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Introduction to Time Series Models

Types of Forecasting Methods

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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

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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

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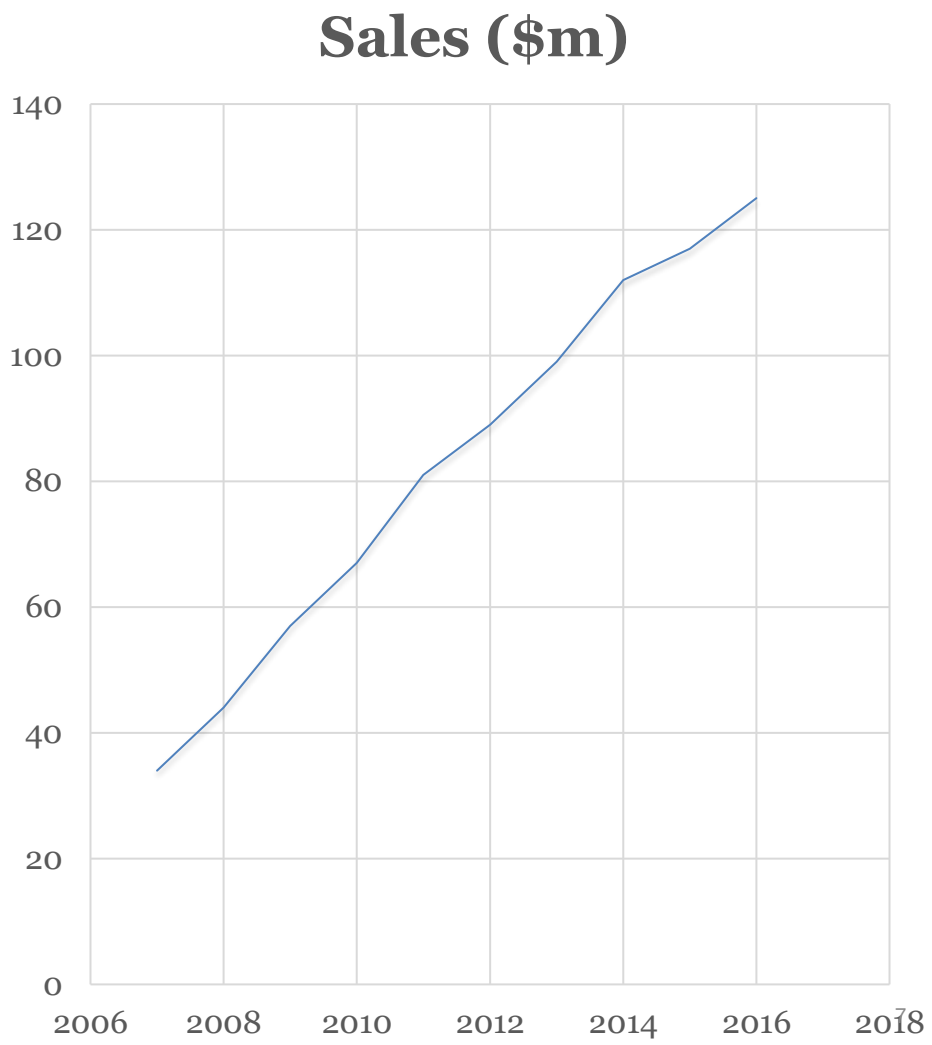
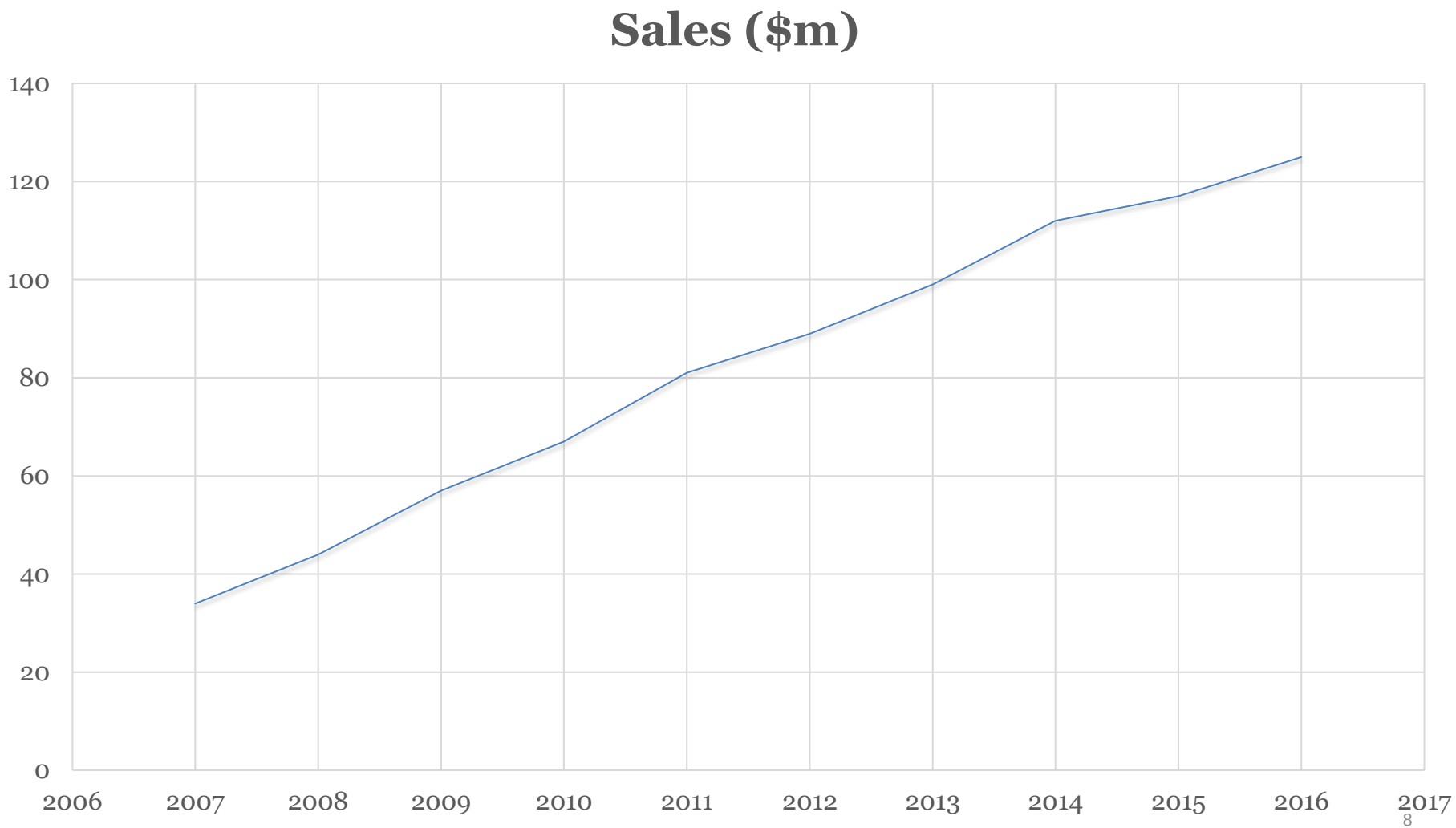
Consider annual Sales ($m) data from 2007 to 2016

