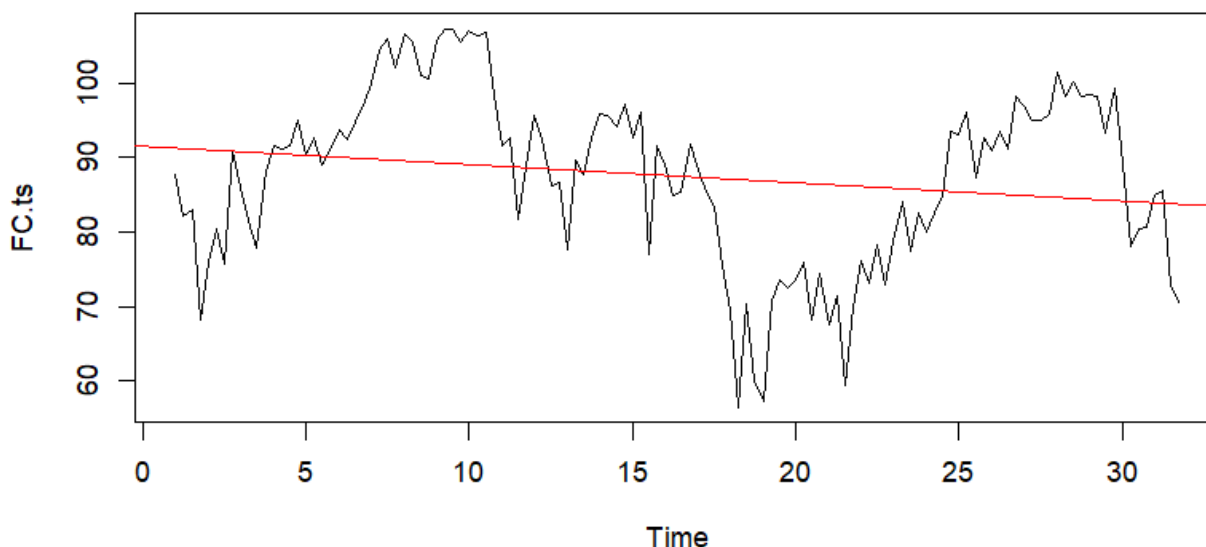


Figure 3 - Quarterly trend of the US consumer confidence index

### Analysis process

The analysis process was carried out by taking into consideration individually the selected variables described above. For each variable, the process was divided into the following phases:

- Data transformation stage: the time series have been made stationary through a degree 1 differentiation process<sup>2</sup>.
- Research phase of the best model ARMA(p,q): this phase saw the use of the PACF and ACF graphs for the initial identification of the orders p (processes AR) and q (processes MA). The choice of the best model was made by analyzing the information criteria values (AIC and BIC), used to compare the various models tested. The choice fell on the model with the lowest AIC.
- Forecast phase for Y-2022, for each chosen variable.
- Multiple linear regression step for estimating sales revenue.

For simplicity of presentation, only the results of the analysis process referring to the variable will be reported below *CPI\_net\_food\_energy* [Fig.4 and 5]:

```
Series: CPI.ts
ARIMA(1,1,3) with drift

Coefficients:
      ar1      ma1      ma2      ma3      drift
    -0.4608  0.7948  0.5890  0.7942 -0.0004
s.e.    0.1010  0.0963  0.1097  0.0574  0.0473

sigma^2 = 0.06168: log likelihood = -3.12
AIC=18.24  AICc=18.96  BIC=35.11

Training set error measures:
              ME      RMSE      MAE      MPE      MAPE      MASE      ACF1
Training set 0.001567239 0.2422672 0.1527383 0.03730735 7.592684 0.3145309 -0.03664434
```

Figure 4 - ARMA best model results (1,3) for *CPI\_net\_food\_energy*

<sup>2</sup>The non-stationarity of the series was verified both graphically, through the study of the Correlogram, and quantitatively, through the ADF test.

