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Introduction to Time Series Models

Types of Forecasting Methods

There are a number of classifications of forecast methods;

Qualitative vs Quantitative

Time Series vs Causal

The above classifications are not mutually exclusive

The forecaster needs to be aware of the **appropriate method to match the forecast situation**

Quantitative vs Qualitative Prediction

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It should be noted that mostly forecasts will be of variables that are measured quantitatively e.g.: sales, costs, exchange rates

The distinction between quantitative and qualitative is **how the prediction is derived.**

Quantitative – the prediction is derived using some algorithm or mathematical technique based on quantitative data

Qualitative – the prediction is based primarily on judgment or opinion

Time Series vs Causal

Time Series – These are methods which rely on the **past measurements of the variable of interest** and no other variables, e.g.: moving average, exponential smoothing, decomposition, extrapolation

Causal methods – where the prediction of the target series or variable is **linked to other variables or time series,** e.g.: regression, correlation and leading indicator methods.

Sources of Data

Predictions and forecasts are based on relevant current and past data.

The data sources can be classified into internal and external;

Internal – sources that come from within the organisation- eg sales data, employment records, customer profiles and spending

External – data that is sourced from outside the organisation e.g.: ABS data, other govt. agencies, internet, trade organisations, commercial data agencies.

Types of Data

A useful classification of data for forecasting is;

Time Series: A sequence of measurements on a variable taken over specified successive intervals of time

e.g.: monthly interest rates, sales/week, tourist arrivals per annum

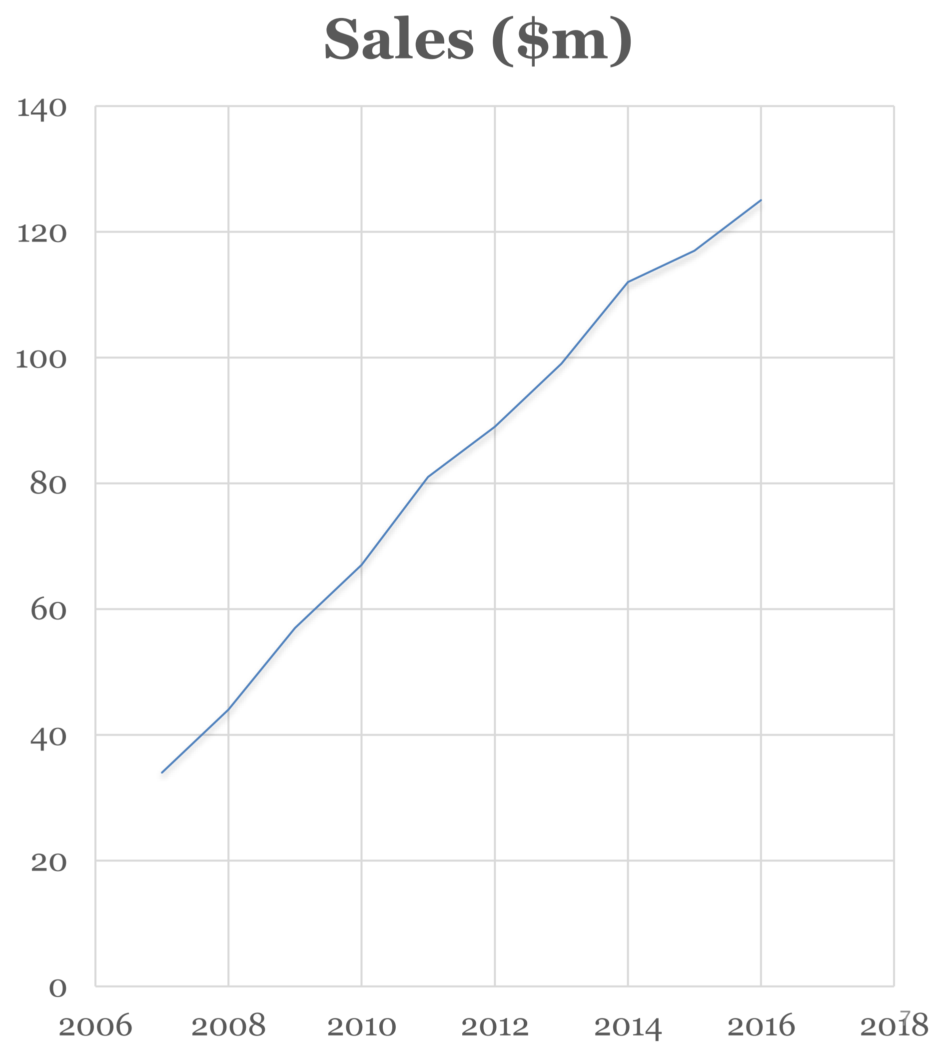
Cross-Sectional: Measurements on a variable that are at one point in time but spread across a population

