Discussion paper

Monthly Labour Force Figures during the 2021 Redesign of the Dutch Labour Force Survey

Jan van den Brakel

Januari 2022

Content

Summary

Monthly figures about the Dutch labour force are based on the Labour Force Survey, which is designed as a rotating panel design. Official figures are produced with a multivariate structural time series model, which is used as a form of small area estimation to improve the precision of monthly estimates and to account for rotation group bias and discontinuities induced by two redesigns that toke place in 2010 and 2012. Based on a Eurostat regulation, Statistics Netherlands is implemented a third redesign, of which the implementation started in 2021. In a well-designed transition process discontinuities are quantified to avoid confounding real period-to-period change from the systematic effect of the redesign on the outcomes of the survey estimates. In this redesign, discontinuities in the first wave are estimated through a parallel run, where data are collected under the old and new survey designs alongside each other for a period of nine months. Discontinuities in the follow up waves are estimated with an extended version of the time series model used for the production of monthly labour force figures. In this paper it is described how the time series model is extended to accommodate discontinuities that are a result of the third redesign. First results for discontinuity estimates are presented, and it is described how uninterrupted monthly labour force figures are produced during the period were the new survey design is implemented.

Keywords

Small area estimation, structural time series model, corona crisis, discontinuities

This work was funded by the European Union under grant no.:
826475-2018-NL-LFS QUALITY BREAKS

1. Introduction

Official monthly statistics about the Dutch labour force are based on the Dutch Labour Force Survey (LFS). Since October 1999, this survey is based on a rotating panel design. The responding households are interviewed five times at quarterly intervals, which implies that every month five waves are being interviewed. The estimation procedure of the LFS is based on the general regression(GREG) estimator (Särnal et al. 1992). In 2010, Statistics Netherlands implemented a model-based estimation procedure based on multivariate structural time series model to produce monthly figures about the labour force (Pfeffermann, 1991; van den Brakel and Krieg, 2015). With this time series model, three problems are solved. The first problem is that the monthly sample size of the LFS is too small to rely on the GREG estimator to produce sufficiently reliable and stable official monthly statistics about the employed and unemployed labour force. The time series model uses information observed in previous periods to improve the effective sample size of the individual months to obtain more precise sample estimates as a form of small area estimation. The second problem is that there are substantial systematic differences between the subsequent waves due to mode and panel effects. This is a well-known problem for rotating panel designs, and in the literature this is referred to as rotation group bias (RGB), (Bailar, 1975). At the moment the LFS changed from a cross-sectional survey to a rotating panel design in October 1999, the effects of the RGB on the outcomes of the LFS became very visible. The time series model accounts for RGB by benchmarking the results observed in the follow-up waves to the level of the first wave. The third problem is the systematic effect on the outcomes of the LFS due to two major redesigns of the survey process in 2010 and 2012. Redesigns generally affect the various non-sampling error sources in a survey process, and therefore result in systematic effects on the outcomes of a survey. In an ideal survey transition process, these so-called discontinuities are quantified in order to keep series consistent and preserve comparability of the outcomes over time. In both redesigns, discontinuities are quantified using parallel data collection and modeling discontinuities in the time series model using intervention variables (van den Brakel and Roels, 2010).

Based on a Eurostat regulation, a third redesign of the Dutch LFS is implemented in 2021. The purpose of this paper is to describe the transition to the new design. Discontinuity estimates based on a parallel with the first wave are presented. Furthermore, it is explained how the time series model, used for the production of monthly labour force figures, is extended to estimate discontinuities in the follow-up waves and how uninterrupted monthly labour force figures are produced during the transition period. Finally it is explained how additional complications, that are the result of the loss of face-to-face interviewing during the lockdown in 2021 are handled.

The paper is organised as follows. Section 2 starts with a description of the LFS, including the new redesign. In Section 3, the time series model used for the publication of monthly labour force figures is described. In section 4 it is explained

how this model is extended to accommodate discontinuities that are the result of the implementation of a new design in 2021. In Section 5, results of the parallel run and the time series model are presented. The paper concludes with a discussion in Section 6.

