

# Purchasing power of English workers from the 16th to the 19th century

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```
library(tidyverse)

## -- Attaching packages ----- tidyverse 1.3.1 --

## v ggplot2 3.3.5    v purrr  0.3.4
## v tibble  3.1.5    v dplyr  1.0.7
## v tidyr   1.1.4    v stringr 1.4.0
## v readr   2.0.2    v forcats 0.5.1

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

## Introduction

The purpose of this peer-reviewed exercise is to do a visualization of the data describing the purchasing power of workers in England between the 16th and 19th century. The data and accompanying visualization was first produced by William Playfair in his book: “A Letter on Our Agricultural Distresses, Their Causes and Remedies”. After exploring the data, we divide this report into three main sections:

1. Reproducing Playfair’s graph
2. Improving Playfair’s graph
3. More graphical enhancements

## Data exploration

We start by importing the data, displaying a few rows and showing some statistics.

```
data = read.csv('data.csv')
data[1:5,]

##   X Year Wheat Wages
## 1 1 1565  41.0  5.00
## 2 2 1570  45.0  5.05
## 3 3 1575  42.0  5.08
## 4 4 1580  49.0  5.12
## 5 5 1585  41.5  5.15

str(data)

## 'data.frame':   53 obs. of  4 variables:
##  $ X      : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Year   : int 1565 1570 1575 1580 1585 1590 1595 1600 1605 1610 ...
```

```
## $ Wheat: num 41 45 42 49 41.5 47 64 27 33 32 ...
## $ Wages: num 5 5.05 5.08 5.12 5.15 5.25 5.54 5.61 5.69 5.78 ...
```