e.g.: tourism spend across age groups, production across sectors of the economy

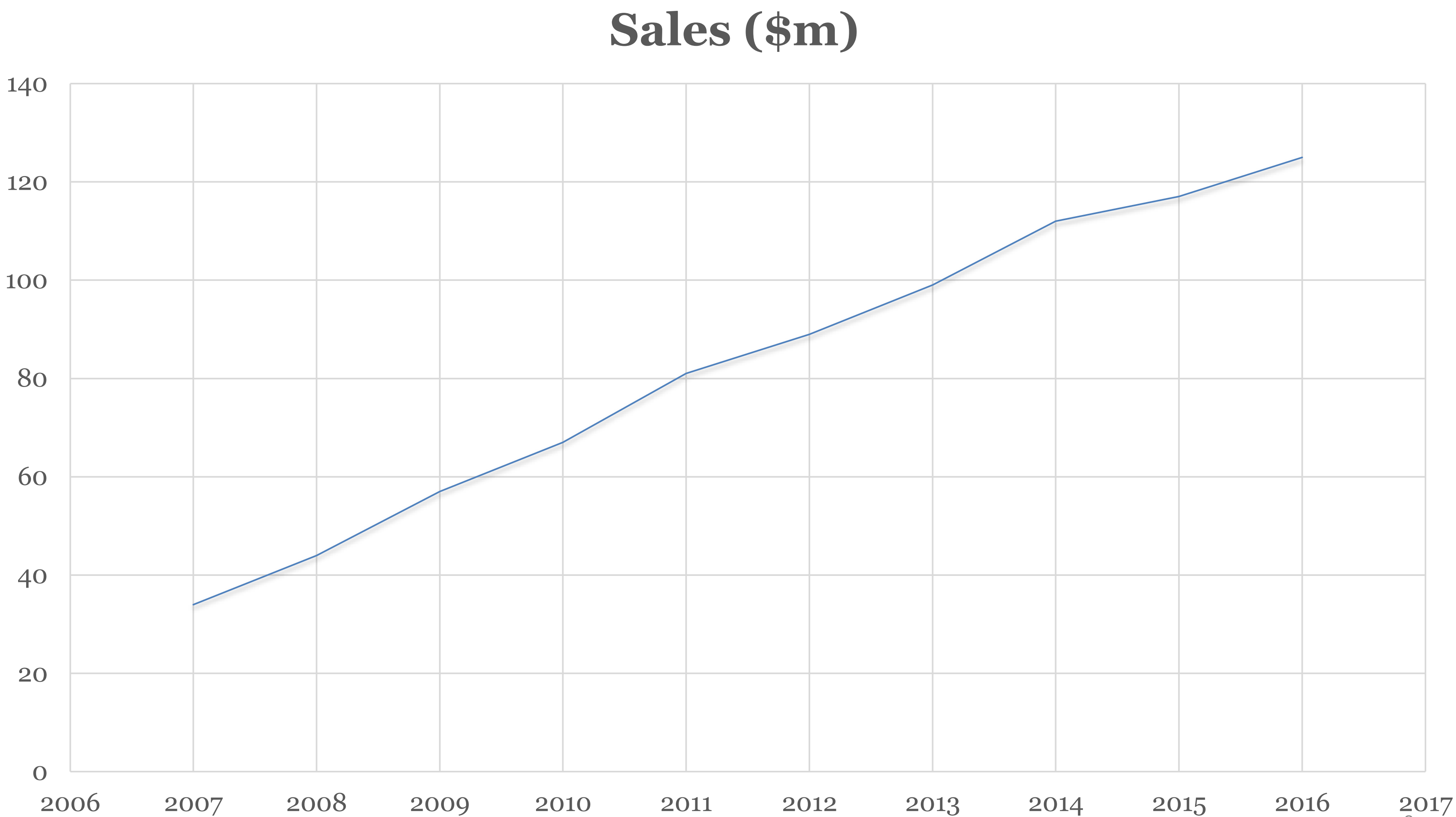
Time Series Example

Consider annual Sales ($m) data from 2007 to 2016

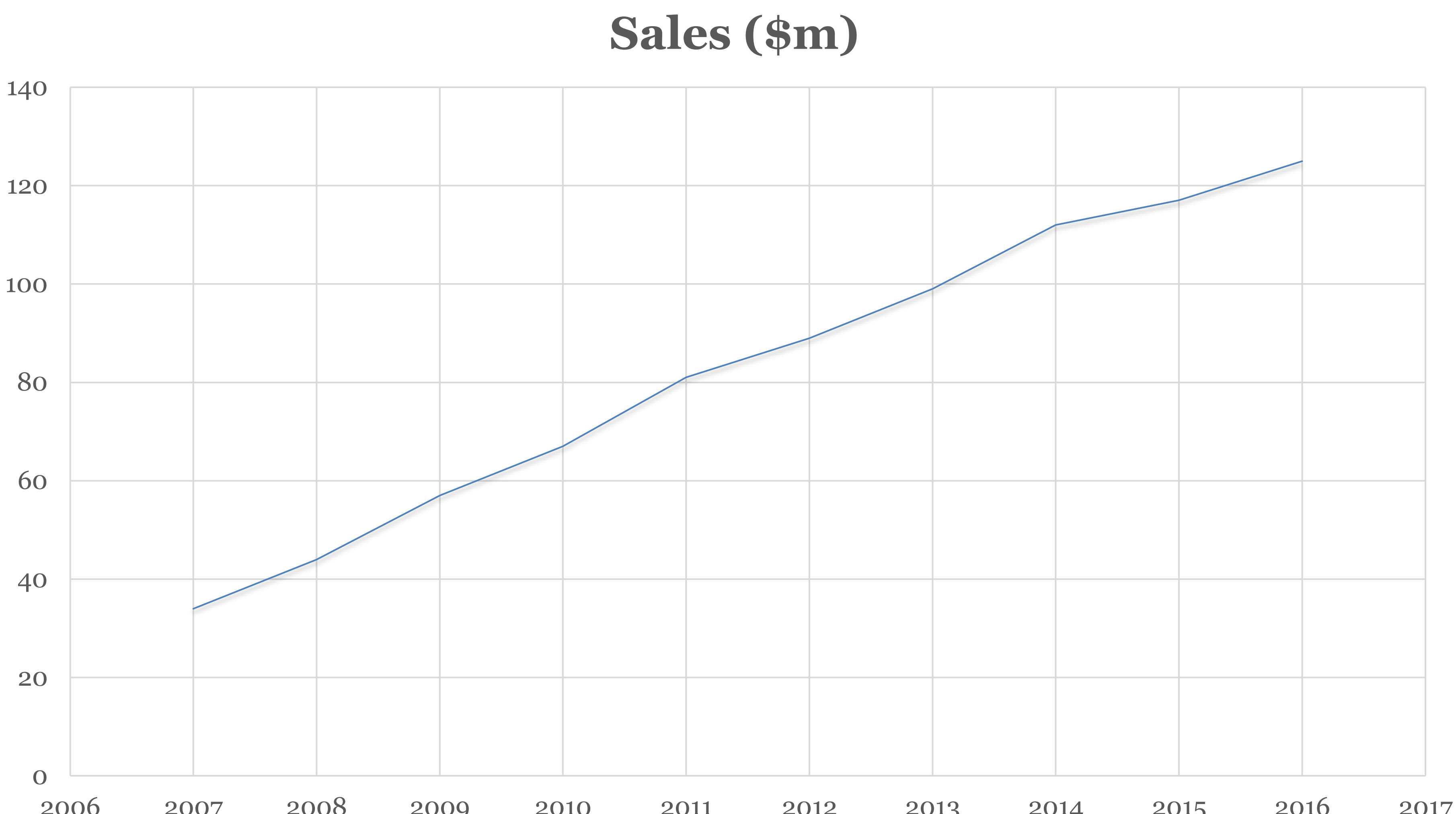
Year	Sales ($m)
2007	34
2008	44
2009	57
2010	67
2011	81
2012	89
2013	99
2014	112
2015	117
2016	125