2. Dutch Labour Force Survey

2.1 Survey design before 2021

The objective of the Dutch LFS is to provide reliable information about the Dutch labour force. Each month a stratified two-stage cluster sample of addresses is drawn. Strata are formed by geographical regions. Municipalities are considered as primary and addresses as secondary sampling units. All households residing at an address, up to a maximum of three, are included in the sample. All household members with an age of 15 years and older are included in the sample. Different subpopulations are oversampled to improve the accuracy of the official releases, for example, addresses where people live, who are formally registered at the employment office, and subpopulations with low response rates. Before 2000, the LFS was designed as a cross-sectional survey. Since October 1999, the LFS has been conducted as a rotating panel design. Until the redesign in 2010, data in the first wave were collected by means of computer assisted personal interviewing (CAPI). Respondents were re-interviewed four times at quarterly intervals by means of computer assisted telephone interviewing (CATI). During these re-interviews, a condensed questionnaire was used to establish changes in the labour market position of the respondents. In 2010, a major redesign for the LFS started. The main objective of this redesign was to reduce the administration costs of this survey. This is accomplished by changing the data collection in the first wave from CAPI to a mixed data collection mode using CAPI and CATI. Households with a listed telephone number are interviewed by telephone, the remaining households are interviewed face-to-face. To make CATI data collection in the first wave feasible, the questionnaire for the first wave needed to be abridged since a telephone interview, according to data collection literature, should not take longer than 15 to 20 minutes. Therefore, parts of the questionnaire were transferred from the first to the second or the third wave. In 2012, a second major redesign of the LFS took place. Data collection changed to a sequential mixed-mode design that starts with Web interviewing. After three reminders the non-responding households are contacted by telephone if they have a listed telephone number. The remaining households are interviewed face-to-face. It was again necessary to change the questionnaire in all the five waves. The monthly gross sample size for the first wave averaged about 8,000 addresses commencing the moment that the LFS changed to a rotating panel design and gradually fell to about 6,500 addresses in 2012. The response rate is about 55% in the first wave and in the subsequent waves about 90% with respect to the responding households from the preceding wave. After the second redesign in 2012, the monthly sample size in the first wave increased to about 8500 households. Response rates in the first wave vary between 50% and 55%, in the second wave about 70% of the households respond with respect to the responding households from the first wave and in the third, fourth and fifth waves about 90% with respect to the responding households from the preceding wave.

2.2 Survey design after 2021

The new survey design of the Dutch LFS, that is implemented in 2021, changed in several ways. The sample design changed from a stratified two-stage cluster sample of households to a stratified two-stage cluster sample of persons. Strata are formed by the same geographical regions used under the old design. Municipalities are considered as primary and persons as secondary sampling units. The target population is people from 15 to 89 years old living in private households. Under the new design, samples will be drawn on a weekly instead of a monthly basis. Data collection periods for several weekly samples will overlap providing a continuous flow of respondents resulting in optimized distribution of responses during the year. The rotation scheme of the panel remained unchanged. The monthly samples are still observed five times with quarterly intervals.

Each sample unit receives an approach letter where the respondent is asked to participate via an online questionnaire. The internet data collection runs approximately one month for every (weekly) sample with two reminders for non-respondents. After the internet data collection phase non-respondents will be approached by CATI or CAPI. The CATI and CAPI data collection of the first wave sample is targeted at specific non-respondents, meaning not all internet non-respondents will be contacted. Groups that respond poorly in the internet data collection phase are targeted more heavily via CATI and CAPI. This way, the differences between response percentages for distinguished groups will be minimized and the combined respondents of all modes will be more representative of the target population. Availability of a telephone number of sufficient quality is the deciding criterion in the assignment procedure to CATI or CAPI. The CATI data collection starts immediately after the internet data collection phase. This means there will also be 52 CATI portions throughout the year creating a continuous response inflow. The CAPI data collection phase is carried out on a monthly base. Due to Covid-19 restrictions the CAPI field work could not be carried out in the first half of 2021 and from mid-December to mid-January.

Respondents from the first wave which are younger than 75 will be approached for the second wave approximately 3 months after responding for the first wave regardless of the mode by which they responded. All respondents in a specific week continue to the next wave where they will be combined in a portion for the second wave. In short, data collection for follow up waves will also start on a weekly basis. This means there will also be 52 portions for the follow up waves throughout the year once again contributing to an evenly inflow of responses. In the follow-up waves, respondents are firstly asked again to participate in the online questionnaire and non-respondents will be approached by CATI if a telephone number is available (which was asked for at the end of the first wave). The same data collection process is repeated for the third, fourth and fifth wave. The sample size is calculated in such a way that it can be expected to have 4 thousand persons responding in the fifth wave of the LFS.