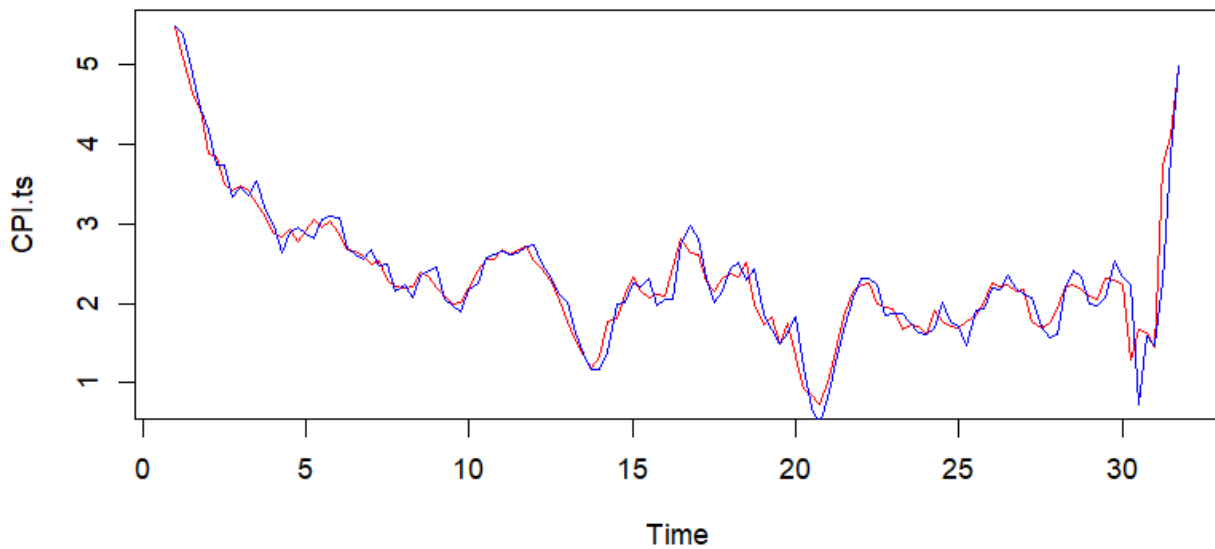


Figure - 5 Comparative chart between real data (red) and the implemented model (blue) for *CPI\_net\_food\_energy*

At the end of the search process of the “*best model*”, using the ARIMA analysis technique, we proceeded to forecast the data for the quarters of 2022, for each variable. Below are the predicted values for the variable *CPI\_net\_food\_energy*[Fig. 6]:

	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
Q1	5.886902	5.567383	6.206421	5.398240	6.375564
Q2	5.667371	5.136663	6.198078	4.855723	6.479018
Q3	5.773416	4.998668	6.548164	4.588541	6.958291
Q4	5.724035	4.644771	6.803298	4.073444	7.374626

