Discussion Paper

# Components of Unemployment



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# Content

## Summary

The possibility of computing and publishing components of unemployment by Statistics Netherlands has been researched.

Components refer to causes of unemployment, whereas segments refer to characteristics of unemployed people. There has been a complex and huge debate in academic literature on components of unemployment. Many theoretical concepts are being proposed in this literature. One of the most practical frameworks has been formulated by Muysken (1984) and contains the following concepts:

- structural quantitative unemployment
- structural qualitative unemployment
- business cycle unemployment.

In the literature, only a small number of empirical methods have been proposed. These methods are usually a reflection of a specific economic school of thought and uses models with specific assumptions. Whereas the (neo)classical tradition focuses on the estimation of the Phillips curve (NAIRU), the (neo-)Keynesian tradition prefers the estimation of the Beveridge curve. There is no agreement in the academic discourse on which concepts and methods should be used. Another problem is that the concepts which are used are not always strictly defined, which may give rise to misunderstandings.

Since Statistic Netherlands has the duty to publish data which are beyond dispute, neither practice (Beveridge/ Phillips curve) is in favour at Statistic Netherlands. For that reason a framework has been developed that:

- uses transparent concepts for a large group of practical users,
- focuses on empirical content,
- uses statistical methods with relatively few assumptions and not related to specific economic schools of thought,
- uses the generally accepted concept of the market for perfect competition as a benchmark model.

In this framework three main lines of thought are introduced:

- A static analysis, which reveals that all unemployment is the result of market imperfections. In this paper it is demonstrated that N is the result of unbalanced rigidities, Q is the result of balanced rigidities. N can be solved by quantitative labour policies, Q by qualitative labour policies. The consequence of this argument is that N can be interpreted as quantitative unemployment, and Q can be interpreted as qualitative unemployment, comparable to the concepts of Muysken.
- A dynamic analysis, which uses statistical cycle extraction techniques to estimate the short (Juglar) cycle, a long cycle, a trend cycle and a trend. These variables are comparable to traditional concepts like unemployment caused by business cycles and the NAIRU. Only a sketch of an explanation has been given for these dynamic components.

– An analysis of mismatches to get more detailed information about the dimensions of qualitative unemployment. The analysis of mismatches offers insight into the dimensions of qualitative unemployment.

Furthermore, a combination of the static and dynamic analysis results in a matrix of four components. These four components have four different explanations. They offer practical information for economic policy. Although this framework offers a good understanding of the performance of the *static* labour market, it provides only global insight into the explanation of the *dynamics* of unemployment. The concepts of this framework are comparable to the components mentioned by Muysken.

An important aspect of this framework is the possibility to compute the amount of unemployment which can be solved by specific qualitative policies, for instance schooling programs. Another important aspect is the metric of labour market imperfection which has been proposed. The metric has some advantages over the traditional metric "labour tightness".

The methods as they are known in the literature (Beveridge/ Phillips curve) have to solve complex econometrical problems because a relation between two different variables has to be estimated (e.g. U and V, U and wages). In the statistical approach the time series U and V are analysed one by one. The statistical problem which has to be solved is much easier. The statistical approach also gives more information on the various dimensions of qualitative unemployment.

At the end of this paper, there is a proposal to publish the following components on a regular basis:

– trend cycle quantitative unemployment ( N_TC)
– trend cycle qualitative unemployment (Q_TC)
– business cycle unemployment (U_S=U_7)
– trend cycle unemployment (U_TC = N_TC + Q_TC = U - U_S)
– the relative share Q_TC% = Q_TC/U_TC
– consistent time series on long and short-term unemployment (1966-2015)
– the metric of labour market imperfection Eff_2 = 100% - $\sqrt{u^2 + v^2}$ / √2
– the amount of unemployment volume(t) = Σ τ WL(t,τ)*τ

As a result of this research, some more questions still need an answer:

– What is the best (statistical) method for cycle extraction?
– Which statistical method offers most information on qualitative unemployment?
– Is it possible to give a more informative explanation of the components which are the result of the dynamic analysis?

**Keywords**
Unemployment, NAIRU, cycle extraction, labour market, components, mismatches

# 1. Introduction

## 1.1 Research questions

Statistics Netherlands commenced this research project to improve reporting on developments in the labour market. The aim of this project was to assess the feasibility of reporting on components of unemployment.

Examples of such components are structural, seasonal, frictional and cyclical unemployment. Statistics Netherlands does not publish these components on a regular basis. Nevertheless, Statistics Netherlands has published about some components (Lodder, 2010), as a result of a project on long time series in the labour market.

This research project addresses the following question:
In what way can Statistics Netherlands contribute to explain unemployment?
The main question has been subdivided in several questions:
1) Which components are customary in economic literature?
2) Is it possible and advisable for Statistic Netherlands to compute and publish components from economic literature?
3) Is it possible to construct components from a statistical perspective?
4) Is it possible to compute the components with data from Statistics Netherlands?
5) Is it possible to give an economic interpretation to components derived from the statistical perspective?
6) What are differences and similarities between the statistical and the economic components?
7) Which other indicators deliver a better understanding of unemployment?
8) Is it possible to publish about components on a regular basis, and if so, at what frequency?

The scope of this project is restricted to research. Although it is possible to extract policy recommendations from the results of this research, it is not the aim of this project.

## 1.2 Structure of the report

After an overview of economic literature on components (chapter 2) this is evaluated with a view to publication by Statistics Netherlands (chapter 3). Chapter 4 introduces a statistical framework for computation of components. Extensions of this framework and an overview of all components with data from Statistics Netherlands are given in chapter 5 and 6 respectively. Chapter 7 gives an economic interpretation of this framework, which is compared to the components in the literature in chapter 8. In chapter 9, some other indicators are described. The publication of components is dealt with in chapter 10. This paper ends with a conclusion.

# 2. An overview of economic literature

In this chapter the next question is answered:
1) Which components are customary in economic literature?

## 2.1 Components and segments

In a long tradition economists have analysed the causes of unemployment. As a result of this analysis components of unemployment emerge, for instance components like structural and seasonal unemployment. On the other hand, unemployment has been divided in many segments, for instance youth unemployment, unemployment in specific regions and so forth. The difference between a segment and a component is that individuals can be assigned to specific segments, but not to components. So for instance, one could say: this person belongs to the segment "youth unemployment" but not: this person belongs to the component "structural unemployment". Structural is *not* another term for long-term unemployed. Components should be compared to statistics like the average and the variance. The average of a sample is a characteristic of the whole sample, but not of specific elements of the sample. The consequence of this way of thinking is that components and segments are complementary in the understanding of unemployment.

A special form of a segment is the flow from one position in the labour market to another position. Loon, Loog, Van der Horst and Souren (2015) analyse the flows of different labour positions: not active, unemployed and employed. Another way of analysing unemployment is to define the segments long and short-term unemployment. Essential in the analysis of components is that each component points to a specific cause. For that reason the knowledge of the quantitative level of components indicates suggestions for policymakers.
Components of unemployment have appeared in the literature after the end of the Second World War. Muysken (1988) gives an overview of this literature. In the next section a summary of his overview will be given. Section 2.3 will be devoted to the Dutch literature on components in the Dutch labour market.

## 2.2 General overview

In this section the overview of Muysken (1988) is given in an abridged form. His overview is organised by four dimensions:
- the debate in the US in the 1950s,
- the debate in the US in 1960s,
- the debate in the UK,
- the debate on the continent of Europe.

The debate in the United States in the 1950s was mainly about the question whether unemployment was due to a deficiency of total (effective) demand (i.e. Keynesian unemployment) or was due to structural causes. This discussion has been summarised by Lipsey (1960).

In the 1960s the debate was dominated by Friedman, who introduced the hypothesis of the natural rate of unemployment (NRU). He used the Phillips curve to lay a scientific foundation for his hypothesis. An important implication of his theory was that the government should not try to reduce unemployment below the natural rate. In that case inflation would rise to a high and unacceptable level.
The school of New Micro economics analysed frictional unemployment and introduced search and adjustment unemployment. In the United States the concept of voluntary and involuntary unemployment was introduced.

In Great Britain Layard and Nickell (1986) introduced the neo-Keynesian response to the NRU of Friedman: the non-accelerating inflation rate of unemployment (NAIRU). The NAIRU is still one of the most used concepts in analysing unemployment. Every year, the OECD publishes the NAIRU of the OECD countries (OECD, 2014).

The debate on the continent of Europe focused on the question whether unemployment was Keynesian or classical (in which case wages are rigid).

Figure 2.1 presents most of the concepts used in the debate. At the heart of the figure are the causes of unemployment: search, wait, adjustment, queue and capital cap. On the right-hand side are the concepts which Lipsey (1960) used in his overview. On the left-hand side the concepts are placed which are used in the discussion on the continent of Europe. On top the concepts are placed which are introduced by Friedman and the adherents of the "Rational Expectations". At the bottom the discussion in Great Britain has been summarised.

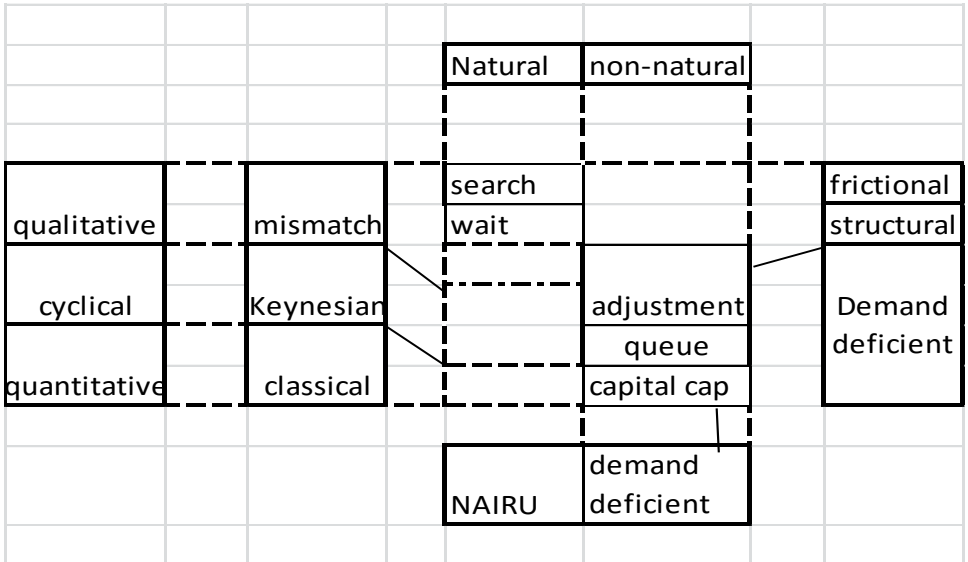


Figure 2.1: Overview of components of unemployment (Muysken, 1988)

For many years the attention was focused on other topics. There have been some publications on mismatches in the labour market recently (Erken, et. al. 2015). EFT (2012) uses several indicators for quantifying mismatches in Turkey. The ECB has carried out a comparative study on European countries (ECB, 2002).

## 2.3 Literature on the Dutch labour market

In 1975, Netherlands Bureau for Economic Policy Analysis (CPB) published several components of unemployment. Muysken (1984) argued that seasonal unemployment is partially the same as cyclical unemployment. For this reason they should not be included in the same classification.

Kuipers and Buddenberg (1975) introduced the concept of "unemployment on account of market imperfections" (abbreviated here as UMI). They referred to a wide range of qualitative discrepancies between demand and supply in dimensions such as education, region, sector and information. The information discrepancies are defined as frictional unemployment.

Van den Berg (1978) uses the UV analysis to compute the UMI. His results were adopted by Muysken (1984).

Muysken (1984) used a macro economic framework and introduced the classification:
- Business cycle unemployment ("conjunctureel")
- Structural unemployment, which consists of UMI and quantitative unemployment.

The publication from Muysken written in 1988 was already discussed in section 2.2.

Bierings and Witteloostijn (1989) and Muysken, Bierings and De Regt (1989) estimate structural unemployment by using an employment function with a CES functional form. An important element of this analysis is that unemployment is lower than the minimum of supply and demand. They argue that in segmented micro markets there are unemployed *or* vacancies, but at macro level there are unemployed *and* vacancies.

De Neubourg (1990) gave an overview of relevant scientific literature. He nominates four possible routes to estimate the UMI: UV-analysis, NAIRU, disequilibrium models and vintage models.

Bierings (1996) elaborated the concept of the CES function as an instrument to estimate structural unemployment.

CPB has estimated an equilibrium unemployment, a Phillips curve (Broer et al. 1999, Kunsing 2011). Recently, CPB (Erken, Van Loon, Verbeek, 2015) has conducted research on mismatches in the labour market using an UV analysis framework. They introduced the concept of "counterfactual" unemployment.

# 3. Components from literature by Statistics Netherlands

In this chapter the next question is answered:
*2) Is it possible and advisable for Statistic Netherlands to compute and publish components from economic literature?*

Although concepts and methods are introduced in literature, there are some problems for Statistics Netherlands in computing and publishing them. An evaluation will be given in this chapter.

## 3.1 Problems with concepts

There is no strict definition of a number of concepts. For instance, the concept of "counterfactual unemployment" (2015, Erken et al.) is not defined. In many cases a concept is abstract, defined differently by different economists and difficult to measure. For instance the concept of a natural unemployment rate. The natural rate of unemployment is defined as the unemployment rate that exists when the labour market is in equilibrium and there is pressure from neither rising inflation rates nor from falling inflation rates (Wikipedia, 2012). For many economists, but not all, this natural rate is equivalent to the NAIRU. But Makinw (2014) defines the natural rate as "the normal rate of unemployment around which the unemployment rate fluctuates", which is in fact the average, or moving average (see figure 6.2.4).

Some concepts have suggestive but not informative names. The concept of natural unemployment suggest a kind of natural phenomenon like magnetism or gravity. But unemployment is clearly a cultural phenomenon and only exists in a relatively modern society. The concept (component) of unemployment (U) by market imperfections (UMI) suggests that the remaining part ( U- UMI) is not explained by market imperfections. This is not the case, as will be demonstrated in chapter 7.

Of course it is possible to overcome the problems with concepts by giving them strict scientific and informative definitions.

Several different concepts could be used. It should be noted that the concept of NAIRU is transparent. The framework used by Muysken (1984) is consistent. But there are some issues with the methods and the neutrality within his framework.

## 3.2 Problems with methods

### Methods for components

One method which has been widely adopted is the UV analysis (or Beveridge curve), but the component derived from it has been interpreted in many ways. Driessen (2009) interprets the result as *equilibrium* unemployment, Bierings and Witteloostuijn (1989) as *structural* unemployment and Kuipers and Buddenberg (1978) as *UMI*.

Another problem with the Beveridge curve is that the theoretical basis for this curve is weak. Clearly there is no causal relationship between unemployment (U) and vacancies (V). The relation between U and V may reflect the result of another labour market model in reduced form. Muysken, Bierings and the Regt (1991) follow this line of argument and estimate a CES employment function. However, in many cases econometric tricks such as the use of dummies are needed to arrive at satisfactory empirical results (see for instance Driessen, 2009).

Another widely used method is the estimation of the (long run) Phillips curve or the NAIRU. The OECD (2001, 2014, 2015) has computed and published the NAIRU since 2001. The problem however is that there are several possible ways to estimate a Phillips curve (Broer et al. 1999, Gechert et al. 2015, Guichard, 2011, OECD, 2001). Even if Statistics Netherlands chooses to publish the NAIRU, it still has to select the best option from several econometrically acceptable options.

The component of unemployment which is due to the business cycle, often referred to as the Juglar, is in economic theory (Compaijen en Van Til, 1978) a cyclical movement around zero. Muysken (1984), on the other hand, shows a time series with an implicit trend component. The "cycle" is above zero over a long period of time: 1966-1981. The disadvantage of this approach is that there is no distinction between the cycle and the trend. Muysken computed this series as the difference between total unemployment and other components.

Although the issues related to the methods are severe, organisations like the OECD, ECB and IMF do publish the NAIRU. This would be the best direction for Statistics Netherlands to go forward.