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?



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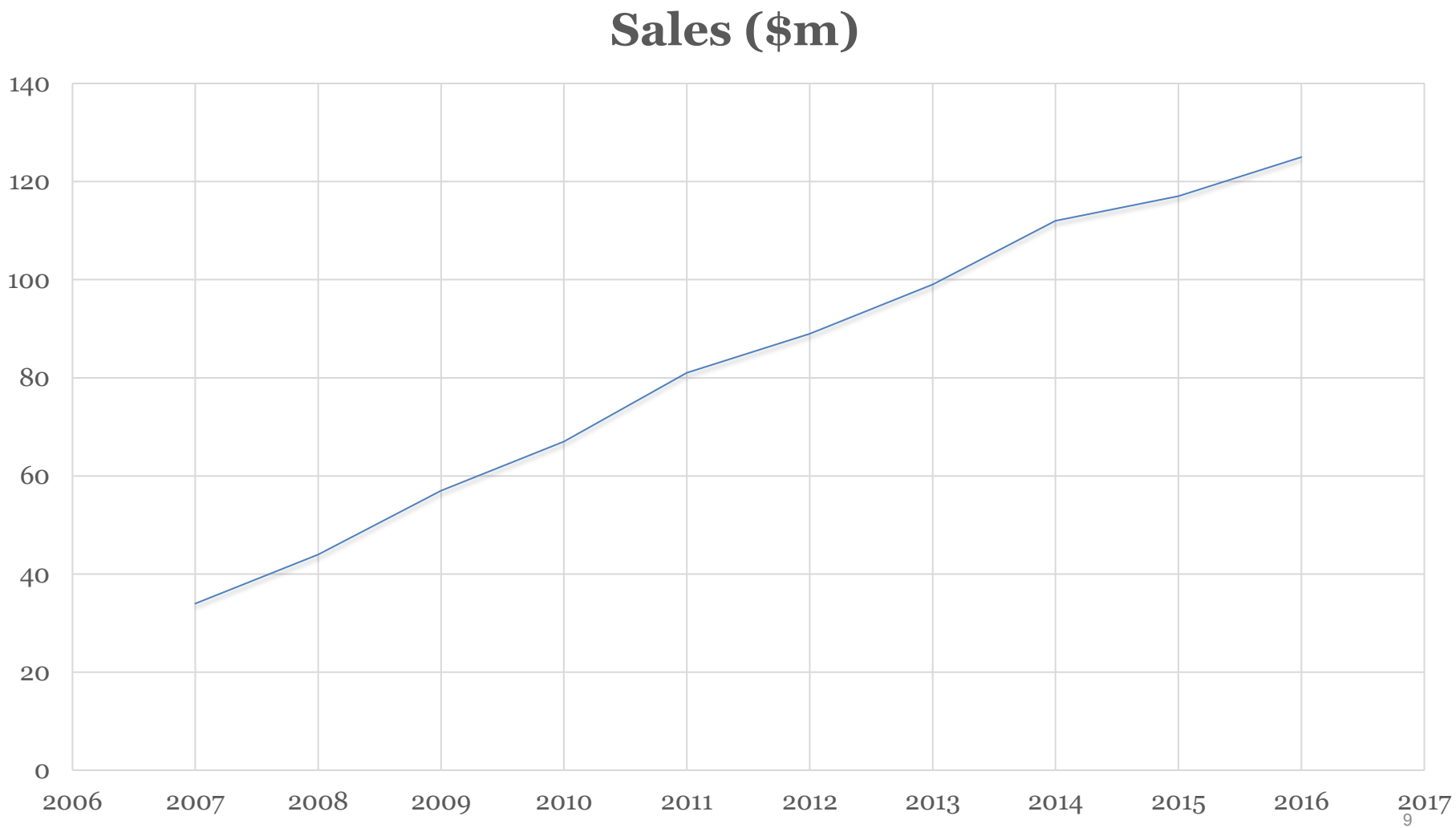
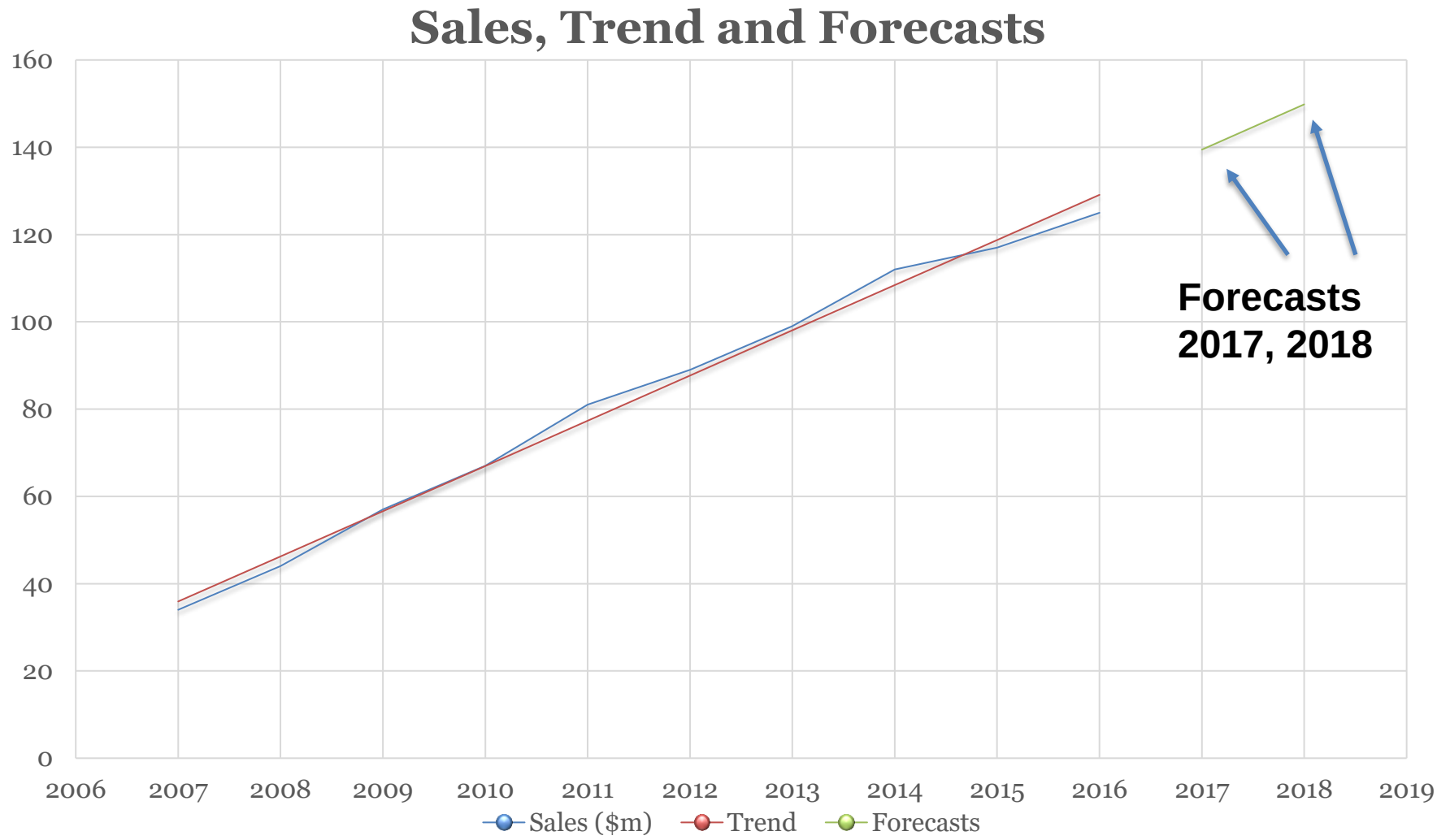