## 1. Reproducing Playfair's graph

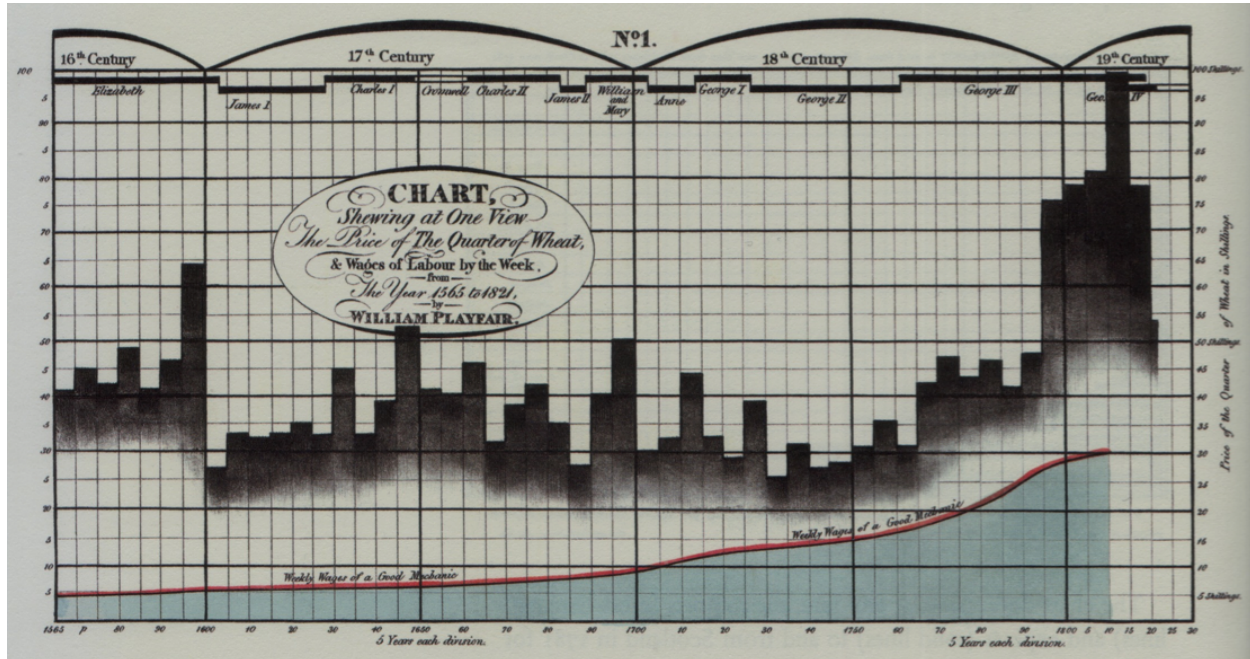
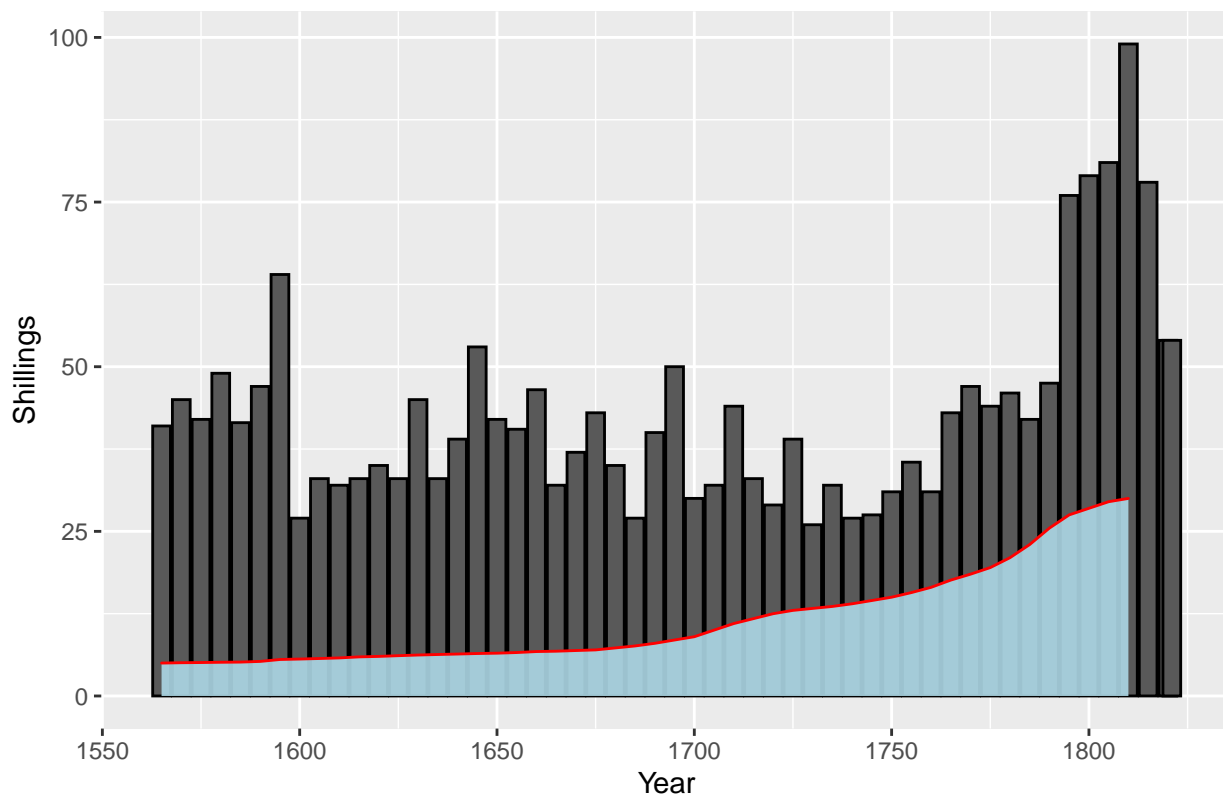


Figure 1: Chart of the Quarter of Wheat & Wages of Labour per week

```
ggplot(data=data, aes(x=Year, y=Wheat)) +
  geom_bar(aes(y=Wheat), position=position_dodge(0.9), colour="black", stat="identity", width=4.5, binwidth=5) +
  geom_area(aes(y=Wages), fill = "lightblue", color='red', alpha=0.9) +
  labs(y = "Shillings", x = "Year") +
  labs(title="The price of a quarter of wheat and wages per week from 1565 to 1861")
```

```
## Warning: Ignoring unknown parameters: binwidth
## Warning: position_dodge requires non-overlapping x intervals
## Warning: Removed 3 rows containing missing values (position_stack).
```

## The price of a quarter of wheat and wages per week from 1565 to 1861



### Comments

1. We can see from the wages curve that there are missing values for the last few years. In the following section, we would remove these missing values as we cannot say much about purchasing power for that period.
2. Unlike the wages which are consistently increasing, the price of wheat does not have a consistent pattern.