### Methods for measuring mismatches

Special attention is paid to the subject of mismatches in the literature. Many authors (Erken et al. 2015) mention qualitative discrepancies by: education, region, sector and information. Although there may be more discrepancies, only these four are listed in the literature.

A useful metric was introduced by Van den Berg (1978):

$$\text{Index} = 1/N * \sum_{i=1}^{n} \frac{U(i)}{U} \left| \frac{U(i)}{U} - \frac{b(i)}{b} \right|$$

With:
U(i) = unemployment in group i, i = 1.., N,
B(i) = the labour force of group i,
U = Σi U(i) , B = Σi B(i) .
Note that $\frac{U(i)}{U}$ before the absolute brackets is a weight. This index can be computed for every distinguished group and every year. Although this formula is meaningful, in statistics it is more common to replace absolute brackets with squares. EFT(2015) has proposed such a formula:

$$CVAR = \sqrt{\sum w_i * (\frac{e_i}{p_i} - \frac{e_0}{p_0})^2} / \sqrt{e_0/p_0}$$

With: $w_i = \frac{e_i}{e_0}$ , $e_0 = \sum e_i$, $p_0 = \sum p_i$

$e_i$ = employment for group i
$p_i$ = population for group i
$w_i$ = weight for group i , the share of $e_i$

Although this formula has similarities with the formula of Van den Berg, there are several drawbacks:
* The formula does not use unemployment data or data on the labour force.
* $(\frac{e_i}{p_i} - \frac{e_0}{p_0})^2$ is not a value for group i, subtracted with its mean, as it should be.
* The statistical formula CVAR(x) = $\frac{\sqrt{s^2}}{\bar{x}}$ has no square root in the denominator.
This formula can be improved by :

$$\text{CVAR(X)} = \sqrt{\sum w_i * (x_i - \bar{x})^2} / \bar{x}$$

with $x_i = \frac{e_i}{p_i}$ or (more preferred): $x_i = \frac{e_i}{b_i}$ or $x_i = \frac{u_i}{b_i}$

Many authors (EFT (2012), ECB(2002)) refer to an article by Lipsey (1960) for the expression VAR($\frac{u_i}{u}$). Unfortunately enough nobody, including Lipsey, gives a definition of this expression. The intention was assumably to use $VAR\left(\frac{u}{\bar{u}}\right)$, which is equal to $[CVAR(u)]^2$ .s

Although literature gives interesting formulae, they are not completely satisfactory from a statistical point of view. Of course it is possible to choose CVAR(U) as a good statistical metric for variation.

## 3.3 Problems with neutrality and objectivity

The discussion on components reflects the academic debate between different economic schools. Muysken (1988) summarises the debate in figure 2.1. If we part from the location of the discussion (US, UK, Europe), the discussion can be framed as

a traditional discussion between (neo-) classical ideas on the one hand and (neo-) Keynesian ideas on the other hand. The (neo-) classical approach emphasises equilibrium and cautions against misplaced government interventions. The (neo-) Keynesian approach emphasises disequilibrium and points to the possibilities for governments to stabilise the labour market by means of intervention, e.g. through refresher programmes.

Three important concepts - unemployment by market imperfections (further abbreviated as UMI), equilibrium and natural unemployment suggest interpretations which are disputable. UMI suggests that only part of unemployment is the result of an imperfect labour market. As will be shown in chapter 4, *all* unemployment is the result of market imperfections. The more interesting question is which imperfection causes which part of unemployment. The equilibrium concept was originally used in a classic analysis of markets. Equilibrium means that supply and demand become equal. But the natural rate hypothesis (or NAIRU) implies equilibrium on the market for goods and services, i.e. no change in inflation. In that case there is no equilibrium on the labour market in the traditional sense, where supply of labour equals demand. Moreover, every individual is only labelled by Statistics Netherlands as unemployed if he (or she) is actively searching for a job. Hence, unemployment is a state with a dynamic context. Another interpretation is that the equilibrium unemployment is stable over time, a kind of long-run unemployment rate. But the equilibrium unemployment by Broer, Draper and Huizinga (1999) is fluctuating widely, as is the case with many empirical time series of the NAIRU (see for instance the NAIRU of OECD, 2001).

An important issue for Statistics Netherlands is the claim to be objective and neutral. Rather than taking up a certain position in an academic debate, Statistics Netherlands would clearly prefer to present data without ideological colour.
For reasons of neutrality, Statistics Netherlands should give up using terms like natural and equilibrium unemployment. Statistics Netherlands is an organisation where statistics are used in the first place.

## 3.4 Conclusion

The result of the debate is that there is no agreement on concepts and methods for the components of unemployment. The problems with concepts and methods can be solved technically. The problem of neutrality is more difficult, however. A solution is to analyse unemployment by adopting a mainly statistical rather than an economic approach.

# 4. A statistical framework for components

In this chapter the next question is answered:
*3) Is it possible to construct components from a statistical perspective?*

## 4.1 Global structure

The mission of Statistics Netherlands is to publish data to enable policymakers and scientists to debate on relevant topics. In order to realise that, Statistics Netherlands should:

- use clear, transparent and comprehensible definitions.
- focus on empirical measurement, not on theory.
- use statistical analysis with few model assumptions.
- use economic theory only if it is widely accepted.

Although this approach seems trivial, it is fruitful and shows interesting results.

## 4.2 Terminology

In order to obtain a clear understanding of the concept of "components", it is useful to introduce three levels of analysis:
1) Macro, the level of functions and phenomena.
2) Meso, the level of sets (groups of people).
3) Micro, the level of elements (individuals) of sets, variables and values of variables.

*Unemployment* is a *phenomenon* at macro level. *Unemployed* is a *set* of people, with elements (individuals) who have the *value* "*unemployed*" on the *variable* "*labour position*". If Ũ denotes the set of unemployed, U = N(Ũ) is the application of the number-function on the set Ũ, which gives the number of unemployed people. In this paper the concept *component* is only used for analysis at macro level. In order to refer to a set of individuals, the concept *segment* is used. The result of this approach is that (groups of) individuals form a segment, but not a component. A component is a scalar, like the average or variance of a sample. Note that in general the components (scalars) cannot be linked to specific individuals in the set, comparable to the phenomenon that in a group (set) of people nobody has a length equal to the average length of the group.

Another important consequence of this terminology is the idea that the possible mismatch between unemployed and vacancies, e.g. for the dimension of education,

is an analysis at meso level, not at micro level. A mismatch is a characteristic of a set, not of one element alone.

Definition: a component of unemployment consists of a name of the component and a scalar which is the magnitude of the component.
(Example: structural unemployment = 200,000.)

In the statistical approach (section 4.3 and 4.4) the name of the component consists of only one character (e.g. N, Q, C, T) without any economic meaning or theory at the beginning of the analysis. The component will only be defined as a statistic formula. Once the components have been defined, their economic meaning will need to be clarified. Interpretation of the components will be given in chapter 7. The problem that has be solved is a kind of dual version of the one that had to be solved by economists. Economists have had difficultyfinding empirical data for their concepts. The statistical approach will need a relevant economic interpretation of the statistics. The economic theory used for interpretation will be described in section 4.5.

## 4.3 Data

The starting point of the analysis is annual data on unemployed (U) and annual data on vacancies (V). Time series of components are constructed from these time series in section 4.4 and in chapter 5. An interpretation will be given afterwards in chapter 7. One usually begins with a theoretical concept and then tries to find empirical evidence; in this paper the empirical data precedes the theoretical interpretation.

## 4.4 Analysis

In this framework, basically three types of analysis (and definitions) are performed:

- Static analysis: Q = Min(U,V), N= Max(U-V,0) ; -> U = Q + N.
- Dynamic analysis: U_T= $\overline{U}$ and U_C = U – U_T; -> U = U_C+U_T ; $\overline{U\_C} = 0$
- Analysis of mismatches, computing CVAR(X) for each mismatch dimension

### Static analysis

- In many practical applications the static analysis is equivalent to: Q = V, N = U - V,
- since U>V is true for most practical situations. A simple intuition behind this
- definition is that N is the shortage of jobs, the number of unemployed without a
- possible match with a vacancy.

### Dynamic analysis

- In the dynamic analysis a simple decomposition is done on the time series U. One
- part, U_T= $\overline{U}$ , has no fluctuation and the other part, U_C = U – U_T , has no level,
- since $\overline{U\_C} = 0$ . In literature (e.g. Durbin and Koopman, 2001) this is a well-known
- decomposition like Z = T + C. This decomposition is comparable to the two most
- important statistical variables of a time series: the average and the variance.

### Analysis of mismatches

Analysis of mismatches offers the possibility to measure the impact of several
- dimensions including education, region and sector on unemployment. For all
- dimensions of mismatches, it is possible to compute a relative index k (k=e,r,s). An
- appropriate formula is CVAR(x) = $\frac{\sqrt{s^2}}{\bar{x}}$, which is equal to:

$$C(k) = CVAR(x(k)) = \sqrt{\sum w(k)_i * [x(k)_i - \overline{x(k)}]^2} \; / \; \overline{x(k)}$$

With:

C(k) = the relative contribution to mismatches from dimension k

$\overline{x(k)} = \sum w(k)_i * x(k)_i$ = weighted average of x(k)

$w(k)_i = \frac{U(k)_i}{U}$ = share of unemployment group i for and dimension k

$x(k)_i = \frac{U(k)_i}{B(k)_i}$ = unemployment rate (%) for group i and for dimension k

$U(k)_i$ = number of unemployed in group i for dimension k.

$B(k)_i$ = number in the labour force in group i for dimension k.

$U = \sum U(k)_i$ = total unemployment, identical for every dimension k.

k = dimension of mismatch, e.g. level of education (e), region (r), sector (s)

i = index for the values of groups, e.g. "Agriculture " for dimension sector.

- For every dimension k the coefficient of variation C(k) can be computed: C( e), C( r) and C(s) .

In chapter 5 this framework will be explained in more detail.

## 4.5 Economic theory

### Theory of perfect competition

In economic theory the concept of perfect competition is generally accepted as a useful model for understanding real markets. According to Begg (2003) the market for perfect competition has the following main characteristics:
- a large number of buyers and sellers, every participant is a price taker,
- free entry and exit,
- homogenous products,
- perfect information (zero transaction and search costs, perfect factor mobility).

Although there are different definitions, these characteristics are widely accepted.

A characteristic of the perfect market is that supply and demand become equal (flexibility) and that there will be no excess demand or excess supply, so U = V = 0. In chapter 9 a metric is proposed to compare a real labour market with the perfect market for which (U,V) = (0,0).

### Theory of business cycles

The business cycle or economic cycle is the downward and upward movement of gross domestic product (GDP) around its long-term growth trend (Wikipedia, 2017).

The theory of perfect competition will be used to explain components of the static analysis, the theory of business cycles will be used to explain components of the dynamic analysis.

# 5. Extensions of the statistical framework

In this chapter the basic analysis which is given in chapter 4 is extended in various ways.

## 5.1 The matrix of components

The static and dynamic analysis of unemployment as formulated in section 4.4 can be combined. Consider the time series N and apply the decomposition technology to it. The result is:

N_T = U_T – V_T = $\overline{U} - \overline{V}$ (standard $\overline{U} > \overline{V}$ )

N_C = N – N_T = U – V - $\overline{U} + \overline{V}$

Apply the decomposition technology to the time series Q. The result is:

Q_T = V_T = $\overline{V}$ (standard $\overline{U} > \overline{V}$, so Q_T= $\overline{V}$ )

Q_C = Q – Q_T = V - $\overline{V}$

The following equation, the matrix of components holds:

U = N_T + Q_T + N_C + Q_C

In many practical applications it is useful to combine the cyclical components:

C= N_C + Q_C

=> U = N_T + Q_T + C

This decomposition of unemployment in three components is the same as the decomposition made by Muysken (1984), although the method of computation is different.

## 5.2 Extracting short cycles and trend cycle

In the basic dynamic analysis, U is divided in two components:

U = U_T +U_ C

It is possible to divide the cyclical part in cycles with different frequencies:

U_C = U_L + U_S + U_1.

With:

U_L = long cycle

U_S = cycle with a period of S years.

U_1 = cycle with a period of 1 year (seasonal unemployment).

Within this framework U_T does not include a cyclical part. In many analyses a "trend" has been formulated which does have a cyclical part (technically: the derivative dT/dt changes its sign from positive to negative and vice versa). In this framework this type of trend is given its more appropriate name *the trend cycle*:
U_TC = U_T + U_L
With: U_TC as the trend-cycle unemployment. It is the unemployment corrected for short cycles.

It is also possible to add an irregular term IR to the dynamic decomposition:
U = U_T + U_L + U_S + U_1 + IR = U_TC + U_S + U_1 + IR

With the aid of cycle-extraction techniques it is possible to extract the (short) cycles. The result is the trend-cycle U_TC and the short cycles U_S and U_1 (and the term IR). The following techniques are widely used:

- filter techniques (Hodrick Presscott filter HP(λ) , Moving Averages (MA), MA(k) denotes the average over the periode [t-k,t+k] ),
- polynomial regression (lineair or higher order with time as dependent variable),
- structural time series model (STM, Durbin and Koopman, 2001),
- econometric methods, based on Beveridge or Phillips curve. (e.g. NAIRU) ,
- spectral analysis, used for extracting cycles with different frequencies.

Which method should be used by Statistics Netherlands is still an open question. In the remaining part of this paper a simple solution has been chosen. DNB uses a business cycle with a period of approximately 7 years. For that reason a moving average with k=3 has been chosen (since 2*3+1=7) for the trend cycle:
U_TC = U_TC_MA(3)
As a result: U_S = U - UTC = U_7

Details of the NAIRU and the structural time series model are given in Appendix 2. It should be noted that the NAIRU of the OECD (2001) is not only a Phillips curve. It is also formulated as a structural time series.

## 5.3 Extracting a long cycle

Once the short cycles are extracted and a trend cycle is constructed, it is possible to extract a cycle with a long period:
U_TC = U_L + U_T => U_L = U_TC - U_T

## 5.4 The trend component

Apart from the trend U_T= $\overline{U}$ it is possible to estimate trends like:
U_T(time) = a + b*time, (linear)
U_T(time)=a + b*ln(time), (log linear)
U_T(time) = a* exp(b*time) (exponential)

All these trends have the attractive property of a first derivative dT/dt which has the same sign (positive/negative) for every observation. The advantage of these trends above the average = $\overline{U}$, is the fact that it gives two kinds of information: the level and the slope. In this paper examples are given for a linear trend.

## 5.5 Simultaneous extraction and interaction effects

It is possible to extract all cycle patterns with the aid of only one model. Theoretically that might be more convenient. Besides, it is possible to model interaction effects between trend and cycle pattern in another way than a trend cycle in a structural time series model (see Koopman and Lee, 2009). DNB has made such an effort but concludes that the interaction effect is negligible.

## 5.6 Components of the labour market

Since N and Q can only be measured by using the vacancies (V), it is more appropriate to distinguish components of the *labour market* (supply and demand), instead of components of unemployment (only supply). The total amount of imperfections of the labour market is MIP = U + V, not only U. This MIP can be divided in three ways:

MIP = U + V = N + Q = { Ns + Nd} + {Qs + Qd}
MIP = U+ V = S_imp + D_imp = { Ns + Qs } + { Nd + Qd}
MIP = U+ V = S_imp + D_imp = { U + E – E* } + { V – E + E* }

For the last decomposition a model of demand and supply is needed to compute E*. Note that qualitative policy not only diminishes U, but also V, and quantitative policy increases V. The value of this extension is that it makes it clear that policies on qualitative imperfections have an effect both on the supply and the demand side. (Qs+Qd)/MIP ≈ 150%* Qs/U (on average,) in the Netherlands in the period 1966-2016.

## 5.7 Analysis of qualitative unemployment

First a rough estimate for frictional unemployment (FR) will be presented, then the values of CVAR(X) (Section 4.3) will be combined with the resulted FR.