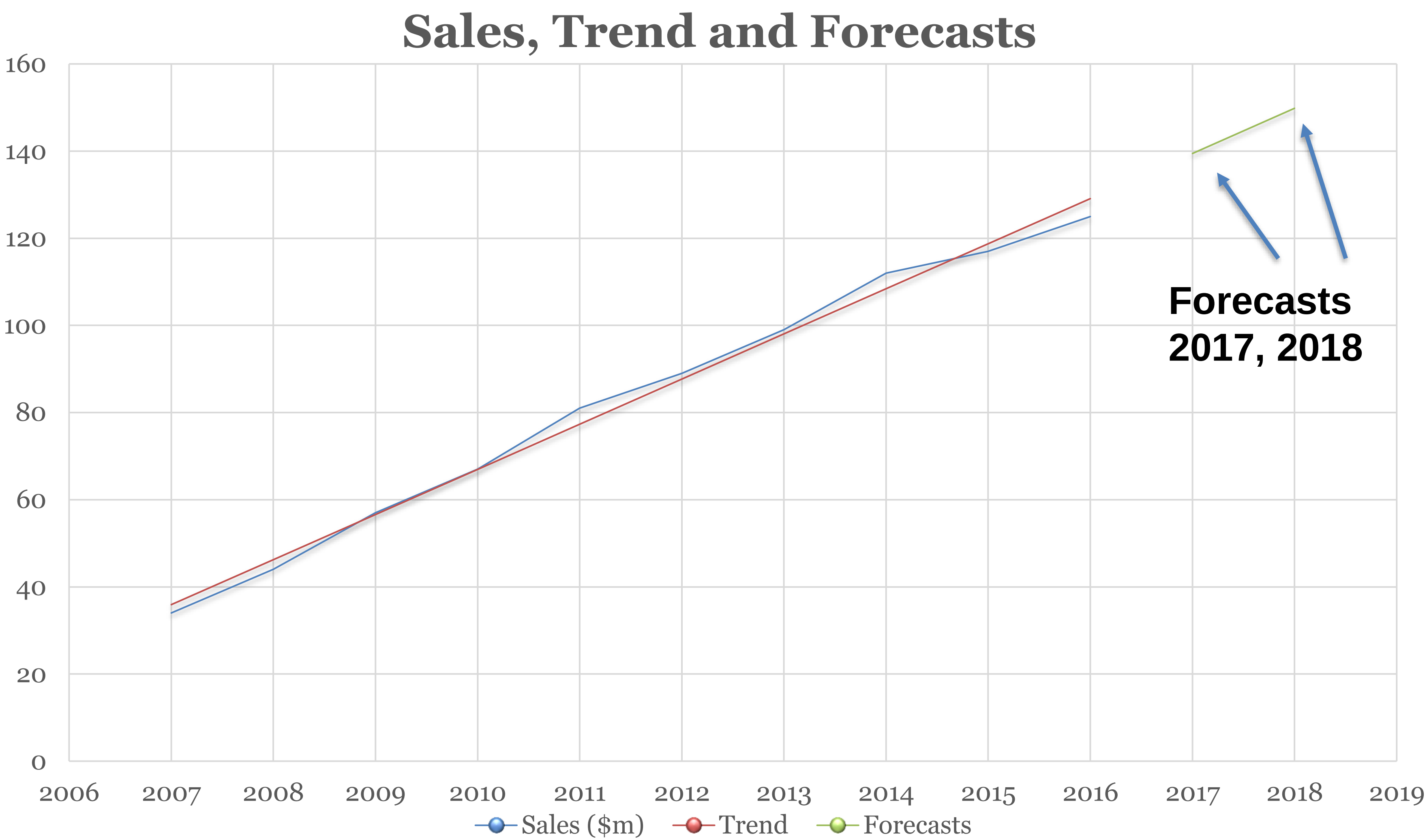
Forecasts for 2017 and 2018?



Forecasts for 2017 and 2018?



Sales, Trend Line and Forecasts



Analysing the 2017, 2018 Forecasts

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The previous example highlighted a number of key points;

1. Evaluation of the time series for **historical patterns**

2. **Matching observed pattern to a relevant algorithm** (in this case a trend line)

3. **Projection** of the algorithm **into the future** for forecasts

Exploring Time Series Patterns

There are **various patterns** that are typically associated with time series

These patterns can usually be ascribed to various **components** of time series

The **systematic components are typically due to explainable factors**

The forecaster needs to understand the components of the time series to **match the appropriate forecast method or algorithm**

Components of a Time Series

The components of a time series are:

- **Level**
- **Trend**
- **Seasonal**
- **Cyclical**
- **Random**

The random component is the only non-systematic component

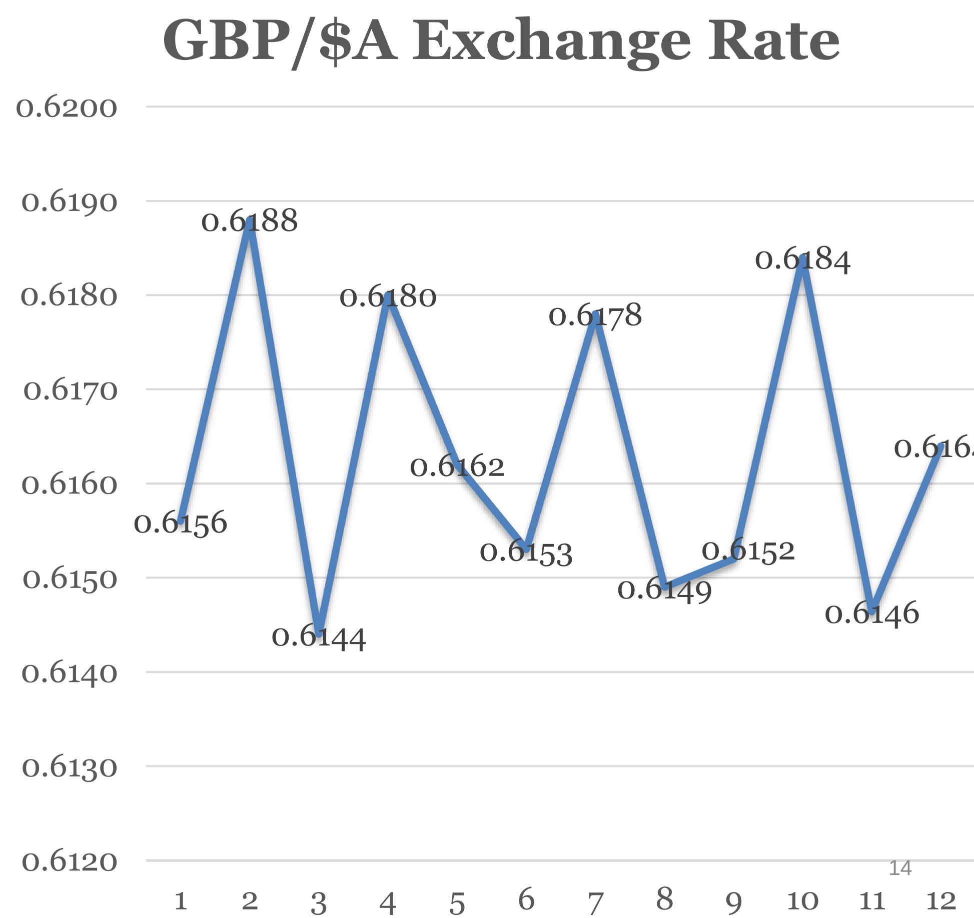
Level

Indicates the **underlying value** of the series on the vertical axis for a given time period.

The level of the time series **may be constant** over time or may change with the influence of the other components.

If the level **remains relatively constant over the entire time series a horizontal data pattern is observed**

Data: GBP/$A exchange rate
For 12 days in January 2017



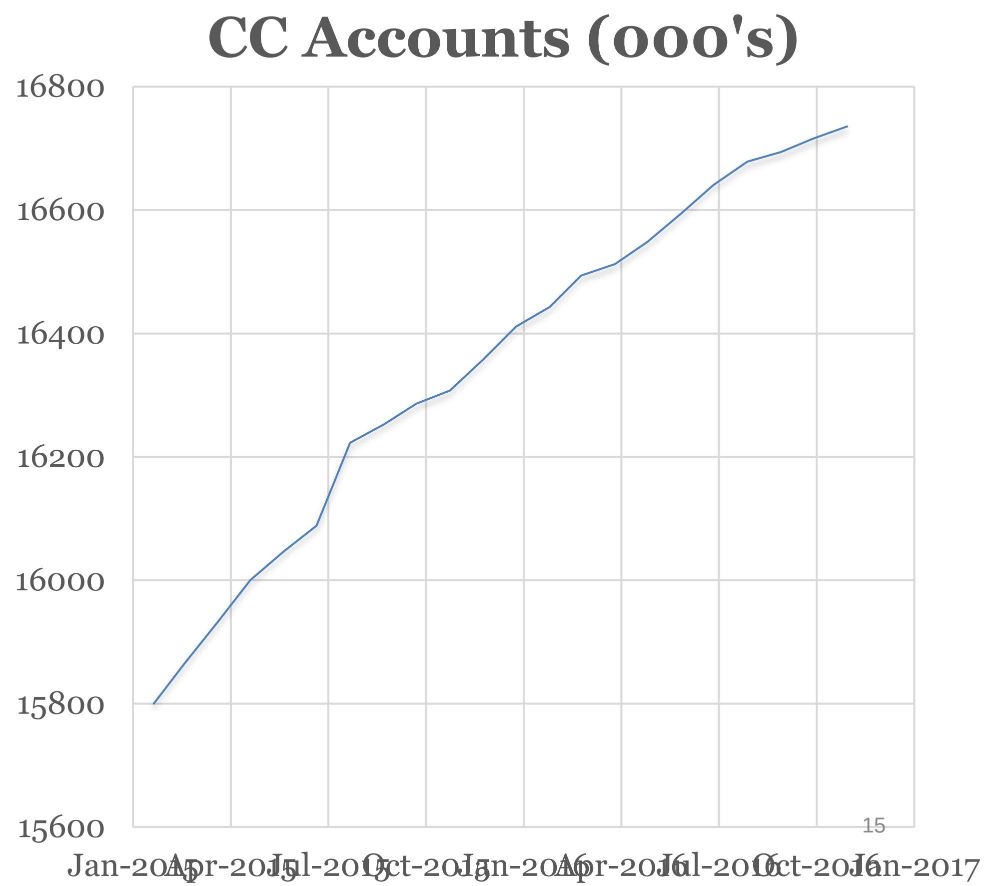
Trend

Tendency for the underlying level of the time series to **systematically increase or decrease** from period to period

The trend **need not be consistent** over the entire time series or linear.