Sales, Trend Line and Forecasts



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

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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

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The components of a time series are:

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

The random component is the only non-systematic component

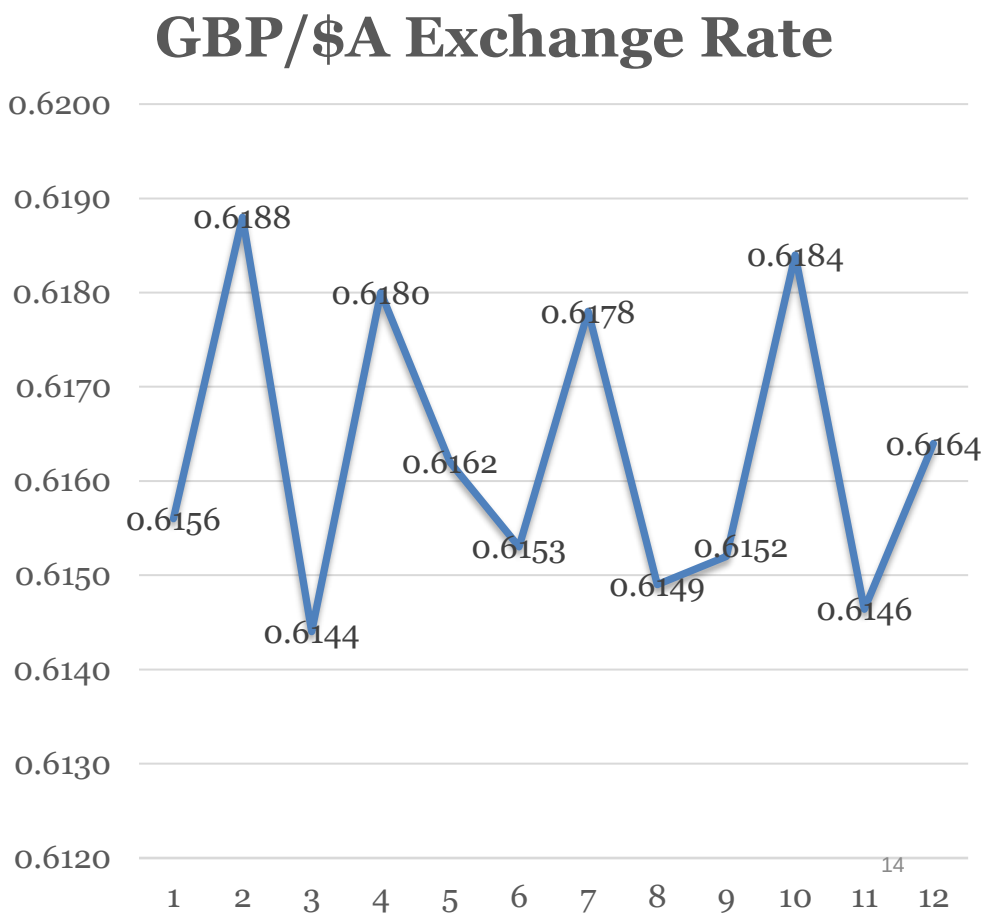
Level

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



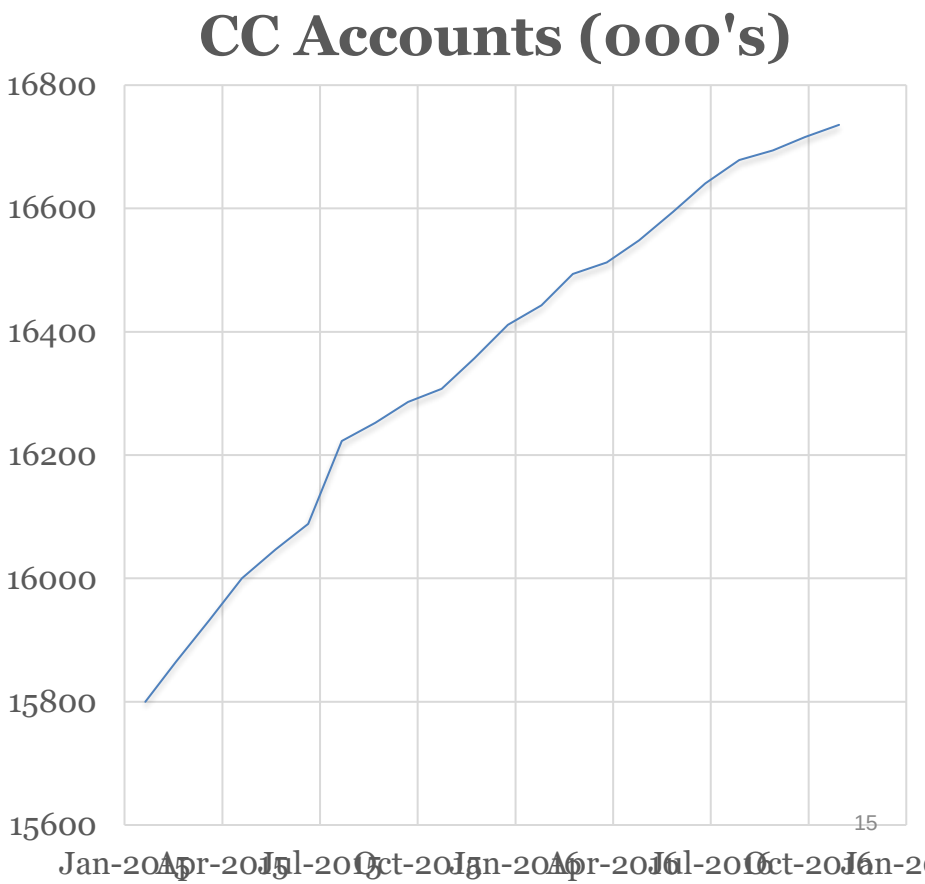
Trend

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.