3. Time series model for official monthly labour force figures

Since June 2010, Statistics Netherlands uses a multivariate structural time series (STS) model for the production of monthly labour force figures. The Labour Force Survey (LFS) is based on a rotating panel design. Each month a new sample enters the panel. This sample is observed five times at quarterly intervals. After the fifth interview round, the sample leaves the panel. The sample observed for the jth time is further shortly denoted as the jth wave. As a result of the rotation scheme, each month data are collected in five independent samples, i.e. the sample of the first wave that enters the panel for the first time, the sample the second wave that entered the panel three months ago and that is observed for the second time, the sample of the third wave that entered the panel six months ago and is observed for the third time, etc. Let $\hat{y}_t^{[j]}$ denote the general regression (GREG) estimator for an unknown population parameter in month t, based on the sample that is observed for the jth time. As a result, each month, a five GREG estimates are observed that con be collected in a five dimensional vector, say $\hat{\boldsymbol{y}}_t = (\hat{y}_t^{[1]}, \dots, \hat{y}_t^{[5]})'$. From this, a five dimensional time series can be constructed, which is the input of the following STS model:

$$\hat{\boldsymbol{y}}_t = \mathbf{1}_{[5]}\theta_t + \boldsymbol{\lambda}_t + \boldsymbol{\Delta}_t^1\boldsymbol{\beta}_t^1 + \boldsymbol{\Delta}_t^2\boldsymbol{\beta}_t^2 + \boldsymbol{\delta}_t^{COV}\beta^{COV} + \boldsymbol{\varepsilon}_t. \qquad (1)$$

This is an extension of the model proposed by Pfeffermann (1991). The six components in STS model (1) can be motivated as follows. In the first component θ_t denotes the unknown population parameter and $\mathbf{1}_{[5]}$ a five dimensional column vector with each element equal to one. This component states that $\hat{\boldsymbol{y}}_t$ contain five GREG estimates for the population parameter in month t. The population parameter is modelled with a so-called basic STM, i.e.

$$\theta_t = L_t + S_t + I_t, \qquad (2)$$

with L_t a time-varying or dynamic trend model for the low frequency variation in the series of the population parameter, S_t a dynamic seasonal model for the monthly effects in the series and I_t a white noise component for the unexplained variation of the population parameter. For L_t the so-called smooth trend model and for S_t the trigonometric seasonal model are used, see Durbin and Koopman 2012, Ch. 3 for details. This first component is used as a form of small area estimation (Rao and Molina, 2015), since it uses sample information observed in previous reference periods to make more stable and accurate estimates for the monthly labour force figures.

The second component in (1), i.e. $\boldsymbol{\lambda}_t$, models the rotation group bias (RGB) induced by the rotating panel design. RGB refers to the phenomena that there are systematic differences between the outcomes of the waves of the panel (Bailar, 1974), which are the net result of differences in questionnaire and data collection

modes applied in the different waves, panel attrition and panel effects. In this application it is assumed that the first wave is free from RGB and thus gives the most reliable estimates for θ_t, see Van den Brakel and Krieg (2009) for a motivation. The other four components contain random walks, denoted $\lambda_t^{[j]}$ ($j = 2, \ldots, 5$), and model the systematic difference between the first wave and the four follow-up waves. As a result, $\boldsymbol{\lambda}_t = (0, \lambda_t^{[2]}, \lambda_t^{[3]}, \lambda_t^{[4]}, \lambda_t^{[5]})'$. Since the RGB of the first wave equals zero, the time series model estimates for θ_t are benchmarked to the level of the GREG series in the first wave. The differences between the first wave and the follow-up waves can gradually change over time since they are modelled with random walks.