### Frictional unemployment

In the literature frictional unemployment (FR) is frequently not estimated. However, with some basic assumptions, it is possible to estimate FR. FR is usually defined as voluntarily unemployed. The following assumptions are made:
* frictional unemployment, FR=Q(i), is qualitative unemployment by mismatches on the dimension information.
* qualitative unemployment has four dimensions: education (e), region ( r) , sector (s) and information ( i) : Q = Q( e)+Q( r) + Q(s) + Q(i) = Q(ers) + Q(i) = Q(ers) + FR.
* Q(ers) has no short cyclical pattern, only a trendcycle pattern; So Q_(ers)_C=0. As a consequence: FR_C = Q_C = V_C.

*FR_TC is the part of U_TC which contains the proportion of the unemployed with a unemployment duration of one month or less: FR_TC = U(1 month)/U * u_TC .
(for example: u_TC = 6%, U = 8% U(1 month) = 2%, then FR_TC=2/8*6% = 1,5%.
* FR = FR_TC + FR_C = U(1 month)/U * u_TC +0; and Q(ers) = Q - FR.

### Qualitative unemployment

As will become clear in chapter 7, the value of Q can be interpreted as the absolute level of qualitative unemployment. In combination with the dimensions of discrepancies which are mentioned in literature (level of education, region, sector, information) this can be formulated as :

Q = $\sum_k Q(k)$ = Q(e) + Q(r) + Q(s) + Q(i)

With Q(k) = the qualitative unemployment for dimension k
(k=(level of education (e), region (r), sector (s) , information (i))
For several dimensions of mismatches the data on unemployment is known. The unemployment (rate) by level of education is known, and the same is true for region and sector. But for one dimension it is not known, namely for the dimension information, which leads to frictional unemployment. Define:

Q(ers) = Q(e) + Q(r) + Q(s)
FR = Q(i), frictional unemployment
Q = Q(ers) + FR

The next step is to compute the absolute value Q(k) for the dimension k. This can be done by a combination of the analysis of mismatches and the result FR.

Q(k) = [ C(k) / (Σj C(j) ] * Q(ers) , k=e,r,s, }
Q(ers) = Q- FR } =>

Q(k) = C(k) / [C(e) + C(r) +C(s)] * ( Q -$FR$), k=e,r,s

With: $\mathrm{C(k)} = \mathrm{CVAR(x(k))} = \sqrt{\sum w(k)_i * [x(k)_i - \overline{x(k)}\,]^2} \;/\; \overline{x(k)}$

## 5.8 Components of segments

Labour market segments are studied for various reasons. Eurostat keeps unemployment rates for every member country. Countries are in fact regional segments of Europe. Values for Q and N can be computed for every segment.

# 6. Overview of components

In this chapter the next question is answered:
*4) Is it possible to compute the components with data from Statistics Netherlands?*

## 6.1 Formulae

*Basic*
U = U_C + U_T
V = V_C + V_T
N = Max(U-V,0)
Q = Min(U,V)
U = N + Q

*Matrix*
U = N_C + N_T + Q_T + Q_C
Q_T = V_T
Q_C = V_C

*Cyclical component*
U= U_ T + U_C
U_C = U_L + U_S

*Traditional components (Muysken)*

| | |
|---|---|
| N_TC | trend cycle quantitative unemployment |
| Q_TC | trend cycle qualitative unemployment |
| U_S=U_7 | Juglar, business cycle unemployment |

U = U_TC + U_S = N_TC + Q_TC + U_7 , traditional decomposition

*Trend cycle unemployment*
U_TC = U_T + U_L = U - U_S = N_TC + Q_TC , trend cycle unemployment

Specifications of the trend cycle component:
U_TC_MA(t,3) = 1/(2*3+1)* $\sum_{i=t-3}^{t+3} U_i$
U_TC_HP = the trend cycle is the result of an optimisation process
(see Ruth et. Al. 2004).
U_TC_NAIRU = see Appendix 2
U_TC_STM = see Appendix 2
U_S = U - U_TC_MA(t,3) = U_7

*Relative shares of unemployment*
U_S% = abs(U_S) / sum
N_TC% = N_TC / sum
Q_TC% = Q_TC / sum

sum = N_TC + Q_TC + abs(U_S) > U (!)
Q% = Q/U
N% = N/U = 1 - Q%
Q_TC% = Q_TC/U_TC
N_TC% = 1 - Q_TC%

*Qualitative component*
Q = FR + Q(ers)
FR_TC = u_TC * U(1 month)/U
FR_C= Q_C = V_C
FR = FR_TC + FR_C
Q(ers) = Q(e) + Q(r) + Q(s) = (Q -FR)
Q(k) = C(k) / [C(e) + C(r) +C(s)] * Q(ers), k=e,r,s

$$\mathrm{C(k)} = \mathrm{CVAR(x(k))} = \sqrt{\sum w(k)_i * [x(k)_i - \overline{x(k)}\,]^2} \;/\; \overline{x(k)}\,,\ \text{k=e,r,s}$$

*Components relevant for policy making*
U = U_7 + N_TC + Q_TC
U = U_7 + U_TC
U = U_T + U_L + U_7
Q(e), Q(r), Q(s)

## 6.2 Graphs

In this paragraph the graphs on several components are shown. On the vertical axis of all the figures the *percentage* (%) of unemployment is shown.

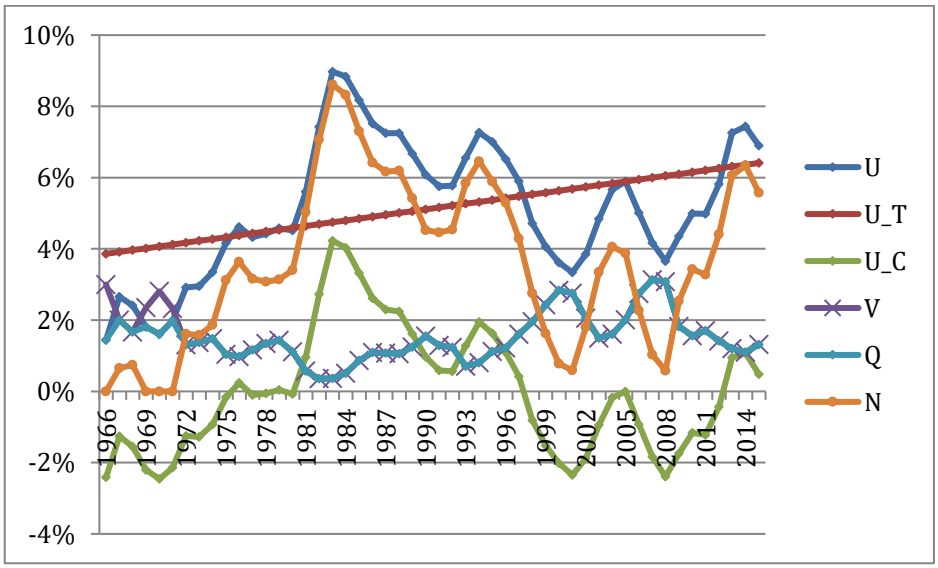


Figure 6.2.1: Basic components

The trend of unemployment is diverging from the equilibrium (u,v) = (0,0). The parameter of the slope is significantly different from 0 (t-value = 3.1). Total unemployment rose from 2% to 7% in the period 1966-2015. Cyclical unemployment

was high in the 1980s, qualitative unemployment was high at the beginning of the 21st century.

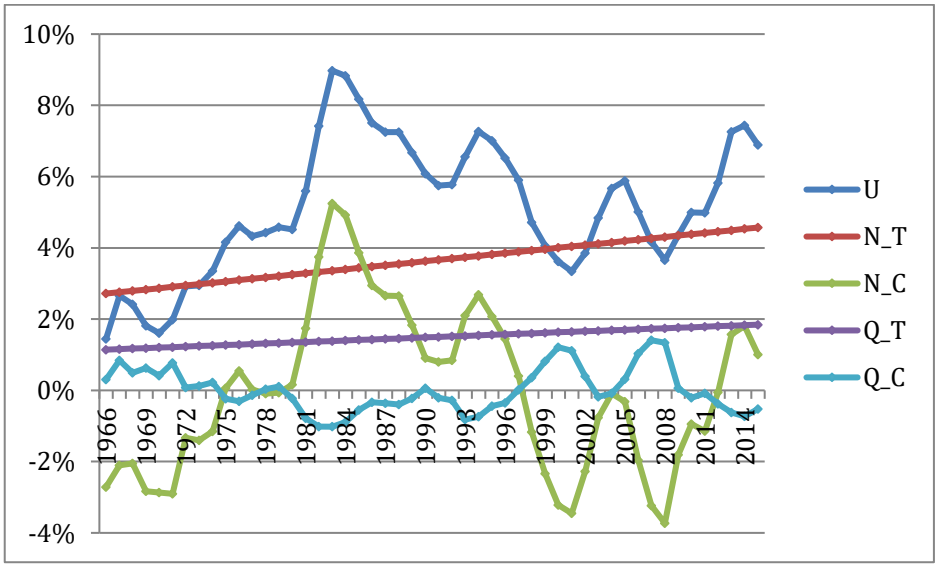


Figure 6.2.2: Matrix of components

The matrix shows that U_T rises every year by 0.0052% and by almost 90% if this rise is due to the rise in N_T (0.0046%) and the rise in Q_T is negligible (the slope is not significantly different from 0, t-value=0.9). Although Q_C is relatively small to N_C, it is relatively large to Q, in 2008 almost 50% ( it is better to compute: abs(Q_C)/{abs(Q_C)+Q_T}, since Q_C can be negative).

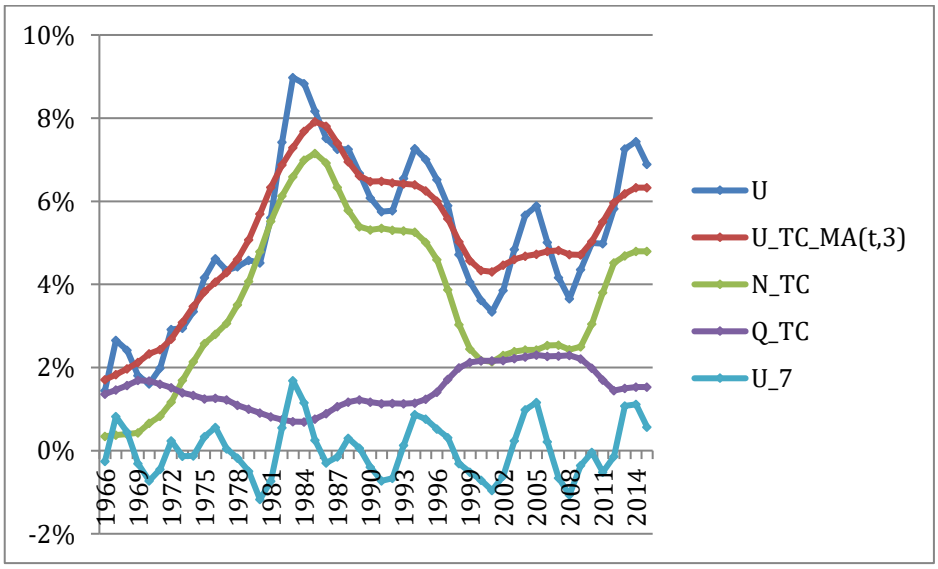


Figure 6.2.3: Traditional components (Muysken)

The traditional decomposition shows a strong fluctuation in the trend cycle quantitative unemployment.

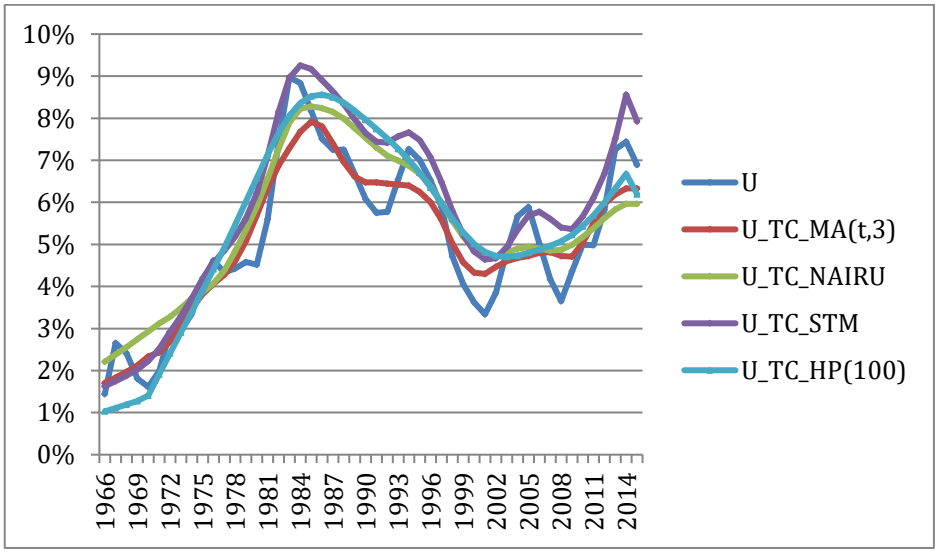


Figure 6.2.4: Trend Cycle in different ways

Although the method of computations differs, the resulted trend cycles are close to each other.

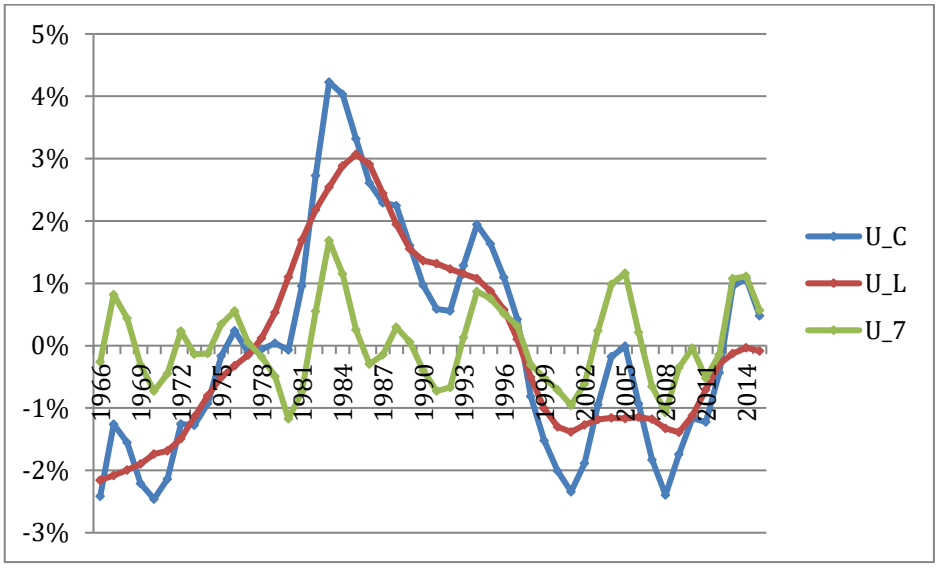


Figure 6.2.5: Cycle : long cycle and Juglar (U_7)

The long cycle is extremely high in 1987.

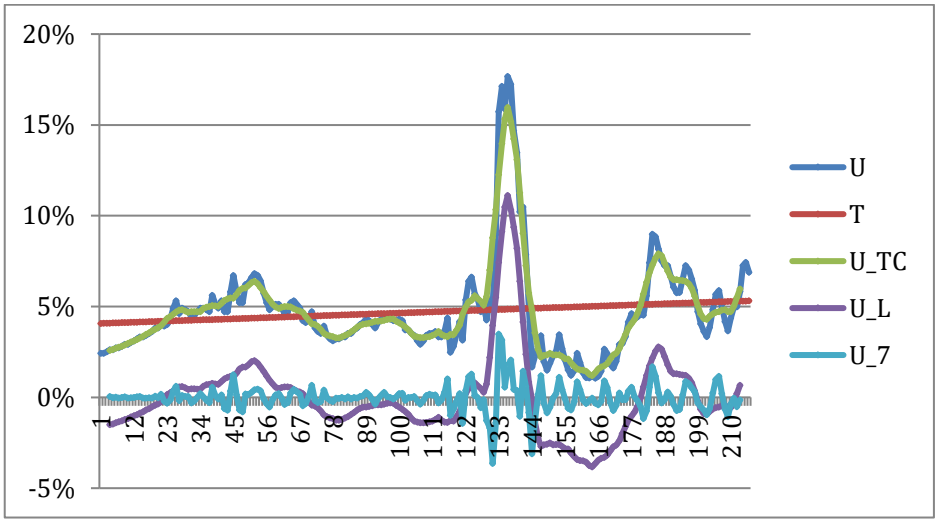


Figure 6.2.6: Trend, long Cycle, Juglar and trend cycle 1800- 2015

The long cycle has a period of about 60 years. The slope of the trend (1800- 2015, 216 years) is about 9 times less steep than the trend which has been computed for the period 1966-2015 (50 years).