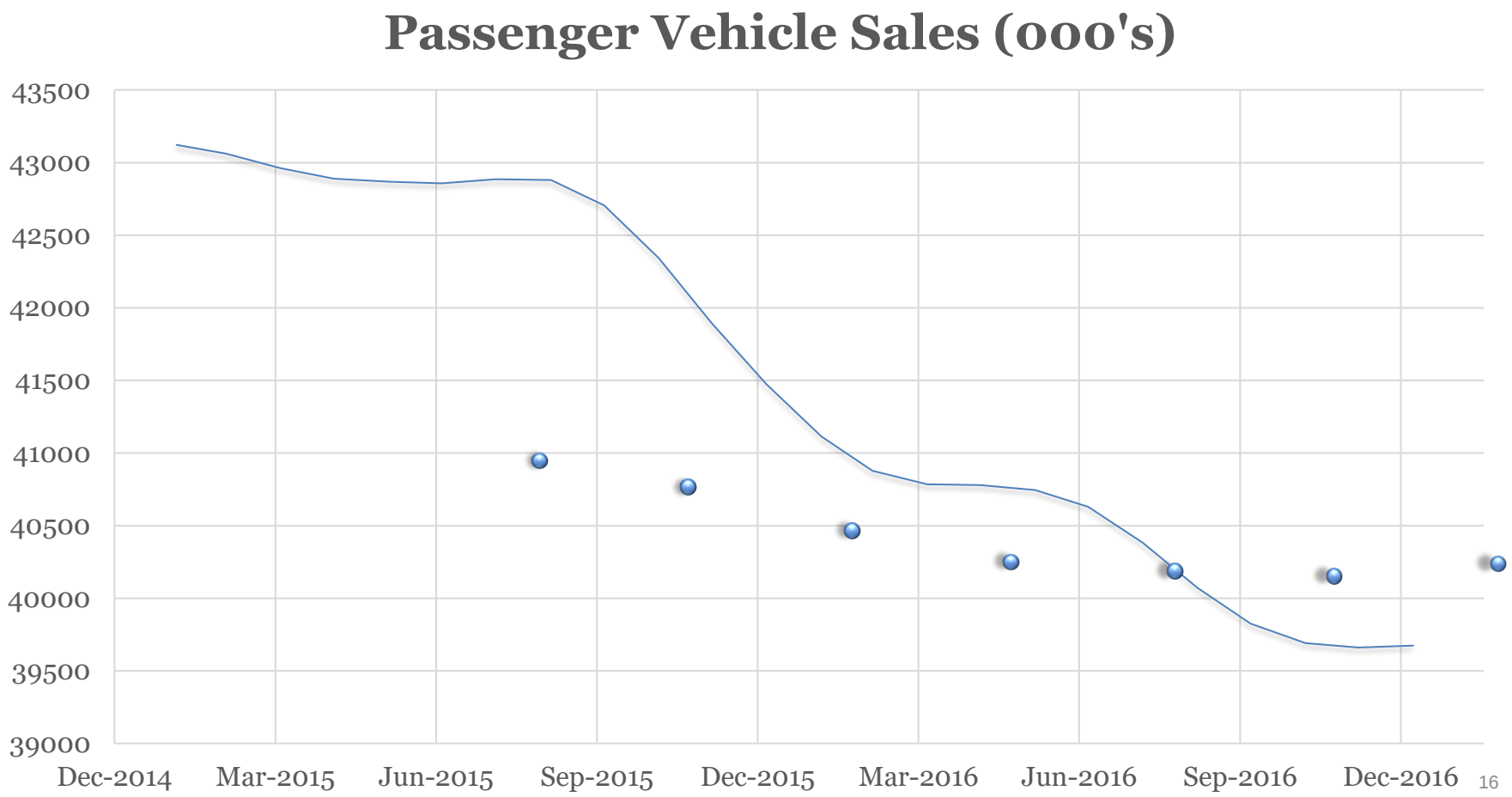
Trends are usually caused by **population changes, technology changes, market expansions etc.**