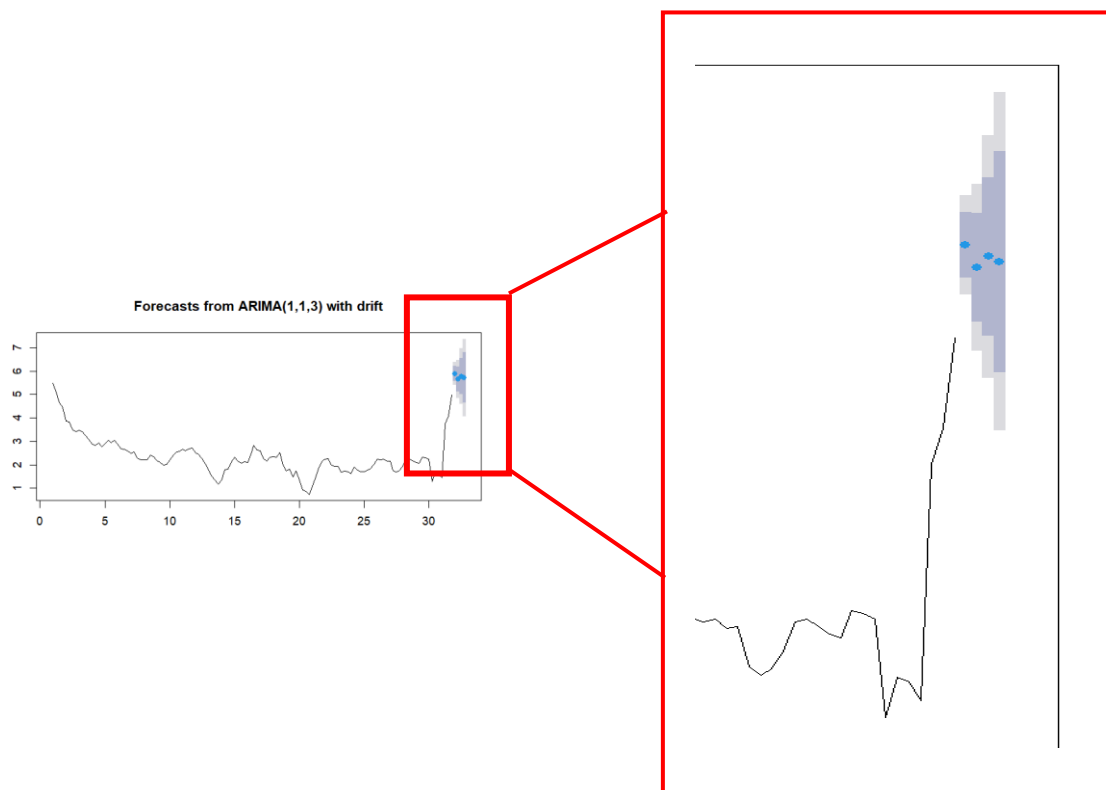


Figure 6 – Graph of *CPI\_net\_food\_energy* forecasts for the year 2022

## Results and final considerations

The last phase of the analysis process saw the implementation of a multiple linear regression model with the company's sales revenues as the dependent variable *Apple*, and as regressors the macroeconomic variables chosen, analyzed and predicted, in the phases described above.

After training and testing our model through the technique of *Cross validation*, you used it to estimate sales revenue for *Apple*, for the 2022 quarters. The results are as follows [Fig.7]:

```
Call:
lm(formula = Ricavi ~ CPI_net_food_energy + Financial_rate_consumer_loans +
    Fiducia_Consumatori_Usa, data = dataset_reg1)

Residuals:
    Min       1Q   Median       3Q      Max
-19997.6  -5521.0  -213.1   5604.6  30341.7

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)    156004.87    7943.14   19.640 < 2e-16 ***
CPI_net_food_energy  13709.41    1261.71   10.866 < 2e-16 ***
Financial_rate_consumer_loans -18785.29    659.28  -28.494 < 2e-16 ***
Fiducia_Consumatori_Usa    649.45     79.37    8.183 3.35e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9589 on 120 degrees of freedom
Multiple R-squared:  0.8755,    Adjusted R-squared:  0.8724
F-statistic: 281.4 on 3 and 120 DF,  p-value: < 2.2e-16
```

Figure 7 – Multivariate linear regression results

From fig.7 we can observe a value of  $R^2$  equal to 0.8724. This indicates that the goodness of fit of the our regression model at the observed points it is 87%. Furthermore, it can be seen that all the variables chosen as regressors are highly significant within the model and therefore significantly influence the trend of the dependent variable "Revenues".

Finally, the predicted values for the revenue variable are the following [fig.8 and 9]:

	fit	lwr [95%]	upr [95%]
Q1-2022	108645.0	97852.96	119437.0
Q2-2022	106323.0	96004.95	116641.0
Q3-2022	108633.1	98025.47	119240.8
Q4-2022	108757.3	98223.58	119291.0

Figure 8 – Predicted values for the revenue variable, with 95% confidence intervals

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<sup>3</sup>The assumptions of the implemented model have been verified through the statistical tests of: Homoskedasticity, normality of the residuals, T-student test for the significance of the regressors, Test-F, Shappiro-Wilks and Kolmogorov-Smirnov for verifying the goodness of estimation of the model