## 2. Improving Playfair's graph

As mentioned in the previous section, we would like to remove missing values from the experiment. We can find these rows as follows:

```
data[rowSums(is.na(data)) > 0, ]
```

```
##      X Year Wheat Wages
## 51 51 1815     78    NA
## 52 52 1820     54    NA
## 53 53 1821     54    NA
```

```
df <- na.omit(data)
summary(df)
```

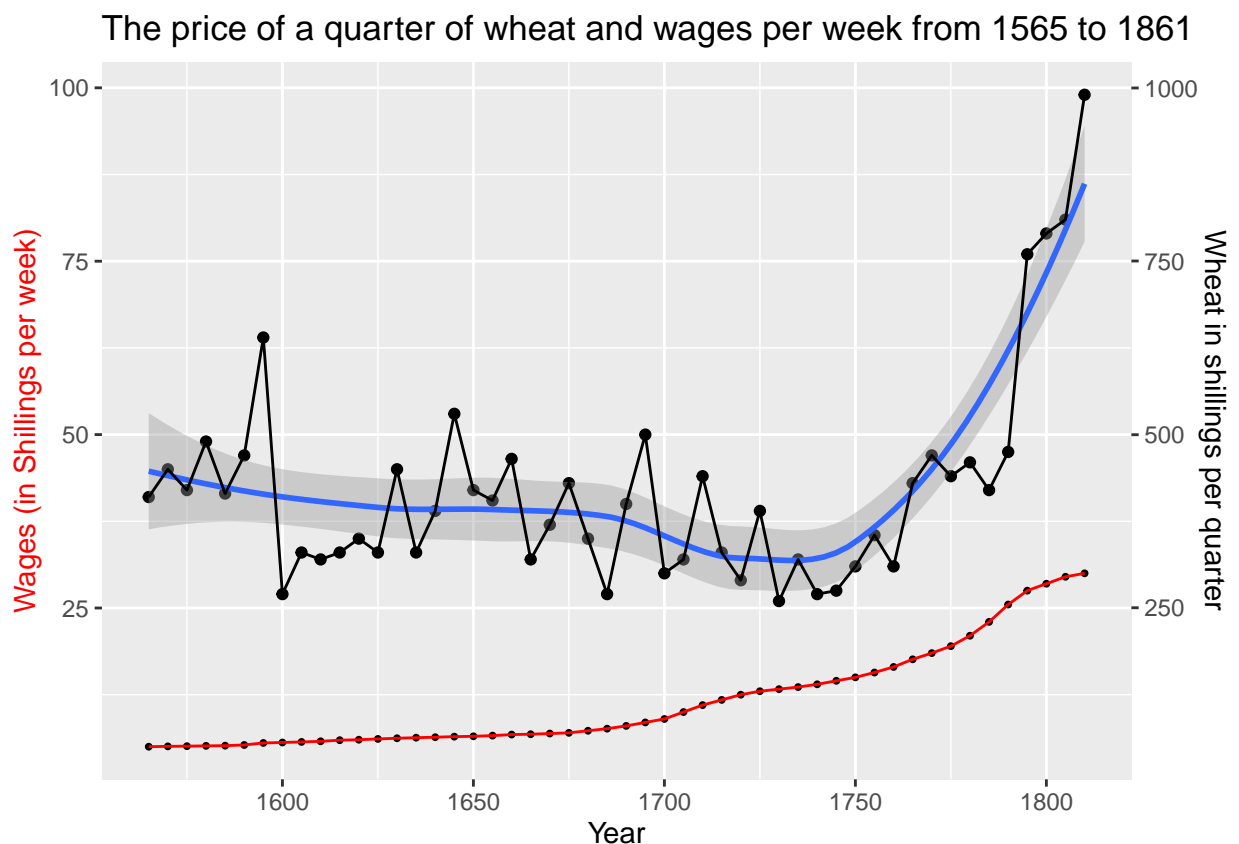
```
##      X      Year      Wheat      Wages
## Min.   : 1.00  Min.   :1565  Min.   :26.00  Min.   : 5.000
## 1st Qu.:13.25  1st Qu.:1626  1st Qu.:32.25  1st Qu.: 6.145
## Median :25.50  Median :1688  Median :40.25  Median : 7.800
## Mean   :25.50  Mean   :1688  Mean   :42.14  Mean   :11.582
## 3rd Qu.:37.75  3rd Qu.:1749  3rd Qu.:45.75  3rd Qu.:14.875
```

```
## Max. :50.00 Max. :1810 Max. :99.00 Max. :30.000
```