The third and fourth component model the discontinuities in the input series that are a result of two major survey redesigns that took place in 2010 and 2012, respectively. The discontinuities are modelled with level interventions, i.e. $\boldsymbol{\Delta}_t^i = diag(\delta_t^{i,[1]}, \delta_t^{i,[2]}, \delta_t^{i,[3]}, \delta_t^{i,[4]}, \delta_t^{i,[5]})$, which denotes a diagonal matrix with dummy variables $\delta_t^{i,[j]}$ that change from zero to one at the moment that the survey in wave j changes from the old to the new design during redesign $i = 1$ in 2010 and $i = 2$ in 2012. Furthermore, $\boldsymbol{\beta}_t^i$ are five dimensional vectors that contain estimates for the discontinuities in the five waves during redesign $i = 1$ in 2010 and $i = 2$ in 2012. For the first redesign $\boldsymbol{\beta}_t^1 = (\beta_t^{1,[1]}, \beta^{1,[2]}, \beta^{1,[3]}, \beta^{1,[4]}, \beta^{1,[5]})'$, where $\beta^{1,[j]}$ denotes the discontinuity of the first redesign in wave j. During the redesign in 2010, the old and new design in the first wave were conducted in parallel for a period of six month. Estimates for the discontinuities in the first wave are derived from the differences between the GREG estimates under the old and new design. During the months of the parallel run the estimates for the discontinuities are equal to the differences between the GREG estimates under the old and new design in that particular month. For the months after the parallel run, the discontinuity in the first wave is equal to the average over the six monthly discontinuities observed during the parallel run. Therefore $\beta_t^{1,[1]}$ is time dependent. These estimates are treated in the time series model as a-priori known values. This resulted in the most smooth transition from the old the new design, Van den Brakel and Krieg (2015). For the other follow-up waves discontinuities are estimated with the time series model and are assumed to be constant in time, i.e. $\beta^{1,[j]}$ for $j = 2, \ldots, 5$. During the redesign in 2012, the old and new design in the first and the second wave were conducted in parallel for a period of six month. Similar to the first redesign, the discontinuities in the first two waves are derived from the differences between the GREG estimates under the old and new design and are equal to the monthly observed differences during the parallel run. For the months after the parallel run, the discontinuity is equal to the average over the six monthly discontinuities. The discontinuities in the other three follow-up waves are estimated with the time series model and assumed to be constant in time. As a result, it follows for the second redesign that the discontinuities for the first two waves are time dependent and the last three waves time-invariant, i.e. $\boldsymbol{\beta}_t^2 = (\beta_t^{2,[1]}, \beta_t^{2,[2]}, \beta^{2,[3]}, \beta^{2,[4]}, \beta^{2,[5]})'$.

The fifth component in (1) contains a correction for the loss of capi respondents in the first wave during the lockdown of the corona crisis in 2020 and 2021. For this component, $\boldsymbol{\delta}_t^{COV} = (\delta_t^{cov}, 0, 0, 0, 0)'$ is a five dimensional vector that contains a

level intervention for the first wave only. The indicator δ_t^{cov} is equal to one during the months of the lockdown without capi respondents and zero otherwise. The coefficient β^{COV} is an approximation of the systematic difference in the first wave that arises as a result of the loss of capi in the first wave. To obtain an estimate for β^{COV}, the input series of GREG estimates for the first wave are recalculated using the web and cati respondents only, for the period from 2012 until the start of the first lockdown in April 2021. Both series with and without capi respondents are combined in a separate time series model to derive an estimate for β^{COV}. This estimate is used as an a-priori known value in (1), similar to the discontinuity estimates based on the parallel runs. See Van den Brakel et al. (2021) for more details how the model for the production of monthly labour force figures is adapted to the effects of the covid-19 crisis.

The sixth component in (1) is a time series model for the survey errors that accommodate heteroscedasticity due to e.g. varying sample sizes over time and serial correlation which is a result of the partial sample overlap of the rotating panel design. The sampling errors are stacked in a five dimensional vector $\boldsymbol{\varepsilon}_t = (\varepsilon_t^{[1]}, \varepsilon_t^{[2]}, \varepsilon_t^{[3]}, \varepsilon_t^{[4]}, \varepsilon_t^{[5]})'$. To account for heteroscedasticity, the sampling errors are scaled with the standard errors of the GREG estimates of the input series, i.e. $\varepsilon_t^{[j]} = \sqrt{var(\hat{y}_t^{[j]})}\tilde{\varepsilon}_t^{[j]}$. The standard errors of the GREG estimates are estimated from the survey data. The scaled sampling error for the first wave, i.e. $\tilde{\varepsilon}_t^{[j]}$, is a normally and independently distributed error term that is not correlated with past observations, since the first wave is observed for the first time. The scaled sampling errors of the follow-up waves are modeled with an AR(1) model to accommodate serial correlation with past observations. See Van den Brakel and Krieg (2015) for details.