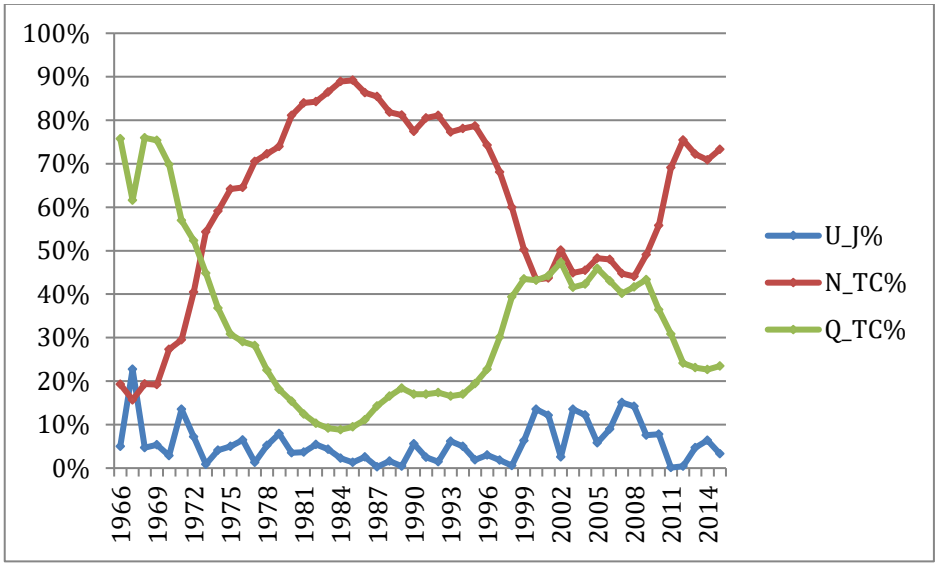


Figure 6.2.7: Relative shares of unemployment

The computation of the basic components show that quantitative unemployment forms the largest part of total unemployment, but the period 2000- 2010 offers quite a different view. Note that unemployment before 1971 was very low, so the relative shares have to interpreted with caution.

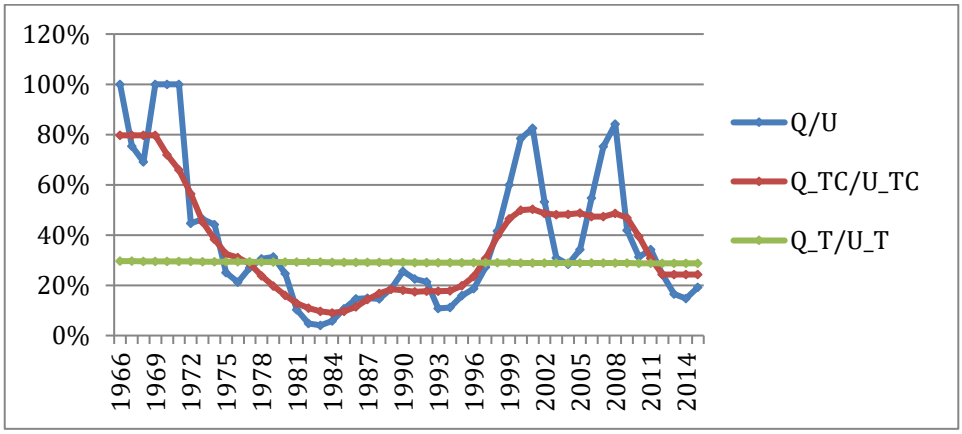


Figure 6.2.8: Relative share of Q to total unemployment (and T,TC variants)

In this graph (figure 6.2.8) the results for Q/U and Q_TC/U_TC have been skipped for the period 1966-1971. Because U was very low over this period, these percentages would be hugely inflated. It is interesting to see that Q/U was very high in some of the years after 2000.

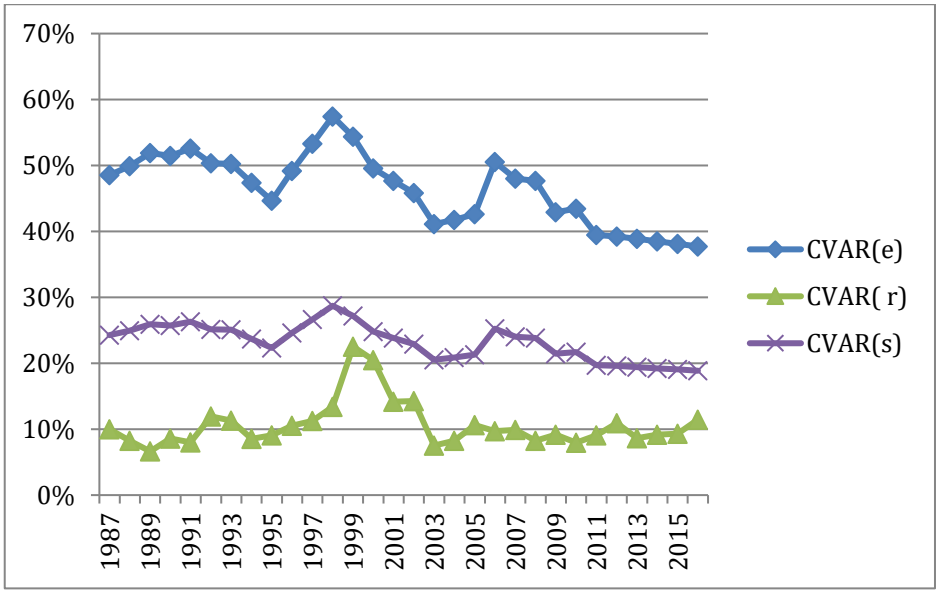


Figure 6.2.9: Coefficient of variation for three dimensions of mismatches.

Education level has a much higher CVAR than region and secor. This means that education level has more impact on unemployment than the other dimensions.

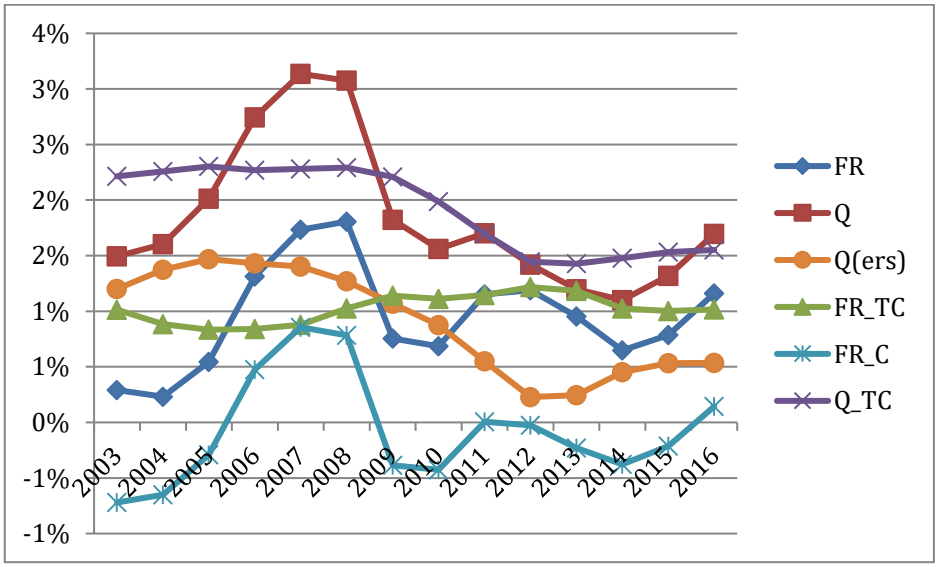


Figure 6.2.10:Frictional unemployment (cyclic, trendcycle)

Frictional unemployment forms the largest part of qualitative unemployment.

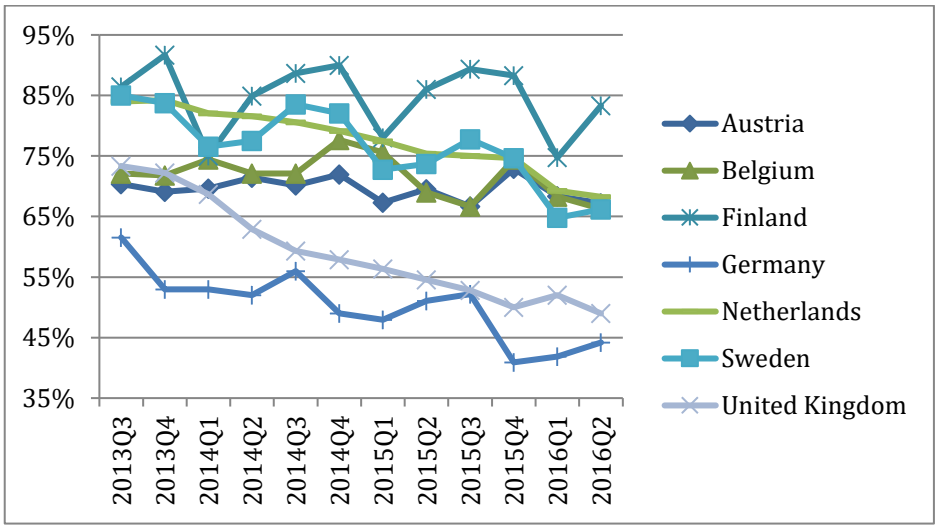


Figure 6.2.11 : The share of quantitative unemployment (N/U) in European countries
Source: Eurostat website

In Germany and the United Kingdom the share of quantitative unemployment is much lower than in other countries.

# 7. Economic interpretation of components

In this chapter the next question is answered:
*5) Is it possible to give an economic interpretation to components derived from a statistical perspective?*

## 7.1 Static analysis: N and Q

The interpretation of N and Q will be done with a static analysis. In a static analysis, time doesn't exist. For that reason there is no short run and even no long run. The static analysis aims to relate unemployment to deviations from a perfect market. And a perfect market, defined as a market of perfect competition, is a static concept. .

There is a long tradition in the Netherlands of analysing unemployment as a form of market imperfection. Before an interpretation is given, this tradition will be studied briefly.

De Neubourg (1990) wrote: "Diagnosing the causes of unemployment is a necessary basis for remedial action. In the past decade several attempts have been made to assess how much of the unemployment in the Netherlands has been due to labour market imperfections (structural unemployment) and thus to what extent labour market rigidities are a cause of current unemployment".
"A common way to measure the so-called structural unemployment is by relating the level of unemployment (U) to the level of vacancies (V). After estimating such a UV-curve, the volume of unemployment due to labour market imperfections can be defined as the U for which U=V".

Kuipers and Buddenberg (1978) wrote:
"It will be investigated what part of unemployment must be ascribed to the imperfections of the labour market. Three categories of unemployment come under this […]first [….] frictional unemployment secondly [ …] the qualities supplied and demanded do not tally [….] Finally [.. .].lack of geographical mobility […] qualitative discrepancies.."

There are some important implicit statements in this approach:

- Only a part of unemployment is due to market imperfections, the remaining part is due to other causes.
- Market imperfections lead to mismatches between supply and demand, in other words: to qualitative unemployment. The underlying imperfection is the heterogeneity of labour and the lack of transparency of information. This can be summarised by the concept of segmentation (the existence of meso or micro markets).

In the static analysis a different approach has been used, with different results. The starting point of analysis is the concept of a perfect market, defined as a market with perfect competition. A market of perfect competition can be summarized with only two characteristics:

- flexibility of prices/wages;
- a unity market (homogenous products/labour, no adjustment costs.

A concrete labour market, which is far from perfect, can be defined as:

- markets with rigid prices/wages, quantities are determined by a rationing mechanism instead of a price mechanism;
- a collection of many meso/micro markets, a segmented market.
-

The first step is to show (see Appendix 1) that in such a market there would be neither unemployment nor vacancies. The consequence of that theorem is all unemployment is the result of imperfections, not only a small part of it.

The second step (see Appendix 1) is to show that on this imperfect market unemployment can only be explained by downward rigidities of the wages. The existence of many micro markets is only a necessary condition for the existence of unemployment and vacancies *at the same time*. Since every micro market is defined as a unity market, on these micro markets there is only one possible market imperfection left: rigidity. As a consequence unemployment on micro markets is explained by downward wage rigidity, and vacancies on other micro markets is explained by upward wage rigidity. The aggregation of micro markets has no effect on the explanation of unemployment. Even if N=0 (and so U=V and S=D) there is no flexibility, because at least two micro markets face rigidity, since U>0 and V>0.

As a consequence of this analysis, a subdivision of unemployment indicating several different causes in the static analysis is not meaningful. There is only one market imperfection which explains the existence of total unemployment. On the other hand, it is obvious that the part of unemployment Q=V can be vanished by unifying all segmented micro markets towards one integrated market (unity). For that reason a subdivision of Q=V and N=U-V is meaningful in the context of *solving* the problem of unemployment.

One possible extension to the explanation of unemployment is the distinction between *balanced* and *unbalanced* rigidities. The part of Q=V is explained by balanced rigidities: there is a balance between the downward rigidities (which causes U=V) and the upward rigidities (which causes V). The part of N=U-V is explained by unbalanced rigidities. With this extension, the decomposition of N and Q does have meaning for the explanation of unemployment.

In the case that N=0 (and U=V), there is an equilibrium on the aggregate level (S=E+U = E+ V=D). This corresponds to the concepts of equilibrium unemployment and in the neo-classical tradition and to MIP in the Keynesian tradition, apart from the time element. It should be mentioned that in the case that N=0, it could be true that none of the meso/micro markets are in equilibrium. For that reason it is more appropriate

to think of a labour market with the characteristic of weak flexibility (or balanced rigidities) rather than (strong) flexibility, since in reality all of the micro markets could have wage rigidities. For that reason, the situation is better characterized by the concept of balanced rigidities than with the concept of equilibrium. Neo-classical economists use the concept of equilibrium, because they evaluate structural unemployment as voluntarily unemployment. But there is no empirical evidence for that conclusion until now.

An extra analysis is useful in the case that U=V. The CVAR(U) gives information about the proportion of micro markets which have flexible prices/wages. In practice it is quite a different case whether only a few markets face wage rigidity (with hundreds of markets with flexible wages), or almost all markets face wage rigidities.

## 7.2 Dynamic analysis: T and C

### 7.2.1 General remarks

The dynamics of unemployment (and vacancies) cannot be explained by the characteristics of an (im)perfect market. For that reason the explanation has to be found in economic theory. The most relevant one is the theory on the business cycle or economic cycle, which defines the business cycle as the downward and upward movement of gross domestic product (GDP) around its long-term growth trend (Wikipedia, 2017).

In this paper the focus lies on the two components: the trend (T) and the cycle (C). If unemployment is approximately explained by a linear vector $U = X*\beta$ then the two components are explained by its counterparts in X: $U_T = X_T*\beta$ and $U_C = X_C*\beta$.

Roughly speaking: if a variable X has a negligible cyclical component, it has no relevance for the cyclical component U_C. Vice versa, if a variable has a huge cyclical component it may have relevance to the cyclical component of unemployment. For instance labour productivity changes slowly over time and has almost no effect on U_C.

Since every linear trend is perfectly correlated to any other linear trend (spurious regression), economic theory is needed to give information on the determinants of the trend component of U. The cyclical component of U can be explained by variables that have (almost) the same frequency (period) as U_C. A phase shift suggests a delay in response. A different amplitude suggests a multiplier effect.