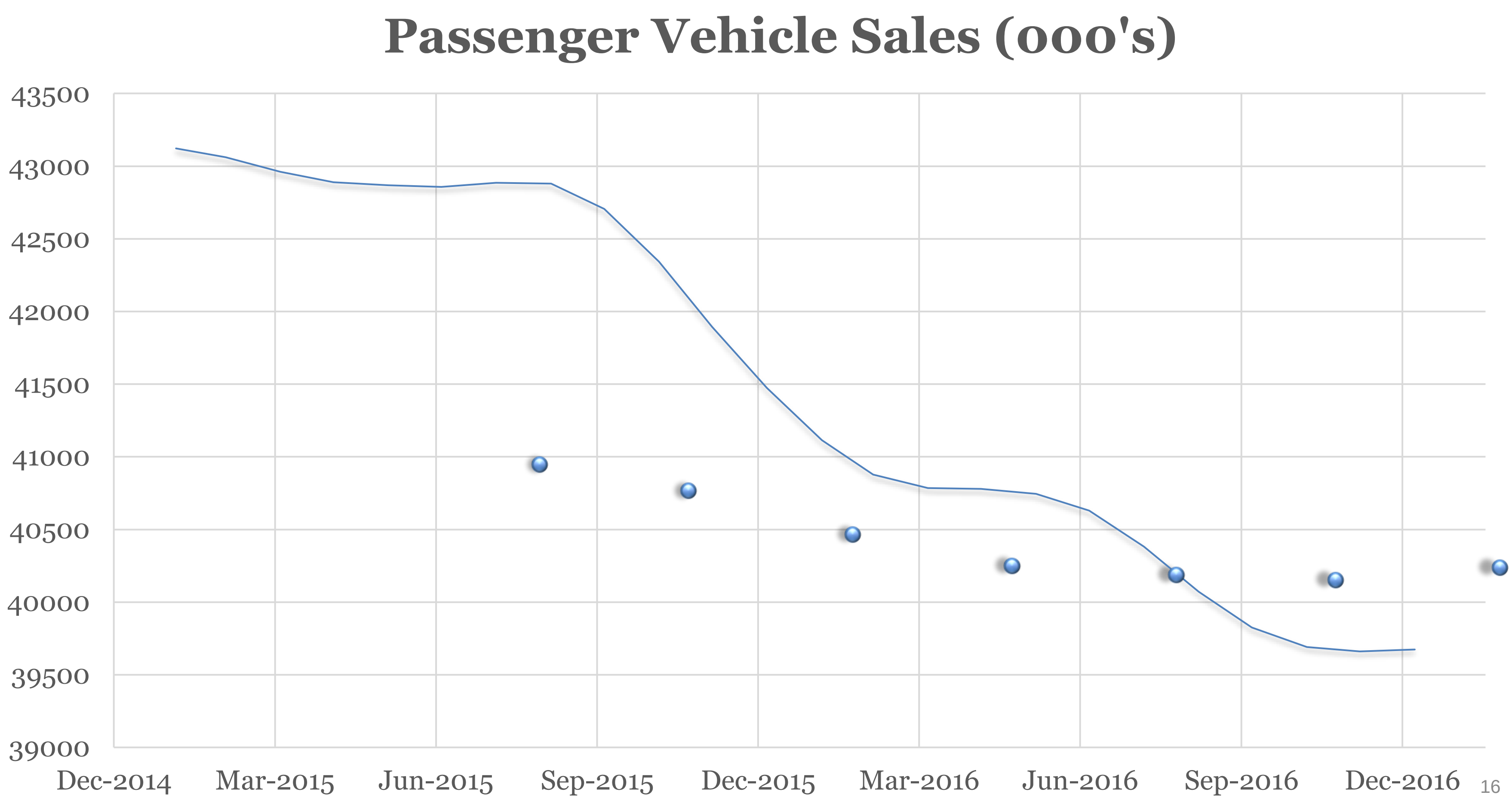
Trends are usually caused by **population changes, technology changes, market expansions etc.**