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



Further Trend Example

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



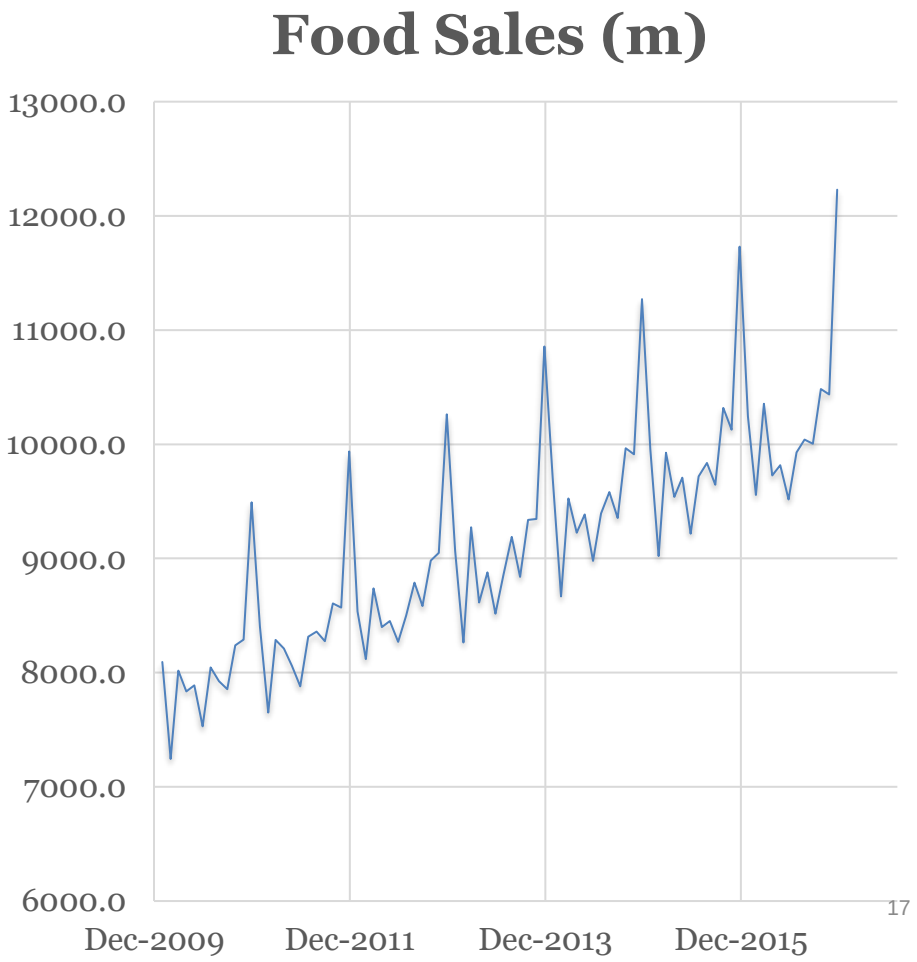
Seasonality

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

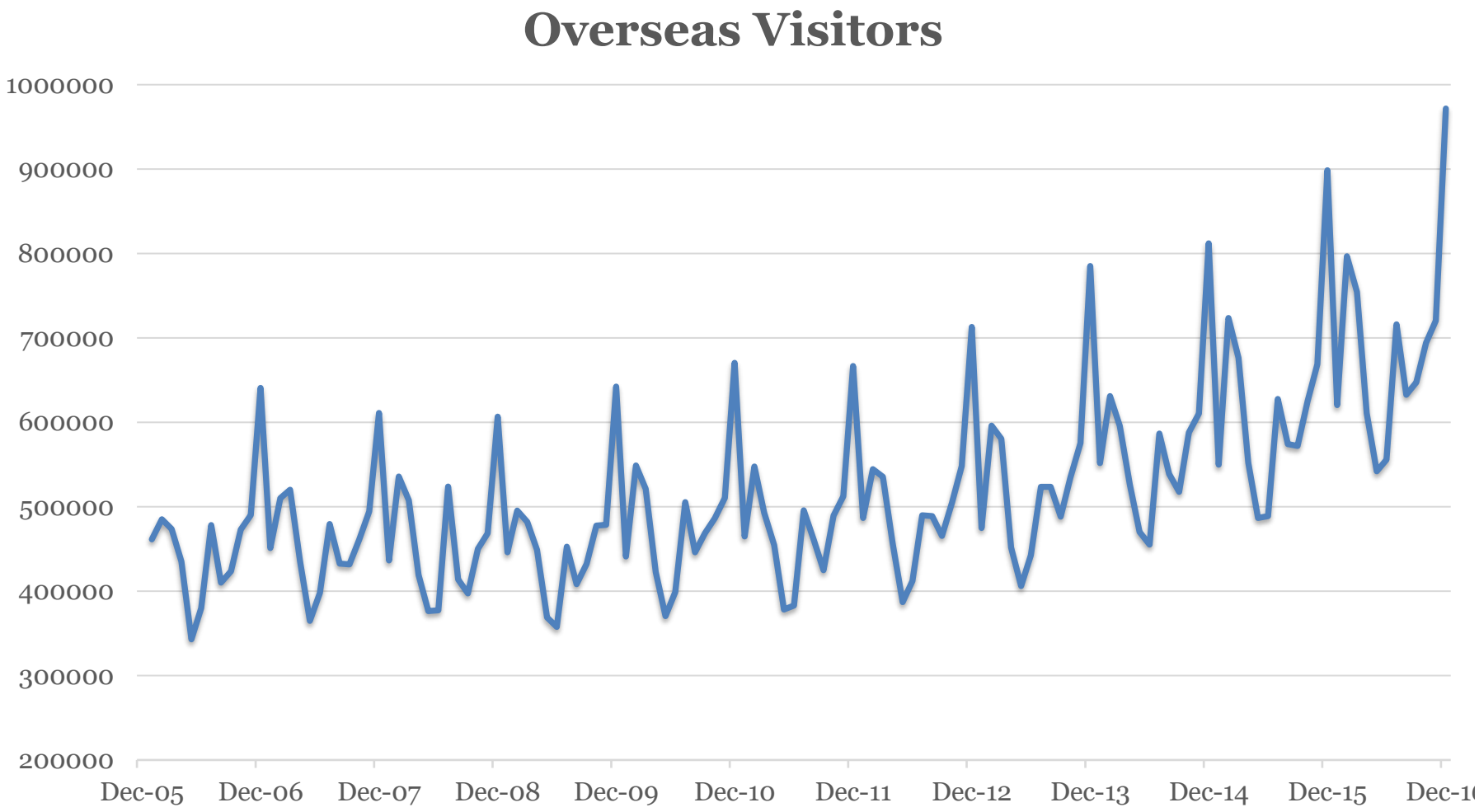
Fluctuations typically repeat themselves in **future iterations of the set time period**