Although it is difficult to explain the two components in depth, it is already useful to use phrases like "trend factors versus cyclical factors". In combination with terms like rigidity and micro markets it gives already a framework with four categories. At the end of this paper it will be clear that the combination of micro markets and cyclical factors explains only a very small part of unemployment.

### 7.2.2 Explanation for C

A general explanation for cycles is the fact that many transitions take time. There are delays in response to changes in technology, for instance. The component C can be divided into a long and a short cycle, for example:
U_C = U_L + U_7.
Each sub-cycle has a different explanation (section 7.4).

### 7.2.3 Explanation for T

The structural development (trend) can be explained by structural developments which determine structural supply and demand for labour. The supply of labour is equal to:

S = Population(15-75)* participation rate=

Total Population *(1- demographic pressure) * participation rate.

The participation rate depends on: wages, cultural phenomenon, structure of households and prices. These factors change only slowly through time. Obviously there is no relation to the cycle component. In figure 7.3.3.1 it is demonstrated that the net supply factor s = (1-demographic pressure)* participation rate is a slowly rising curve, like the trend of unemployment.

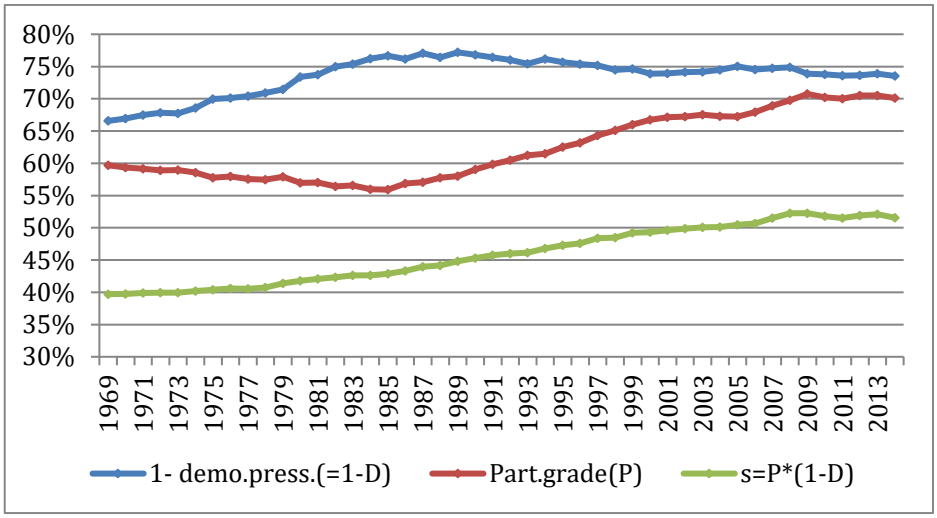


Figure 72.1 Supply factors on the labour market

More important than the supply factors are are the demand factors. De Galan (1991) gives the following list:

- level of (desired) production
- production technology
- wages
- labour productivity, percentage full time jobs.

The aim of this paper is to compute components. Obviously it is a difficult task to compute the effect of one of these factors alone on unemployment. In this paper all these factors are summarised as "trend factors". It may be possible to incorporate some results from the Phillips curve to obtain more details about the effect of wage rigidity.

## 7.3 The matrix of components

The explanation of the four components which are constructed by cycle-extraction on the quantitative and qualitative unemployment is a combination of the results in section 7.1 and section 7.2:

- N_T can be explained by trend factors and rigidity. Wage rigidity (sticky wage theory) is the one of the most known phenomena.
- N_C can be explained by cyclical factors and rigidity. The phenomenon that unemployment arises when effective demand diminishes, and not when wages are lowered is an example.
- Q_T can be explained by trend factors and micro markets. The fact that labour supply by education is relatively stable and does not react to (effective) demand is an example.
- Q_C can be explained by cyclical factors and micro markets. When students choose their education, they consider the market situation in their decision. In difficult times, the unemployed restrict their search time and instead settle for an inferior job.

## 7.4 Long cycles, short cycles

The explanation of these cycles has traditionally been found in the relation between the labour market and the market for goods and services. The short cycle, with a period of 7-11 years, is the famous business cycle, also called the Juglar. The long cycle, with a period of 40-60 years is Kondratieff. But these are only names, no explanations! In order to explain these cycles one should link these cycles on the labour market to cycles on the market for goods and services. In this paper only a sketch of this approach is made.

In Van Ruth(2010) several economic indicators are given to describe the business cycle. One of theseis consumer spending on durable goods (detrended!). According to the Keynesian theory of decline of effective demand, it seems logical to compare unemployment with consumer spending on durable goods. An important model for explaining cycles is the "multiplier accelerator model of the business cycle" (Begg, p. 440). This model explains why cycles arise.

In figure 7.4.1 the time series of both series are given. There is almost no phase shift, but there is a multiplier effect of 0.1 (U_C=0.1*Durable goods). The correlation between the two series is 0.47. Therefore, the right choice in explaining the cycles in unemployment seems to be with the Keynesian theory of decline of the effective demand, although more statistical research should be done.

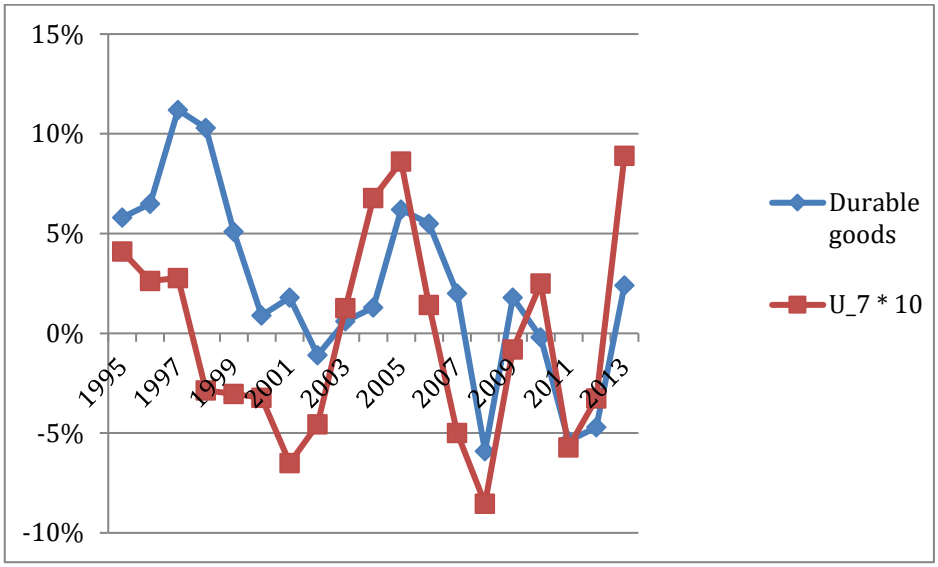

Figure 7.4.1. Cyclical unemployment and the demand for durable goods

## 7.5 Qualitative factors

Each dimension of qualitative unemployment has different explanations. It seems logical that mobility, including the market for real estate, influences component unemployment caused by region. But statistical facts have to be found to prove such a relationship. Because of technological developments , more different types of jobs and education emerge. As a result, each vacancy can be filled by groups of unemployed which are increasingly limited. Although this seems logical, statistical evidence still has to be found to prove this. It is beyond the scope of this paper to go into more details. A micro economic study on the determinants of unemployment will be helpful to understand qualitative factors.

Generally speaking, not all unemployed (U) match the vacancies (V). So it is tempting to define Q=U. But it is more informative to define Q as the number unemployed for which there are jobs, but no suitable ones.

# 8. Comparison and discussion

In this chapter the next question is answered:
*6) What are differences and similarities between the statistical and the economic components?*

## 8.1 General remarks

In this paper two different approaches are introduced. A static analysis uses data of U and V to define components N and Q, with two causes: rigidity and micro markets. A dynamic analysis define components T and C. An in-depth analysis of the causes is not within the realm of this paper. For this reason, two groups of causes are defined: cyclical factors and trend factors. The two approaches can be combined and produce four components with four (groups of) causes.

The components which are constructed are empirical phenomena. Aside from the possibility of comparing these components with results from literature, they hold value on their own. Especially N and Q which have been related to rigidity and the existence of micro markets is a framework with relevance sto the empirical facts of unemployment. The dynamic approach enables to distinguish long-term and short-term dynamics. But the explanation of T and C is only a rough indication and needs to be analysed more in-depth.

## 8.2 Comparison to the literature

In the next table the similarities between concepts in this paper and in the literature are given.

| **In this paper** | **In literature** |
|---|---|
| TC , trend cycle unemployment | NAIRU, OECD |
| U_S=U_7 Juglar cycle unemployment | Keynesian unemployment , Juglar |
| C_L Long cyclical unemployment | Kondrateiff long cycle, Kondrateiff |
| N_T trend quantitative unemployment | structural quantitative, Muysken<br>structural quantitative, Kuypers<br>classical unemployment, Heylen |
| Q_T, trend qualitative unemployment | structural qualitative, Muysken<br>UMI / structural qualitative, Kuypers |
| U_T= $\overline{U}$ trend unemployment | natural rate, Makinw |

## 8.3 Discussion

Although the statistical approach has a different methodology, the results are comparable to many components in the economic literature. Since the framework of Muysken has similar concepts, it is interesting to compare the results with the statistical framework, introduced in this paper. In order to compare them properly, all computations are done on the same data, the data used by Muysken (1984). The results of several components are more plausible than the results from Muysken:

- The meaning of the concepts is the same.
- Q_T and Q_T_Muysken have quite different slopes.
- Q_T follows V (as expected), Q_T_Muysken does not follow V
- C_Muysken>0 , on the other hand C changes from sign regularly.

See figure 8.2.1 for the results.

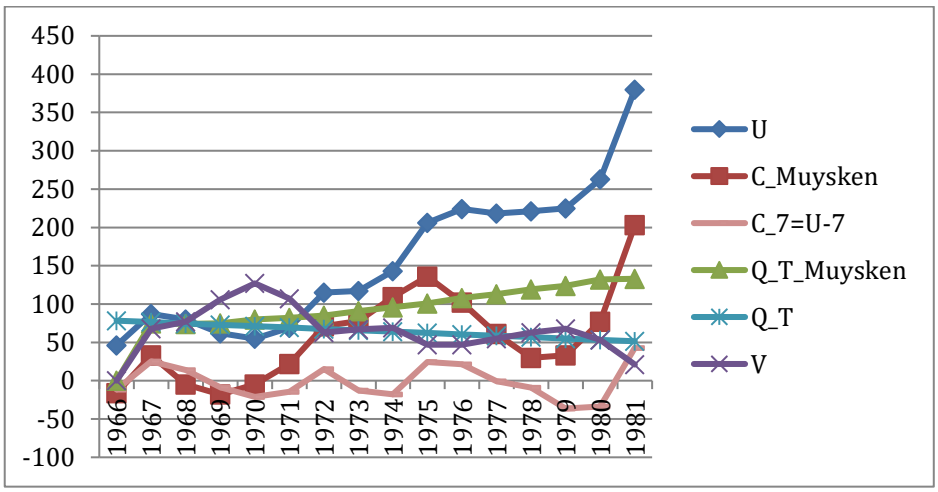


Figure 8.2.1 : Comparison between statistical framework and framework by Muysken, components of unemployment x 1000 unemployed.

The methods which are known in literature (Beveridge/ Phillips curve) have to solve complex econometrical problems because a relation between two different variables has to be estimated (e.g. U and V, U and wages). In the statistical approach the time series U and V are analysed one by one. The statistical problem which has to be solved is much easier. OECD solved their econometric problem with the aid of the statistical technology (structure time series). In fact, their solution is partly statistical, not purely econometrical.

Erken (2015) gives an estimation of an upper bound for Q(s). In this paper estimates are given for every mismatch dimension: education, region and sector. This estimation is possible because of the knowledge of Q (=V) and the interpretation (chapter 7, qualitative unemployment).

# 9. Other indicators

In this chapter the next question is answered:
*4) Which other indicators deliver a better understanding of unemployment?*

## 9.1 Short and long-term unemployment

Another important segment in labour market analysis is the part long-term unemployment (here defined as an unemployment duration > 1 year). Statistics Netherlands has two different time series, one from 2003-2014 (P3) and one from 1990-2008 (P2). In this research project these series are combined with data from Bierings(1996, P1) and a correction for the change in definition has been done in order to construct a consistent time series over the period 1976-2014). The construction of the consistent time series has been done on the share held by long-term unemployment in total unemployment (=U_long/U).

The next figure shows the different time series with the breaks and the corrected consistent time series for the whole period.

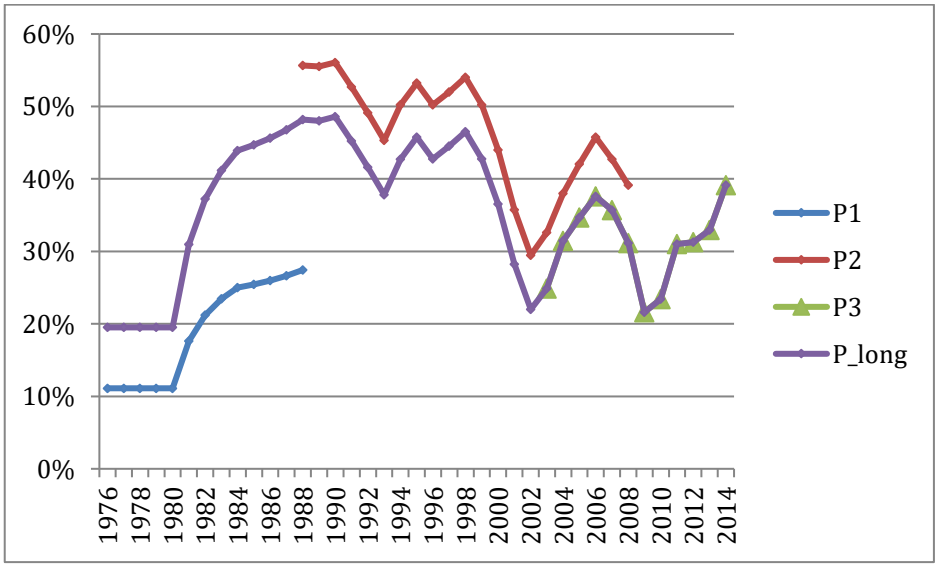


Figure 9.1.1: Original time series on the share of long-term unemployment in total unemployment

The results of the consisted time series are used to compute the unemployment rate by duration (long/short).

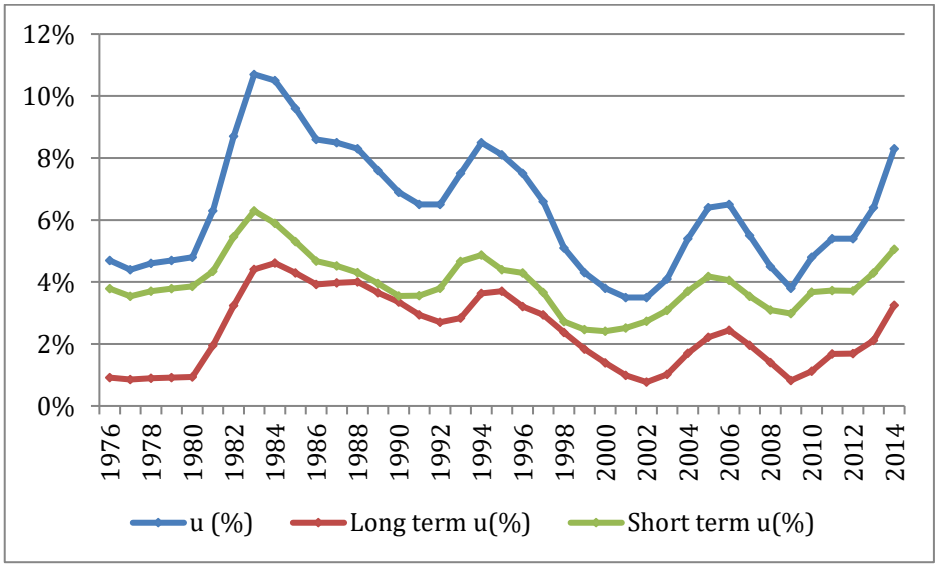


Figure 9.1.2: Long-term (>1 year) and short-term unemployment 1976-2014

## 9.2 Labour tightness

Labour tightness is often used in labour market analysis.

labour tightness = LT = V/U

It is a measurement which indicates how many vacancies are available for every group of unemployed. In the next figure LT is shown for the period 1966-2014.