Data: Number of Credit Card Accounts (000s) monthly, Jan 2015 – Oct 2016



Further Trend Example

Data: Passenger Vehicle Sales (Australia), monthly 000's



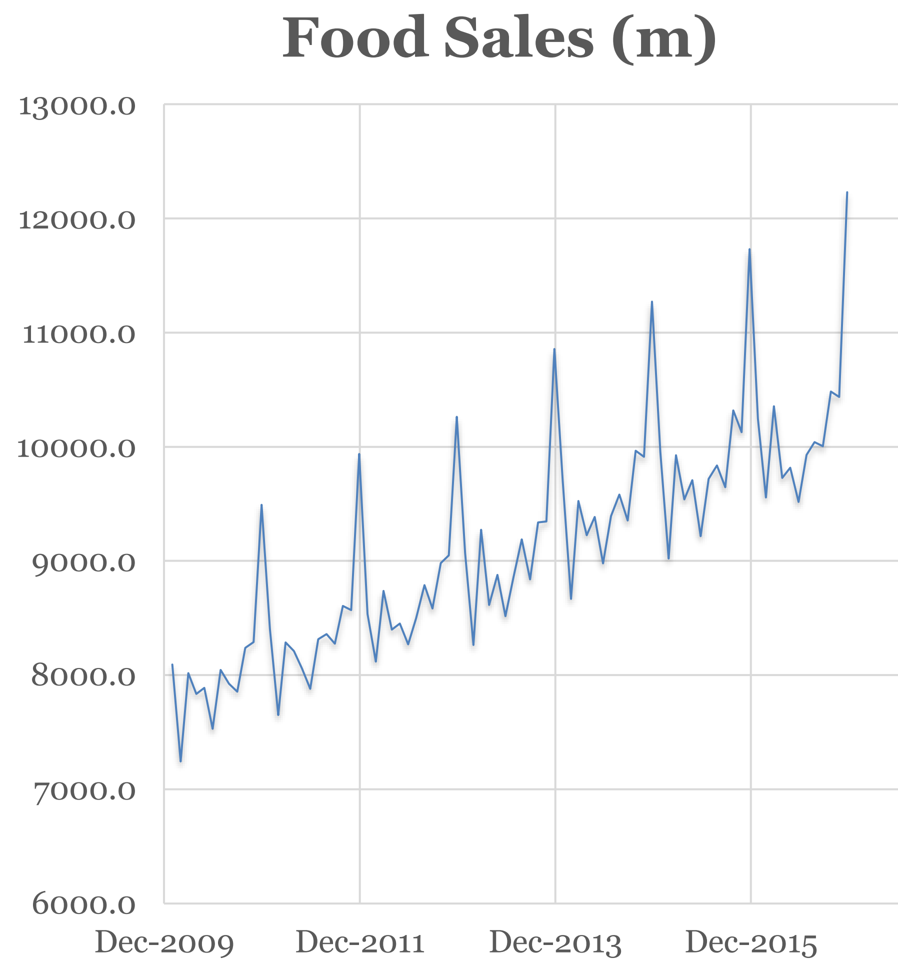
Seasonality

Systematic and repeatable fluctuations in the time series that usually occur within a **well defined time period** (year, week).

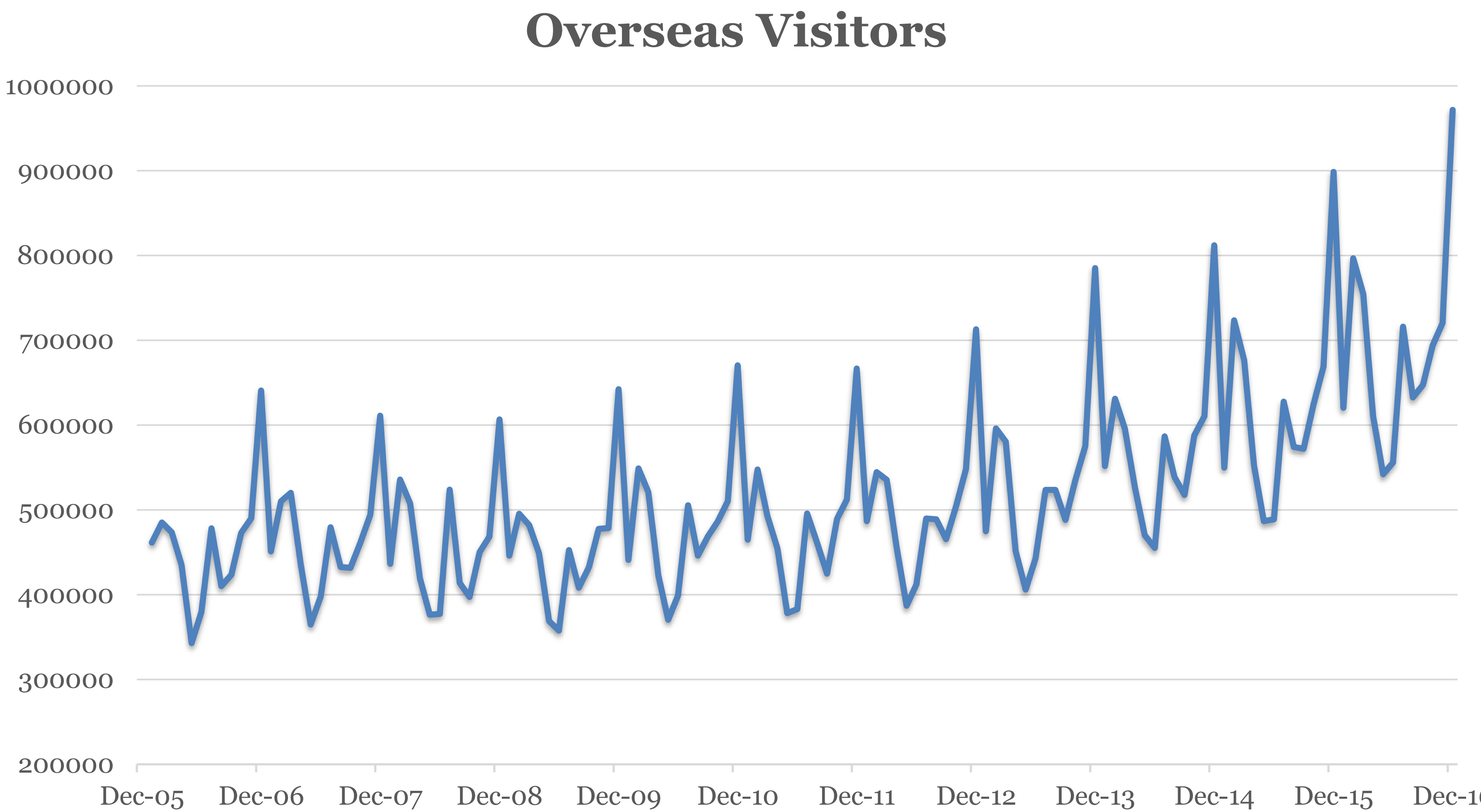
Fluctuations typically repeat themselves in **future iterations of the set time period**