To improve the original graph we can add an additional y-axis label where the left side is the price of wheat in shillings per quarter and the right side is the wages in shillings per week.

```
ggplot(df) +
  aes(x = Year) +
  geom_point(aes(y=Wheat)) +
  geom_point(aes(y=Wages), size=0.7) +
  geom_smooth(aes(y=Wheat)) +
  geom_line(aes(y=Wheat)) +
  geom_line(aes(y=Wages), color='red') +
  scale_y_continuous( name = "Wages (in Shillings per week)", sec.axis = sec_axis( trans=~.*10, name="Wheat in shillings per quarter" ) ) +
  labs(title="The price of a quarter of wheat and wages per week from 1565 to 1861") +
  theme(axis.title.y.left = element_text(colour = "red"))
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



To observe the evolution of wheat price and wages of the specified period, we use lines to enhance the presentation. We also include a confidence interval for the evolution of wheat price as it has a higher variance in the interval. This graph better highlights the presentation of the first graph by showing that while wages were steadily increasing during the period, wheat price was largely fluctuating until the 18th century when we see a steady upward trend.

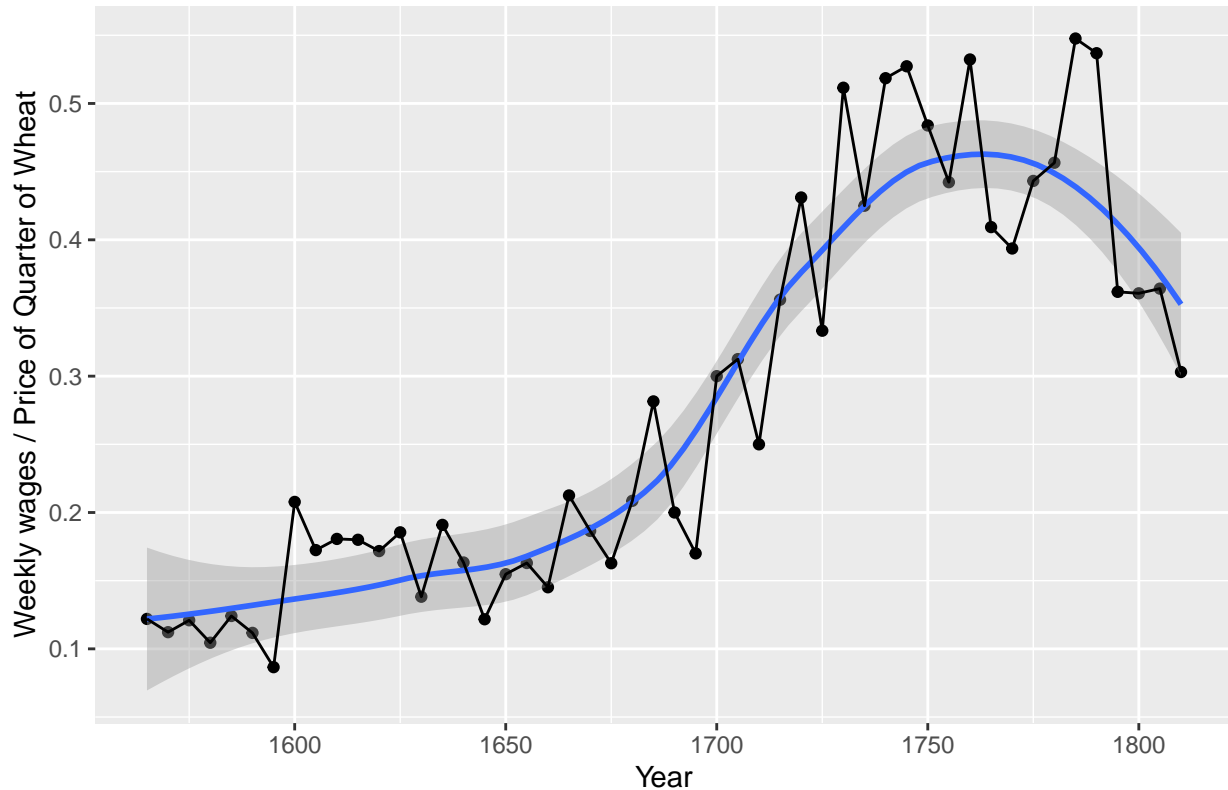
### 3. More graphical enhancements

In the section, we demonstrate purchasing power by defining it as the quantity of wheat (in quarters) a worker can buy with his weekly salary. In particular, we update our data to include an additional column where we divide the Wages by the price of wheat. We then plot the resulting ratio as function of time.