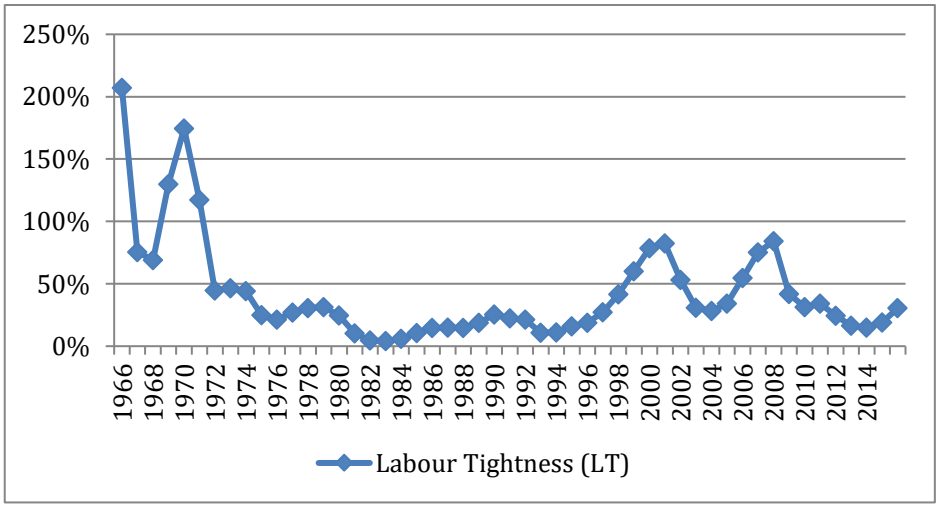


Figure 9.2.1 : Labour tightness 1966 – 2014

Labour tightness was relatively high in the early 1970s, in 2001 and in 2008.
It declined rapidly after 2008 as a result of the financial crisis.

A methodological problem with the metric is the fact that quite different situations have the same LT, for instance (U,V) = (100,10) and (U,V) = (1000,100). Another

problem is that in a perfect market, with (U,V) = (0,0) there is no value of LT. On the basis of these facts it is necessary to develop another metric with a better performance. In this paper two other metrics are proposed.

## 9.3 Unemployment volume

It is good practice to compute the labour volume in order to correct for part-time workers. Analogous to this, it is possible to define an unemployment volume as:

unemployment volume = $U\_Y(t) = \Sigma\ \tau\ U(t,\tau)*\tau$

In year **t** the volume is weighted by the unemployment duration time. An impression is given in the next table. The metric corrects for the duration of unemployment by giving long-term unemployment a greater weight.

| Year | U avg. duration (months) | U (x 1000) | U_Y ( x 1000) |
|---|---|---|---|
| 2003 | 10.1 | 395 | 331 |
| 2004 | 11.1 | 466 | 430 |
| 2005 | 12.6 | 489 | 512 |
| 2006 | 13.3 | 419 | 463 |
| 2007 | 13.0 | 355 | 383 |
| 2008 | 11.5 | 318 | 306 |
| 2009 | 9.5 | 381 | 303 |
| 2010 | 9.6 | 435 | 349 |
| 2011 | 10.9 | 434 | 395 |
| 2012 | 11.5 | 516 | 496 |
| 2013 | 11.6 | 647 | 627 |
| 2014 | 13.3 | 660 | 730 |

Table 9.3.1: Average unemployment duration (months and years)

## 9.4 The measurement of imperfection

Apart from the components it is desirable to have a general metric on the efficiency of the labour market. This paper suggests that all unemployment and all vacancies are inefficient, compared to the perfect market in which (U,V)=(0,0).
So one logical metric would be to define a distance function like:

Distance1(u,v) = u + v (rates in %)

And the efficiency could be defined as:

Eff_1 = 100% - Distance1(u,v) / Distance1(1,1) = 1 - Distance1(u,v)/2
This metric is 100% in a perfect market and 0% when u and v reach their maximum.

A correction factor Distance1(1,1) has been introduced to restrict Eff_1 to [0%,100%]. In this metric the efficiency is neutral in type: u or v. In the traditional UV analysis economists observe that the market becomes less efficient as the UV curve shifts away from the perfect market (U,V) = (0,0). Analogous to that philosophy it is logical to define the distance function as:

Distance2(u,v) = $\sqrt{u^2 + v^2}$ (u and v in % of the labour force)

Distance2 is the distance from a point (u,v) to (0,0) in a two-dimensional space. The metric:

Eff_2 = 100% - Distance2 / Distance2 (1,1) = 100% - Distance2 / √2

has the same properties as Eff_1. If one needs a metric for the trend of unemployment than it is necessary to replace U by U_T and V_T, as well in the correction factor: Distance3 = Distance2(u_T,v_T). The results are shown in the next figure.

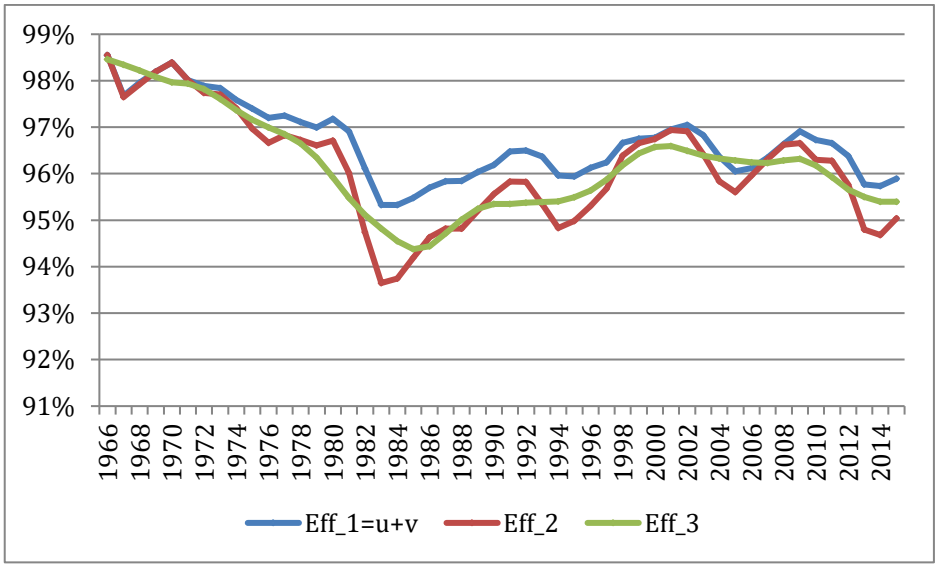


Figure 9.4.1 Efficiency on the labour market

Market performance was bad around 1984. In recent decades it has been relatively stable, although it has declined since 2012. Before 1980 the labour market had its golden period. Note that this metric can be computed for every market segment.

For many economists frictional unemployment (FR) was unavoidable. Therefore, instead of computing the distance between (u,v) and (0,0) it is also possible to compute the distance between (u,v) and (u_fr,v_fr) : Distance4(u,v) = $\sqrt{(u - u\_fr)^2 + (v - v\_fr)^2}$
Note that Distance2 = $\sqrt{Distance1^2 - 2uv}$ > Distance1. If one considers U and V as phenomena in the same dimension, efficiency is better than if one considers U and V as two different dimensions.

# 10. Publication of components

In this chapter the next question is answered:
*5) Is it possible to publish about components on a regular basis, and if so, with which frequency?*

It is possible to publish about components on a regular basis, because all components are derived from the time series unemployment (U) and vacancies (V). Another question is: which time series has the highest relevance to policymakers on the labour market? The following remarks can be made:

- policymakers want to look not only at what happens today, but also at what will happen tomorrow. That makes U_T and U_TC relevant and provides better insight than U, which still incorporates a business cycle.
- policymakers want to know what the causes are of unemployment. For that reason N_TC and Q_TC offer a better perspective, especially the part Q_tc_e which they can influence by introducing training / refresher programmes.
- policymakers want to have an overall view on the performance of the labour market. Eff_2 offers good insight into efficiency.
- publication on an annual basis makes sense as there is already a monthly publication with seasonally adjusted time series.

In summary, Statistics Netherlands could publish the following time series with an annual frequency:

- trend cycle quantitative unemployment ( N_TC)
- trend cycle qualitative unemployment (Q_TC)
- business cycle unemployment (U_S=U_7)
- trend cycle unemployment (U_TC = N_TC + Q_TC = U - U_S)
- the relative share Q_TC% = Q_TC/U_TC
- consistent time series on long and short-term unemployment (1966-2015)
- the metric of labour market imperfection Eff_2 = 100% - $\sqrt{u^2 + v^2}$ / √2
- the amount of unemployment volume(t) = Σ τ WL(t,τ)*τ

As a result of this research, more questions still need to be answered:

- What is (statistically) the best method for cycle extraction?
- Is it possible to give a more informative explanation of the components which are the result of the dynamic analysis?

# 11. Conclusion

The possibilities for Statistics Netherlands to compute and publish results on components of unemployment have been researched. This paper addresses several questions regarding components of unemployment.

*1) Which components are customary in economic literature?*
Components refer to causes of unemployment, whereas segments refer to characteristics of unemployed people. Components of unemployment have been the subject of a huge and complex debate in academic literature. A wide variety of theoretical concepts have been proposed. One of the most practical frameworks has been formulated by Muysken (1984) and contains the following concepts:

- structural quantitative unemployment;
- structural qualitative unemployment;
- business cycle unemployment.

However, the number of empirical methods that have been proposed is relatively small. These methods are usually a reflection of a specific economic school of thought and use models with specific assumptions. Whereas the (neo-) classical tradition focuses on the estimation of the Phillips curve, the (neo-) Keynesian tradition prefers the estimation of the Beveridge curve.

*2) Is it possible and advisable for Statistics Netherlands to compute and publish components from economic literature?*
There is no agreement in the academic discourse on which concepts and method should be used. Another problem is that the concepts which are used are not always strictly defined which gives possibilities of misunderstanding. Since Statistics Netherlands has an obligation to publish data which are beyond dispute, neither practice (Beveridge/ Phillips-curve) is favoured by Statistics Netherlands.

*3) Is it possible to construct components from a statistical perspective?*
Despite the conceptual, methodological and ideological problems it is possible to compute components from a statistical perspective, which:

- uses transparent concepts for a large group of practical users
- focuses on empirical content, not on theory;
- uses statistical methods with relatively few assumptions and not related to economic schools of thought;
- uses the generally accepted concept of the market for perfect competition as a benchmark model.

In this framework three lines of thought are introduced:

- A static analysis which reveals that all unemployment is the result of market imperfections. In this paper it is shown that all unemployment is the result of all kinds of rigidities. In addition, the *simultaneous existence* of both unemployment (Q=V) and vacancies (V) is the result of the existence of micro markets.

- A dynamic analysis which uses statistical cycle extraction techniques to estimate the short (Juglar) cycle, a long cycle, a trend cycle and a trend. These variables are comparable to traditional concepts such as unemployment caused by business cycles and the NAIRU. Only a sketch of explanation has been given for these dynamic terms.
- An analysis of mismatches by computing CVAR for different dimensions (level of education, region, sector).

It is possible to combine the static and dynamic analysis and present a matrix of four components. These four components have four different types of explanations. They offer practical information for economic policy. Although this framework provides a good understanding of the performance of the labour market, it offers only global insight into the explanation of the dynamics of unemployment. The results of this framework are comparable to the components mentioned by Muysken.

*4) Is it possible to compute the components with Statistics Netherlands data?*
The computation of this framework can be done on the time series of unemployment and vacancies of Statistics Netherlands. There is no need for other information.

*5) Is it possible to give an economic interpretation to components derived from a statistical perspective?*
The static analysis offers a perspective on the labour market as a market with imperfections. N is the result of unbalanced rigidities, Q is the result of balanced rigidities. N can be solved by quantitative labour policies, Q by qualitative labour policies. The consequence of this argument is that N can be interpreted as quantitative unemployment, and Q can be interpreted as qualitative unemployment, comparable to the concepts of Muysken. The dynamical perspective offers a perspective on business cycle unemployment and long cycles comparable to the Kondratieff. The trend cycle is comparable to the NAIRU and equilibrium unemployment. The analysis of variation offers insight into the dimensions of qualitative unemployment. The component Q in combination with formulas of relative indices allows precise estimation of several subcomponents with relevant policy implications.

*6) What are differences and similarities between the statistical and the economic components?*
The methods as described in the literature (Beveridge/ Phillips curve) have to solve complex econometrical problems because a relation between two different variables has to be estimated (e.g. U and V, U and wages). In the statistical approach the time series U and V are analysed one by one. The statistical problem which has to be solved is much easier. The statistical approach gives more information on the several dimensions of qualitative unemployment.

*7) Which other indicators deliver a better understanding of unemployment?*
Another important aspect is the proposed metric of labour market imperfection. The metric has some advantages over the traditional metric "labour tightness".

*8) Is it possible to publish about components on a regular basis, and if so, with which frequency?*

Statistics Netherlands could publish the following time series with an annual frequency:

- trend cycle quantitative unemployment ( N_TC)
- trend cycle qualitative unemployment (Q_TC)
- business cycle unemployment (U_S=U_7)
- trend cycle unemployment (U_TC = N_TC + Q_TC = U - U_S)
- the relative share Q_TC% = Q_TC/U_TC
- consistent time series on long and short-term unemployment (1966-2015)
- the metric of labour market imperfection Eff_2 = 100% - $\sqrt{u^2 + v^2}$ / √2
- the amount of unemployment volume(t) = Σ $\tau$ WL(t,$\tau$)*$\tau$

As a result of this research still more questions need to be answered:

* What is (statistically) the best method for cycle extraction?

* Is it possible to provide a more informative explanation of the components which are the result of the dynamic analysis?

*In what way can Statistics Netherlands contribute to explain unemployment?*

Statistics Netherlands can contribute to explain unemployment by computing and publishing components from a statistical perspective. The framework which has been expounded in this paper offers a good understanding in the way market imperfections and business cycles cause unemployment. Moreover it offers a different perspective than the traditional approaches based on basic analysis and basic theory.

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# 14. Appendix 1: Economic interpretation of components

## 14.1 Static analysis

### 14.1.1 Definitions

In order to prove the theorems of chapter 7, some definitions will be given.

### 14.1.2 Perfect and non-perfect market

In section 4.5 the theory of perfect competition has been introduced. This market has four characteristics. In this paper the four characteristics will be summarised as:
Flexibility (F) =

- a large number of buyers and sellers, every participant is a price taker,
- free entry and exit;
-

Unity (I) =

- homogenous products,
- perfect information (zero transaction and search costs, perfect factor mobility).
-

A perfect market has characteristic F &I. The opposite is an imperfect market with characteristics Rigidity = ¬ Flexibility and Segmented (micro) markets = ¬ Unity, abbreviated as (¬ F & ¬ I).

A market with flexible wages has prices/wages w=w*, for which S(w*)=D(w*)
Deviations from this perfect market are:

- Downward rigidity of prices/wages (Rd), w> w*
- Upward rigidity of wages (Ru) w< w*
- Segmented micro markets (Seg)
- Weak flexibility, S(w*)=D(w*) on the aggregate level, but not for every micro market j : Sj(w) <> Dj(w) for some (>1) values of j
- Balanced rigidity: Ru=Rd : U=V
- Unbalanced rigidity: Ru<>Rd : U<>V ( or Ru>Rd; U>V)
- Positive unbalanced rigidity : Rd<Ru : U<V
- Negative unbalanced rigidity : Rd>Ru : U>V

#### Price Mechanisms

A price/wage can arranged with two different ways:

1. By tradition or authority, the quantity is the result of the rationing mechanism: E(p) = Min[ S(p), D(p) ]
2. By the price mechanism, the invisible hand: the quantity is the result of:

E* = E(p*) = S(p*) = D(p*)

E = Employment, S=supply, D=Demand

### Definition of markets

On a market of perfect competition, a perfect market, rules the price mechanism.
On an imperfect market rules the rationing mechanism.