Occurs due to **weather** or **institutional reasons** e.g.: holidays, special celebrations or accounting periods

Data: Food Sales ($m), NSW quarterly Jan-2010 to Dec-2016



Further Seasonal Example



Cyclical

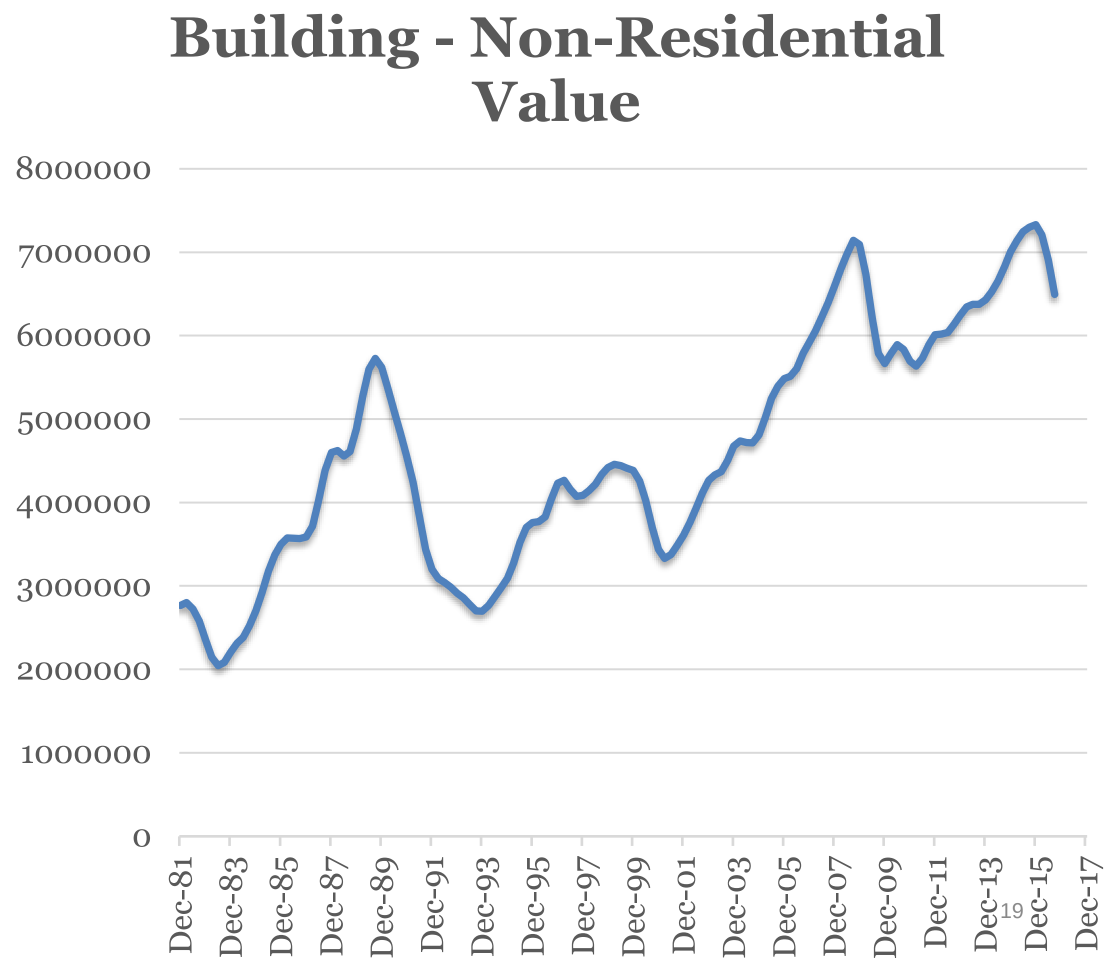
Similar to seasonal fluctuations but the cycle period is **not as regular as seasonality**

This makes the cyclical component **difficult to predict**

It is usually **subjectively assessed**

Generally the **economic cycle** will influence the cyclical behaviour of the series.

Data: Non-residential value, Aust. quarterly Dec-81 to Dec 16



Random

The random component is **non-systematic** and **not able to be predicted** with any accuracy

Typically the random component incorporates effects on the time series that **cannot be explained by the variables** that influence the systematic components

Includes **one-off effects** such as introduction of GST, cataclysmic events (e.g.: **a tsunami**) or difficult to observe and quantify effects such as **confidence and security**

The extent of the random component will determine the **maximum level of forecast accuracy achievable**