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

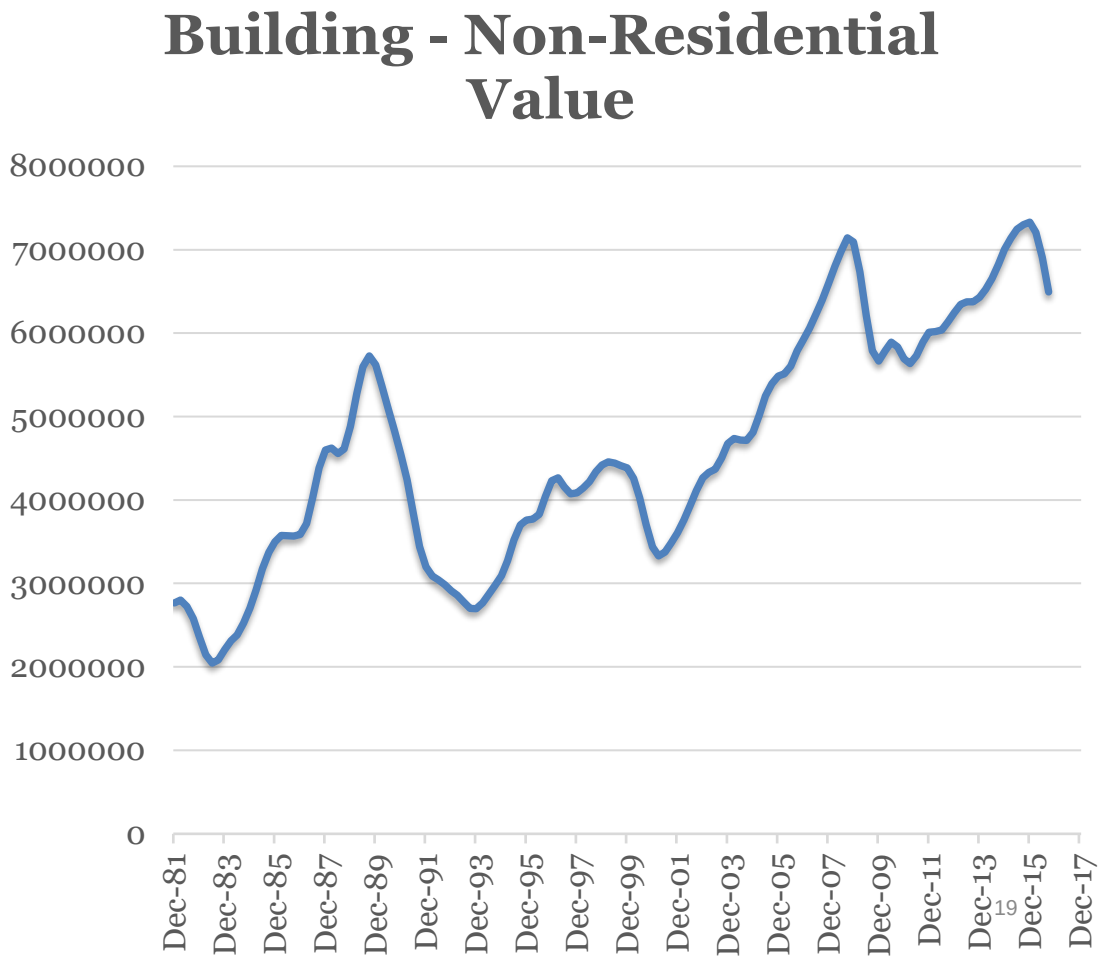
Similar to seasonal fluctuations but the cycle period is **not as regular as seasonality**

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

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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**