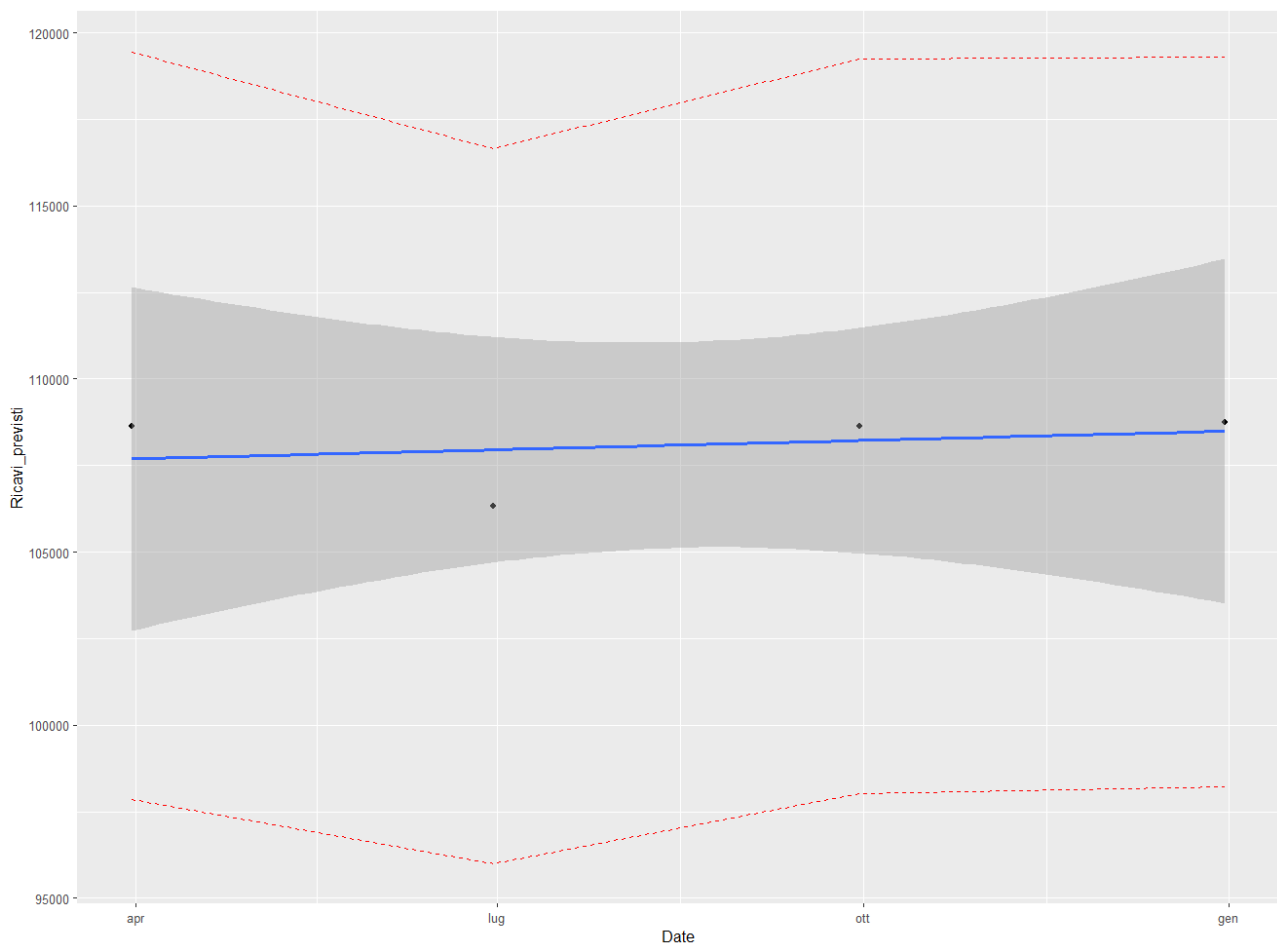


Figure 9 - Graph of predicted values for the variable "Revenues", with 95% confidence intervals

According to the estimates of the model implemented, the revenues from sales for the company *Apple* are destined to increase, exceeding the \$100 billion mark. This positive trend despite both the rising index of the inflation variable and the falling index of consumer confidence tell of a difficult situation within American society.

The factor of interest rates on personal loans, on the other hand, seems to confirm our initial assumption. In fact, from the analyzes carried out, a downward trend is forecast for 2022 as well. A trend that would make this financial instrument even more attractive and used among consumers as a tool for purchasing new products *Apple*.

However, it should be emphasized that this analysis only takes into account factors and implications that influence the demand for goods *Apple*. In order to make the analysis more complete and reliable, a future work should consider some factors that influence the supply of goods produced by the company as variables. For example, a possible increase in production factors, which would affect the final price of products, could lead demand to shift to cheaper substitute products.

Finally, to complete the analysis, the so-called regression variables could be considered "*intangible assets*" of the company, such as the *brand awareness* (potentially measured by the share of revenues reinvested in *advertising* from *Apple*) and the market presence of this company (choice of sales and distribution channels or number of stores in a given country).