### Aggregate and micro markets

The labour market consists of several micro markets. For each market there is Si(p) and Di(p)
The aggregate market is the collection of all micro markets, S = ∑i S(i), D=∑i D(i), U = ∑i U(i), V=∑i V(i), Ei = ∑i E(i)
The vector (U,V) of the aggregate market is defined as:
(U,V) = { (U1,V1),….,(Un,Vn)}  i=1,.., n micro markets

### Supply, Demand, Employment, Unemployment and vacancies

S(w) = E(w) + U(w)
D(w) = E(w) + V(w)
S(w) is a non-decreasing function of w : If s w1>=w2 ⇔ S(w1)>=S(w2)
D(w) is a non-increasing  function of w : Als w1>=w2 ⇔ D(w1)=<D(w2)
S(0) < D(0)  ( with the consequence that w* exists) .

### Imperfections

Supply imperfections: S_imp = ∑j | S(j) – S*(j) |  j=1,..,n micro markets
Demand imperfections : D_imp = ∑j | D(j) – D*(j) |

### Definition cause and effect

If A leads always to B , then A is a sufficient condition for B, or : A -> B (or A suff B)
If C is necessary for a result B, then C is a necessary condition for B. As a consequence, if C not happens ( not C) than B will not happen (not B), or: [ not C ] -> [not B] = C nec B
If C nec B and Not { C -> B } then C does not leads automatically to B. But without C, B will not happen.
If A nec B and A suff B then A is a necessary and a sufficient condition for B, or : A< -> B: If B happens, then A preceded B.

Summarized:
A -> B = A suff B
Not-A -> Not-B = A nec B
A ⇔ B = A suff+nec B

## 14.1.3 Theorems

*Theorem 1: In a perfect market there is no unemployment and there are no vacancies. In a perfect market there is an equilibrium, supply meets demand and equilibrium unemployment, defined as the level of unemployment at equilibrium, is zero.*
Prop A1 and A2 are needed for A3:

A1) Rd -> p> p* -> p>=p* < => S(p)>=S(p*) = D(p*) >=D(p) ⇔ S(p)>D(p) <=> E(p) = Min [ S(p),D(p) ] = D(p) ⇔ E(p)=D(p)=E(p)+V(p) ⇔ V(p)=0
So Rd -> V=0. (A1)
A2) Ru -> p < p* -> p=<p* <=> p=<p* => S(p)=<S(p*) = E(p*)=D(p*) =<D(p) ⇔ E(p)=S(p)=E(p)+U(p) ⇔ U(p)=0 , So Ru -> U=0. (A2)

A3) Perfect market -> Flexibility (F) -> p=p* ⇔ { P I A1 and A2 } ⇔ V(p*) =0 and U(p*) = 0

A4) If Rd -> p>p* ⇔ ( p I A1 en Niet-A3 } ⇔ V(p) = 0 en Niet { V(p)=0 en U(p)=0} ⇔ V(p)=0 en U(p)<>0 , so Rd -> (U,V) = (U,0) (A4)

A5) If Ru: p<p* ⇔ ( p I A2 en Niet-A3 } ⇔ U(p) = 0 en Niet { V(p)=0 en U(p)=0} ⇔ V(p)<>0 en U(p)=0, so Ru -> (U,V) = (0,V) (A5)

A6) U>=0, V>=0 (trivial )

*Theorem 2: Unemployment is due to downward rigidity (Rd) : Rd -> U>0*
Theorem A4 and A6: Rd ⇔ U>0 (and V=0)

*Theorem 3 : Vacancies(V>0) are due to upward rigidity (Ru) : Ru -> V>0*
Theorem A5 and A6: Ru ⇔ V>0 (and U=0)

*Theorem 4: As a consequence of 1), all unemployment is due to market imperfections.*
Since a perfect market has U*=0, If U>0 there is no perfect market, so there are market imperfections

*Theorem 5: All unemployment is due to one market imperfection: downward rigidity of wages, and not heterogeneity of labour.*

Since Rd ⇔ U>0 , Rd is sufficient and necessary condition for U>0.
Segmentation means that (U,V) = { (U1,V1),….,(Un,Vn)} i=1,.., n micro markets
An example is: (U,V) = (0,10) = { (0,4), (0,6)} . Segmentation is not a sufficient condition for unemployment in this example -> not a sufficient condition in general.

*Theorem 6: Heterogeneity of labour/segmentation is neither a necessary nor a sufficient condition for unemployment.*

For example: (U,V) = (6,0) = { (6,0) } -> U>0 and homogeneity ( 1 market) -> Heterogeneity of labour/segmentation is a not a necessary condition for U>0.
For example: (U,V) =(0,9) = { (0,3) , (0,6) } -> : U=0 and segmentation -> segmentation is a not a sufficient condition for unemployment (U>0).

*Theorem 7: Heterogeneity of labour (Seg) is a necessary but not a sufficient condition for the existence of unemployment and vacancies at the same time { (U,V)>(0,0)} , at the aggregated level.*

Assume Not Seg => (U,V) = { (U,V) } (one market)
Assume p=p* -> U*=V*=0 (A3) -> Not { (U,V)>(0,0)} -> S nec { (U,V)>(0,0)} QED
Assume p< p* -> Ru -> U=0 , V>0 (A8) -> Not { (U,V)>(0,0)} -> S nec { (U,V)>(0,0)} QED
Assume p> p* -> Rd -> U>0 , V=0 (A7) -> Not { (U,V)>(0,0)} -> S nec { (U,V)>(0,0)} QED
-> For every p -> S nec { (U,V)>(0,0)} QED
The intuition about this proof is that if the market is not perfect, a rationing mechanism gives the clearing of the micro markets. For every micro market (U,V) = (U,0) or (U,V) = (0,V). So (U,V)>(0,0) is an aggregate market which consists at least at two markets, so there is segmentation.

*Theorem 8: Heterogeneity of labour, downward and upward rigidity are necessary and sufficient conditions for the existence of unemployment and vacancies at the same time, at the aggregate level.*

Rd -> U>0 , V=0 market 1
Ru -> V>0, U=0, market 2
Seg -> at least two markets exists, one with Rd, one with Ru.
(U,V) = {(U,0), (0,V)} = (U,V)>(0,0) QED

*Theorem 9: A division of unemployment in quantitative and qualitative unemployment is not meaningful if the intention is to explain the unemployment, to give information about the causes.*

Since all employment is due to one cause, downward rigidity of wages, no division of components for understanding the cause is meaningful.

*Theorem 10: In the context of solving the problem of unemployment, the division of in quantitative and qualitative unemployment is meaningful, since qualitative unemployment (Qs=V) can be solved by vanishing the heterogeneity of labour (segmentation, micro markets). Quantitative unemployment (N=U-V) can only be solved by vanishing the downward wage rigidity*

Since every unemployed can approve on the vacancies if there is one integrated (not segmentated) market, V will vanish (since usually U>V) and U will become N=U-V.

*Theorem 11: Q=V is the result of (no un) balanced (positive) rigidity, N=U-V is the result of unbalanced rigidity.*

Rd=Ru => U = N + Q; U=V; Q=V => = U= V = N +V => N=0.
Rd>Ru => U>V => N= U-V>0 , Q=V
N rises with U-V when the rigidity becomes unbalanced. QED
Q = V in both situations -> Rd=Ru is sufficient, but not necessary for Q=V.
Rd >= Ru are nec and suff for Q=V. or: Not [Rd<Ru] ⇔ Q=V
The absence of positive unbalanced rigidity has Q=V as result. More practical: balanced rigidity has Q=V as result.
Special case: If Rd<Ru Q=U<V (positive unbalanced rigidity). N=0.
N=U-V>0 with Rd>Ru : Rd>Ru is nec and suff for N=U-V>0

Since quantitative and qualitative unemployment can only be measured by using the number vacancies (V), it is more appropriate to distinguish components of the labour market (supply and demand), instead of components of unemployment (only supply). The total amount of imperfections of the labour market is MIP = U + V, not only U. This MIP can be divided in three ways:

MIP = N + Q (quantitative versus qualitative imperfections) ( Q = Qd + Qv = 2*V)

MIP = S_mip + D_mip (Supply versus Demand imperfections)

MIP = { Ns + Qs } + { Nds + Qd } = S_mip + D_mip

*Theorem 11: MIP = U + V*

Assume: In market 1 : S(w)>D(w), in market 2 : S(w)<D(w).
Define MIP = ∑ j | S(j) – S*(j) | + ∑j | D(j) – D*(j)|=
E(1)+U(1) – E*(1) + E*(1)-E(1) + E*(2)-E(2) + E(2)+V(2) – E*(2) = U(1)+V(2) = U + V
Or MIP = {(U*-U) + (E-E*)} + {(V-V*) + (E*-E)} = U+V

*Theorem 12:*
*S_imp = ∑j | S(j) – S*(j) | = U(1) + A = Ns + Qs*
*D_imp = ∑j | D(j) – D*(j) | = V(2) – A = Nd + Qd*
*With A = E(1) – E*(1) + E*(2) – E(2) (2 markets) or A = E – E* (one market)*

Matrix

| D/S | S_mip | D_mip | Totaal |
|---|---|---|---|
| N | Ns=N+A | Nd = - A | N |
| Q | V | V | 2*Q=2*V |
| Totaal | U + A | V – A | U+V |

### 14.1.4 Conclusion

- N can be interpreted as quantitative unemployment and can only be solved by reducing downward wage rigidity.
- Q van be interpreted as qualitative unemployment and can be solved by two ways:
- reducing heterogeneity of labour / segmentation
- reducing downward wage rigidity.
- All unemployment is explained by one market imperfection: downward wage rigidity.
- N is explained by unbalanced rigidity; Q is explained by balanced rigidity.

## 14.2 Dynamic analysis

Description of dynamics: trend and cycles.
U = T + C
C = C_L + C_J + C_S
U_TC = T + U_L

In this paper the explanation of the dynamics of unemployment is only solved roughly. Three factors are responsible for the dynamics:
* trend factors, with no possibility to go back to the equilibrium (u,v) =(0,0). For instance, once a machine has been invented, labour is outdated for ever.
* long cycle factors, with the possibility to adjust slowly (with a period of 60 years) to the new situation.
* short cycle factors, with the possibility to adjust "quick" (with a period of 7-11 years) to the new situation, for instance the change in effective demand.

Although this formal analysis is not very informative, it gives three dynamic components and a basic understanding of changes on the labour market. Further research should be done on this item.

# 15. Appendix 2: Models

## 15.1 NAIRU

The following text is from OECD (2001, box 1) :
As shown in the Appendix, the expectations-augmented Phillips curve relationship can be derived as a reduced form equation of structural wage and price setting models of the type described in Layard et al. (1991), which can be expressed using the following two-equation system. The first equation (1) identifies explicitly only the temporary supply shocks and the second expression (2) includes the long-lasting supply shocks, which fundamentally determine the NAIRU, subject to various long-term adjustment lags.

$\Delta\pi(t) = \alpha(L) * \Delta\pi(t-1) - \beta[U(t) - U^*(t)] - \theta(L) * \Delta U(t) + \Upsilon(L) * ZT(t) + e(t),$ (1)

$U^*(t) = [K(t) + \Upsilon(L) * ZL(t)] / \beta$ (2)

where $\Delta$ is the first difference operator, $\pi(t)$ is inflation, U(t) is the observed unemployment rate, ZL(t) and ZT(t) are vectors of respectively long-lasting and temporary supply shock variables, $\alpha(L)$, $\theta(L)$, $\Upsilon(L)$ and v(L) are polynomials in the lag operator and e a white noise error term. K t is a moving parameter capturing all other unspecified influences on the NAIRU.

## 15.2 structural time series model

In chapter 5 and 6 the trend component from a structural time series model (TR_STM) is presented. The model which has been used is the same as the model from Van Ruth en Schouten (2004), and also formulated by Durbin and Koopman ( 2001, p. 43). The model is:

$$y_t = \mu_t + c_t + \varepsilon_t,$$
$$\mu_t = \mu_{t-1} + \nu_{t-1} + \xi_t$$
$$\nu_t = \nu_{t-1} + \eta_t,$$

With :

$$c_t = \sum_{k=1}^{K} c_{k,t},$$

and

$$\begin{bmatrix} c_{1,t} \\ c_{2,t} \end{bmatrix} = \begin{bmatrix} \cos(\lambda) & \sin(\lambda) \\ -\sin(\lambda) & \cos(\lambda) \end{bmatrix} \begin{bmatrix} c_{1,t-1} \\ c_{2,t-1} \end{bmatrix} + \begin{bmatrix} \kappa_t \\ \kappa_t^* \end{bmatrix},$$

The component $\mu_t$ is the trend component, $c_t$ is the cyclical component. The disturbance terms are assumed to have Normal distributions.

# 16. Appendix 3: Data

## 16.1 Basic (in%)

| Year | U | U_T | U_C | Q=V | N |
|---|---|---|---|---|---|
| 1966 | 1.4 | 3.9 | -2.4 | 3.0 | -1.6 |
| 1967 | 2.7 | 3.9 | -1.3 | 2.0 | 0.7 |
| 1968 | 2.4 | 4.0 | -1.6 | 1.7 | 0.7 |
| 1969 | 1.8 | 4.0 | -2.2 | 2.3 | -0.5 |
| 1970 | 1.6 | 4.1 | -2.5 | 2.8 | -1.2 |
| 1971 | 2.0 | 4.1 | -2.1 | 2.3 | -0.3 |
| 1972 | 2.9 | 4.2 | -1.3 | 1.3 | 1.6 |
| 1973 | 2.9 | 4.2 | -1.3 | 1.4 | 1.6 |
| 1974 | 3.3 | 4.3 | -0.9 | 1.5 | 1.9 |
| 1975 | 4.2 | 4.3 | -0.2 | 1.0 | 3.1 |
| 1976 | 4.6 | 4.4 | 0.2 | 1.0 | 3.6 |
| 1977 | 4.3 | 4.4 | -0.1 | 1.2 | 3.2 |
| 1978 | 4.4 | 4.5 | -0.1 | 1.3 | 3.1 |
| 1979 | 4.6 | 4.5 | 0.0 | 1.4 | 3.1 |
| 1980 | 4.5 | 4.6 | -0.1 | 1.1 | 3.4 |
| 1981 | 5.6 | 4.6 | 1.0 | 0.6 | 5.0 |
| 1982 | 7.4 | 4.7 | 2.7 | 0.4 | 7.1 |
| 1983 | 9.0 | 4.7 | 4.2 | 0.4 | 8.6 |
| 1984 | 8.8 | 4.8 | 4.0 | 0.5 | 8.3 |
| 1985 | 8.2 | 4.9 | 3.3 | 0.9 | 7.3 |
| 1986 | 7.5 | 4.9 | 2.6 | 1.1 | 6.4 |
| 1987 | 7.2 | 5.0 | 2.3 | 1.1 | 6.2 |
| 1988 | 7.3 | 5.0 | 2.2 | 1.1 | 6.2 |
| 1989 | 6.7 | 5.1 | 1.6 | 1.2 | 5.4 |
| 1990 | 6.1 | 5.1 | 1.0 | 1.6 | 4.5 |
| 1991 | 5.8 | 5.2 | 0.6 | 1.3 | 4.5 |
| 1992 | 5.8 | 5.2 | 0.6 | 1.2 | 4.5 |
| 1993 | 6.6 | 5.3 | 1.3 | 0.7 | 5.8 |
| 1994 | 7.3 | 5.3 | 1.9 | 0.8 | 6.5 |
| 1995 | 7.0 | 5.4 | 1.6 | 1.1 | 5.9 |
| 1996 | 6.5 | 5.4 | 1.1 | 1.2 | 5.3 |
| 1997 | 5.9 | 5.5 | 0.4 | 1.6 | 4.3 |
| 1998 | 4.7 | 5.5 | -0.8 | 2.0 | 2.8 |
| 1999 | 4.1 | 5.6 | -1.5 | 2.4 | 1.6 |
| 2000 | 3.6 | 5.6 | -2.0 | 2.8 | 0.8 |
| 2001 | 3.3 | 5.7 | -2.3 | 2.8 | 0.6 |

| | | | | | |
|---|---|---|---|---|---|
| 2002 | 3.9 | 5.7 | -1.9 | 2.1 | 1.8 |
| 2003 | 4.8 | 5.8 | -0.9 | 1.5 | 3.3 |
| 2004 | 5.7 | 5.8 | -0.2 | 1.6 | 4.1 |
| 2005 | 5.9 | 5.9 | 0.0 | 2.0 | 3.9 |
| 2006 | 5.0 | 5.9 | -0.9 | 2.7 | 2.3 |
| 2007 | 4.2 | 6.0 | -1.8 | 3.1 | 1.0 |
| 2008 | 3.7 | 6.0 | -2.4 | 3.1 | 0.6 |
| 2009 | 4.4 | 6.1 | -1.7 | 1.8 | 2.5 |
| 2010 | 5.0 | 6.2 | -1.2 | 1.6 | 3.4 |
| 2011 | 5.0 | 6.2 | -1.2 | 1.7 | 3.3 |
| 2012 | 5.8 | 6.3 | -0.4 | 1.4 | 4.4 |
| 2013 | 7.3 | 6.3 | 0.9 | 1.2 | 6.1 |
| 2014 | 7.4 | 6.4 | 1.1 | 1.1 | 6.3 |
| 2015 | 6.9 | 6.4 | 0.5 | 1.3 | 5.6 |
| Average | 5.1 | 5.1 | 0.0 | 1.6 | 3.6 |