```
df <- transform(df, wheat_wages = Wages / Wheat)
ggplot(df) +
  aes(x = Year) +
  geom_point(aes(y=wheat_wages)) +
  geom_smooth(aes(y=wheat_wages)) +
  geom_line(aes(y=wheat_wages)) +
  labs(title = "Evolution of purchasing power of English workers from 16th to the 19th century.", y="Weekly wages / Price of Quarter of Wheat")

## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

### Evolution of purchasing power of English workers from 16th to the 19th century

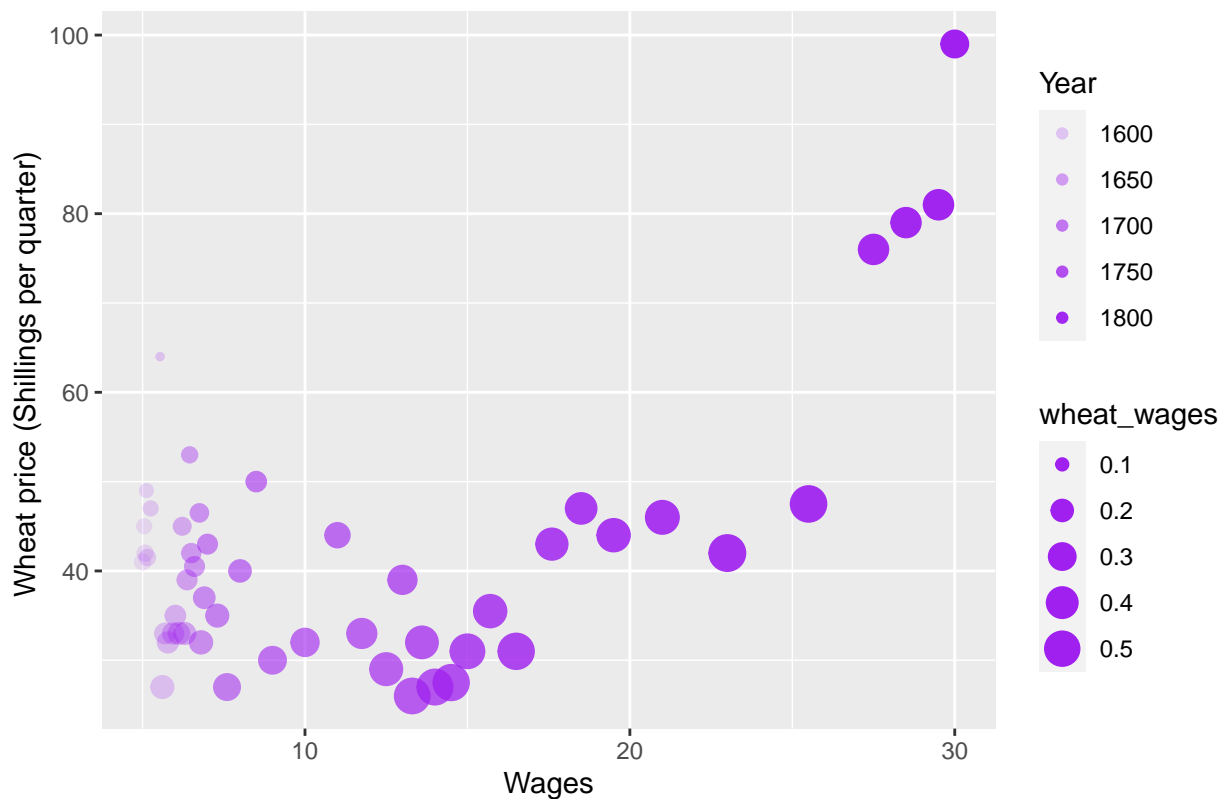


It is clear from this graph that purchasing power increased from the 16th century until a peak around 1770. It then started to decline continuously beyond this point. This may be attributed to the sharp increase in the price of wheat as highlighted in the previous graph.

We can also present the data in a graph where the wheat price is on the y-axis and the weekly wages is on the x-axis. This is presented below:

```
ggplot(df, aes(x=Wages, y=Wheat, size=wheat_wages, alpha=Year)) +
  geom_point(color = "purple") +
  labs(title="Scatterplot of purchasing power of English workers from 16th to the 19th century", y="Weekly wages / Price of Quarter of Wheat")
```

Scatterplot of purchasing power of English workers from 16th to the 19th ce



Here we have use a scatter plot to compare the wheat price and wages and we use colors to illustrate the years of the data. In particular, the brightest colors represent the earlier years (16th century) and the darker colors represent more recent years (19th century). We also use the ratio of wheat price to wages to capture the strength of the purchasing for each data point. Specifically, larger circles represent higher purchasing power and smaller circles represent lower purchasing power.

## Conculsion

We have presented the Playfair's data on purchasing power between 16th and 19th century using different graphical methods. In particular, we started by replicating Playfair's original graph and then making enhancements to better highlight the trends in purchasing power over the period considered. Of all the graphs presented, the most intuitive is the third one that takes a ratio of the price of wheat and the wages for each year and produces a plot of the variation over time. On the other hand, the scatter plot comparing wheat price and wages with color gradients for years and circle size for purchasing power is less intuitive for the data.