## 16.2 Matrix (in%)

| Year | U | N_T | N_C | Q_T | Q_C |
|---|---|---|---|---|---|
| 1966 | 1.4 | 2.5 | -4.0 | 1.4 | 1.6 |
| 1967 | 2.7 | 2.5 | -1.8 | 1.4 | 0.6 |
| 1968 | 2.4 | 2.5 | -1.8 | 1.4 | 0.2 |
| 1969 | 1.8 | 2.6 | -3.1 | 1.4 | 0.9 |
| 1970 | 1.6 | 2.6 | -3.8 | 1.4 | 1.4 |
| 1971 | 2.0 | 2.7 | -3.0 | 1.4 | 0.9 |
| 1972 | 2.9 | 2.7 | -1.1 | 1.4 | -0.1 |
| 1973 | 2.9 | 2.8 | -1.2 | 1.5 | -0.1 |
| 1974 | 3.3 | 2.8 | -0.9 | 1.5 | 0.0 |
| 1975 | 4.2 | 2.9 | 0.3 | 1.5 | -0.4 |
| 1976 | 4.6 | 2.9 | 0.7 | 1.5 | -0.5 |
| 1977 | 4.3 | 3.0 | 0.2 | 1.5 | -0.3 |
| 1978 | 4.4 | 3.0 | 0.1 | 1.5 | -0.1 |
| 1979 | 4.6 | 3.0 | 0.1 | 1.5 | -0.1 |
| 1980 | 4.5 | 3.1 | 0.3 | 1.5 | -0.4 |
| 1981 | 5.6 | 3.1 | 1.9 | 1.5 | -0.9 |
| 1982 | 7.4 | 3.2 | 3.9 | 1.5 | -1.2 |
| 1983 | 9.0 | 3.2 | 5.4 | 1.5 | -1.2 |
| 1984 | 8.8 | 3.3 | 5.0 | 1.5 | -1.0 |
| 1985 | 8.2 | 3.3 | 4.0 | 1.5 | -0.7 |
| 1986 | 7.5 | 3.4 | 3.1 | 1.5 | -0.4 |
| 1987 | 7.2 | 3.4 | 2.8 | 1.5 | -0.5 |

| | | | | | |
|---|---|---|---|---|---|
| 1988 | 7.3 | 3.5 | 2.7 | 1.5 | -0.5 |
| 1989 | 6.7 | 3.5 | 1.9 | 1.6 | -0.3 |
| 1990 | 6.1 | 3.5 | 1.0 | 1.6 | 0.0 |
| 1991 | 5.8 | 3.6 | 0.9 | 1.6 | -0.3 |
| 1992 | 5.8 | 3.6 | 0.9 | 1.6 | -0.3 |
| 1993 | 6.6 | 3.7 | 2.2 | 1.6 | -0.9 |
| 1994 | 7.3 | 3.7 | 2.7 | 1.6 | -0.8 |
| 1995 | 7.0 | 3.8 | 2.1 | 1.6 | -0.5 |
| 1996 | 6.5 | 3.8 | 1.5 | 1.6 | -0.4 |
| 1997 | 5.9 | 3.9 | 0.4 | 1.6 | 0.0 |
| 1998 | 4.7 | 3.9 | -1.2 | 1.6 | 0.3 |
| 1999 | 4.1 | 4.0 | -2.3 | 1.6 | 0.8 |
| 2000 | 3.6 | 4.0 | -3.2 | 1.6 | 1.2 |
| 2001 | 3.3 | 4.0 | -3.5 | 1.6 | 1.1 |
| 2002 | 3.9 | 4.1 | -2.3 | 1.6 | 0.4 |
| 2003 | 4.8 | 4.1 | -0.8 | 1.6 | -0.2 |
| 2004 | 5.7 | 4.2 | -0.1 | 1.7 | 0.0 |
| 2005 | 5.9 | 4.2 | -0.4 | 1.7 | 0.4 |
| 2006 | 5.0 | 4.3 | -2.0 | 1.7 | 1.1 |
| 2007 | 4.2 | 4.3 | -3.3 | 1.7 | 1.5 |
| 2008 | 3.7 | 4.4 | -3.8 | 1.7 | 1.4 |
| 2009 | 4.4 | 4.4 | -1.9 | 1.7 | 0.1 |
| 2010 | 5.0 | 4.5 | -1.0 | 1.7 | -0.1 |
| 2011 | 5.0 | 4.5 | -1.2 | 1.7 | 0.0 |
| 2012 | 5.8 | 4.6 | -0.1 | 1.7 | -0.3 |
| 2013 | 7.3 | 4.6 | 1.5 | 1.7 | -0.5 |
| 2014 | 7.4 | 4.6 | 1.7 | 1.7 | -0.6 |
| 2015 | 6.9 | 4.7 | 0.9 | 1.7 | -0.4 |
| Average | 5.1 | 3.6 | 0.0 | 1.6 | 0.0 |

## 16.3 Cyclic unempolyment (in %)

| Year | U | U_T | U_L | U_J |
|---|---|---|---|---|
| 1966 | 1.4 | 3.9 | -2.2 | -0.3 |
| 1967 | 2.7 | 3.9 | -2.1 | 0.8 |
| 1968 | 2.4 | 4.0 | -2.0 | 0.4 |
| 1969 | 1.8 | 4.0 | -1.9 | -0.3 |
| 1970 | 1.6 | 4.1 | -1.7 | -0.7 |
| 1971 | 2.0 | 4.1 | -1.7 | -0.4 |
| 1972 | 2.9 | 4.2 | -1.5 | 0.2 |
| 1973 | 2.9 | 4.2 | -1.1 | -0.1 |

| | | | | |
|---|---|---|---|---|
| 1974 | 3.3 | 4.3 | -0.8 | -0.1 |
| 1975 | 4.2 | 4.3 | -0.5 | 0.3 |
| 1976 | 4.6 | 4.4 | -0.3 | 0.6 |
| 1977 | 4.3 | 4.4 | -0.2 | 0.0 |
| 1978 | 4.4 | 4.5 | 0.1 | -0.2 |
| 1979 | 4.6 | 4.5 | 0.5 | -0.5 |
| 1980 | 4.5 | 4.6 | 1.1 | -1.2 |
| 1981 | 5.6 | 4.6 | 1.7 | -0.7 |
| 1982 | 7.4 | 4.7 | 2.2 | 0.6 |
| 1983 | 9.0 | 4.7 | 2.5 | 1.7 |
| 1984 | 8.8 | 4.8 | 2.9 | 1.2 |
| 1985 | 8.2 | 4.9 | 3.1 | 0.3 |
| 1986 | 7.5 | 4.9 | 2.9 | -0.3 |
| 1987 | 7.2 | 5.0 | 2.4 | -0.1 |
| 1988 | 7.3 | 5.0 | 1.9 | 0.3 |
| 1989 | 6.7 | 5.1 | 1.6 | 0.1 |
| 1990 | 6.1 | 5.1 | 1.4 | -0.4 |
| 1991 | 5.8 | 5.2 | 1.3 | -0.7 |
| 1992 | 5.8 | 5.2 | 1.2 | -0.7 |
| 1993 | 6.6 | 5.3 | 1.2 | 0.1 |
| 1994 | 7.3 | 5.3 | 1.1 | 0.9 |
| 1995 | 7.0 | 5.4 | 0.9 | 0.8 |
| 1996 | 6.5 | 5.4 | 0.6 | 0.5 |
| 1997 | 5.9 | 5.5 | 0.1 | 0.3 |
| 1998 | 4.7 | 5.5 | -0.5 | -0.3 |
| 1999 | 4.1 | 5.6 | -1.0 | -0.5 |
| 2000 | 3.6 | 5.6 | -1.3 | -0.7 |
| 2001 | 3.3 | 5.7 | -1.4 | -1.0 |
| 2002 | 3.9 | 5.7 | -1.3 | -0.6 |
| 2003 | 4.8 | 5.8 | -1.2 | 0.2 |
| 2004 | 5.7 | 5.8 | -1.2 | 1.0 |
| 2005 | 5.9 | 5.9 | -1.2 | 1.2 |
| 2006 | 5.0 | 5.9 | -1.1 | 0.2 |
| 2007 | 4.2 | 6.0 | -1.2 | -0.7 |
| 2008 | 3.7 | 6.0 | -1.3 | -1.1 |
| 2009 | 4.4 | 6.1 | -1.4 | -0.4 |
| 2010 | 5.0 | 6.2 | -1.1 | 0.0 |
| 2011 | 5.0 | 6.2 | -0.7 | -0.5 |
| 2012 | 5.8 | 6.3 | -0.3 | -0.1 |
| 2013 | 7.3 | 6.3 | -0.1 | 1.1 |
| 2014 | 7.4 | 6.4 | 0.0 | 1.1 |
| 2015 | 6.9 | 6.4 | -0.1 | 0.6 |
| Average | 5.1 | 5.1 | 0.0 | 0.0 |

## 16.4 Relevant components for policy making (in%)

| Year | U | U_TC_MA(t.3) | N_TC | Q_TC | U_S=U_7 |
|---|---|---|---|---|---|
| 1966 | 1.4 | 1.7 | 0.3 | 1.4 | -0.3 |
| 1967 | 2.7 | 1.8 | 0.4 | 1.5 | 0.8 |
| 1968 | 2.4 | 2.0 | 0.4 | 1.6 | 0.4 |
| 1969 | 1.8 | 2.1 | 0.4 | 1.7 | -0.3 |
| 1970 | 1.6 | 2.3 | 0.7 | 1.7 | -0.7 |
| 1971 | 2.0 | 2.4 | 0.8 | 1.6 | -0.4 |
| 1972 | 2.9 | 2.7 | 1.2 | 1.5 | 0.2 |
| 1973 | 2.9 | 3.1 | 1.7 | 1.4 | -0.1 |
| 1974 | 3.3 | 3.5 | 2.1 | 1.3 | -0.1 |
| 1975 | 4.2 | 3.8 | 2.6 | 1.2 | 0.3 |
| 1976 | 4.6 | 4.1 | 2.8 | 1.3 | 0.6 |
| 1977 | 4.3 | 4.3 | 3.1 | 1.2 | 0.0 |
| 1978 | 4.4 | 4.6 | 3.5 | 1.1 | -0.2 |
| 1979 | 4.6 | 5.1 | 4.1 | 1.0 | -0.5 |
| 1980 | 4.5 | 5.7 | 4.8 | 0.9 | -1.2 |
| 1981 | 5.6 | 6.3 | 5.5 | 0.8 | -0.7 |
| 1982 | 7.4 | 6.9 | 6.1 | 0.7 | 0.6 |
| 1983 | 9.0 | 7.3 | 6.6 | 0.7 | 1.7 |
| 1984 | 8.8 | 7.7 | 7.0 | 0.7 | 1.2 |
| 1985 | 8.2 | 7.9 | 7.2 | 0.8 | 0.3 |
| 1986 | 7.5 | 7.8 | 6.9 | 0.9 | -0.3 |
| 1987 | 7.2 | 7.4 | 6.3 | 1.1 | -0.1 |
| 1988 | 7.3 | 7.0 | 5.8 | 1.2 | 0.3 |
| 1989 | 6.7 | 6.6 | 5.4 | 1.2 | 0.1 |
| 1990 | 6.1 | 6.5 | 5.3 | 1.2 | -0.4 |
| 1991 | 5.8 | 6.5 | 5.3 | 1.1 | -0.7 |
| 1992 | 5.8 | 6.4 | 5.3 | 1.1 | -0.7 |
| 1993 | 6.6 | 6.4 | 5.3 | 1.1 | 0.1 |
| 1994 | 7.3 | 6.4 | 5.3 | 1.1 | 0.9 |
| 1995 | 7.0 | 6.2 | 5.0 | 1.2 | 0.8 |
| 1996 | 6.5 | 6.0 | 4.6 | 1.4 | 0.5 |
| 1997 | 5.9 | 5.6 | 3.9 | 1.7 | 0.3 |
| 1998 | 4.7 | 5.0 | 3.0 | 2.0 | -0.3 |
| 1999 | 4.1 | 4.6 | 2.4 | 2.1 | -0.5 |
| 2000 | 3.6 | 4.3 | 2.2 | 2.2 | -0.7 |
| 2001 | 3.3 | 4.3 | 2.1 | 2.2 | -1.0 |
| 2002 | 3.9 | 4.5 | 2.3 | 2.2 | -0.6 |
| 2003 | 4.8 | 4.6 | 2.4 | 2.2 | 0.2 |
| 2004 | 5.7 | 4.7 | 2.4 | 2.3 | 1.0 |
| 2005 | 5.9 | 4.7 | 2.4 | 2.3 | 1.2 |

| | | | | | |
|---|---|---|---|---|---|
| 2006 | 5.0 | 4.8 | 2.5 | 2.3 | 0.2 |
| 2007 | 4.2 | 4.8 | 2.5 | 2.3 | -0.7 |
| 2008 | 3.7 | 4.7 | 2.4 | 2.3 | -1.1 |
| 2009 | 4.4 | 4.7 | 2.5 | 2.2 | -0.4 |
| 2010 | 5.0 | 5.0 | 3.0 | 2.0 | 0.0 |
| 2011 | 5.0 | 5.5 | 3.8 | 1.7 | -0.5 |
| 2012 | 5.8 | 6.0 | 4.5 | 1.4 | -0.1 |
| 2013 | 7.3 | 6.2 | 4.7 | 1.5 | 1.1 |
| 2014 | 7.4 | 6.3 | 4.8 | 1.5 | 1.1 |
| 2015 | 6.9 | 6.3 | 4.8 | 1.5 | 0.6 |
| Average | 5.1 | 5.1 | 3.6 | 1.5 | 0.0 |

## Explanation of symbols

| | |
|---|---|
| Empty cell | Figure not applicable |
| . | Figure is unknown, insufficiently reliable or confidential |
| * | Provisional figure |
| ** | Revised provisional figure |
| 2015–2016 | 2015 to 2016 inclusive |
| 2015/2016 | Average for 2015 to 2016 inclusive |
| 2015/'16 | Crop year, financial year, school year, etc., beginning in 2015 and ending in 2016 |
| 2013/'14–2015/'16 | Crop year, financial year, etc., 2013/'14 to 2015/'16 inclusive |

Due to rounding, some totals may not correspond to the sum of the separate figures.

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