The general way to fit Model (1), is to express the model in the so-called state space representation and apply the Kalman filter to obtain optimal estimates for the state variables, see e.g. Durbin and Koopman (2012). State variables are the variables that define the different components in the STM (1), like the level of the trend, the variables that define the seasonal effects, the RGB etc. Filtered estimates for state variables for period t are based on the information available up to and including period t, i.e. the time series $\widehat{\boldsymbol{y}}_t$ observed from $t = 1, \ldots, t$. The filtered estimates of past state vectors can be updated if new data become available. This procedure is referred to as smoothing and results in smoothed estimates that are based on the completely observed time series. In this application, interest is mainly focused on the filtered estimates, since they are based on the complete set of information that is available in the regular production process to produce a model-based estimate for month t. The analysis is conducted with software developed in OxMetrics in combination with the subroutines of SsfPack 3.0, see Doornik (2009) and Koopman et al. (2008). All state variables are non-stationary with the exception of the survey errors. The non-stationary variables are initialized with a diffuse prior, i.e. the expectation of the initial states are equal to zero and the initial covariance matrix of the states is diagonal with large diagonal elements. The survey errors are stationary and therefore initialized with a proper prior. The initial values for the survey errors are equal to zero and the covariance matrix is available from the aforementioned

model for the survey errors. The hyperparameters of the state space model, i.e. the variances of the disturbance terms of the stochastic models used for the state variables, are estimated with maximum likelihood, see Durbin and Koopman (2012). In Ssfpack 3.0, an exact diffuse log-likelihood function is obtained with the procedure proposed by Koopman (1997).

Population parameters estimated by the time series model are the unemployed labour force, employed labour force and the total labour force. These three parameters are estimated at the national level and a break down in six domains that is based on the cross classification of gender and age in three classes. Parameters of interest are the trend (L_t) and the signal. The latter is defined as the trend plus the seasonal component ($L_t + S_t$). These estimates are corrected for discontinuities. Until the end of 2012, official publication were based on the survey design that was used until 2010, i.e. the published trends were defined as L_t and the signals as $L_t + S_t$. In 2013 the publications changed to the level of the survey design that is implemented in 2012, i.e. the published trends were defined as $L_t + \beta_t^{1,[1]} + \beta_t^{2,[1]}$ and the signals as $L_t + S_t + \beta_t^{1,[1]} + \beta_t^{2,[1]}$. It is understood that official monthly publications were never based on the intermediate survey design that was used in the period from 2010 until 2012.

4. Extension of the time series model for the transition to the new design

For the change over to the new design the following transition plan was initially developed (Van den Brakel and Das, 2020). As explained in Section 2, a parallel run for the first wave was planned for the last quarter of 2020. In January 2021, data collection in the first wave would change from the old to the new design. Subsequently the new design would be gradually phased in, in the follow up waves according to the rotating panel design of the LFS. That means that the second wave would change from the old to the new design in April 2021, the third wave July 2021, etc. It was foreseen that until June, publication would be based on the level of the old design and that in June 2021 the publications would change to the level of the new design. According to the simulations conducted in Van den Brakel and Das (2020), this would result in the most smooth transition, conditionally that there is budget for a parallel run of three months.

Due to the lockdown, no capi data collection was possible in the first two quarters of 2021. The transition to a new design during this period results in an increased risk of incorrectly estimating the development of monthly labour force figures because, for example, real turning points as a result of the lockdown would coincide with the discontinuities that are a result of the transition to the new design. Therefore it was decided to continue data collection in the first wave under the old design in the first two quarters of 2021. This eventually resulted in a parallel run of nine months, with the limitation that the parallel run in the first two quarters of 2021 is conducted without capi.

Based on these new conditions the transition plan was adapted as follows. Data collection under the old design in the first wave stopped in July 2021. For the production of official monthly labour force figures from July 2021 on, the input series for the first wave are based on the estimates observed under the new design from January 2021. Similar to the initial plan, the new design is gradually phased in, in the follow up waves according to the rotating panel design of the LFS. Thus for the second wave, the input series change from the old to the new design in April 2021, the third wave in July 2021, etc. With the available parallel run of nine months, the discontinuities as a result of the change over from the old design with capi to the new design without capi can be estimated accurately. An extended version of the time series model from Section 4.1, which will be detailed below, is used during the third and fourth quarter of 2021 to produce official monthly labour force figures at the level of the old design with a correction for the loss of capi.

During the third and fourth quarter of 2021 data in the first wave of the new design are collected with capi. These data are used to estimate the effect for the

loss of capi in the first wave under the new design. It is anticipated that in January 2022, sufficient data are available to estimate the systematic effect that arise as a result of the loss of capi in the first wave under the new design. This information is used to make an adjustment in the estimated discontinuities that are a result of the change-over from the old design with capi to the new design without capi, observed with the aforementioned parallel run. In this way in January 2022 estimates for the discontinuities that are a result of the change-over from the old design with capi to the new design with capi are obtained. In January 2022 the official monthly labour force figures will published at the level of the new design (with capi in the first wave).

To facilitate this transition plan, the time series model (1) is extended with an additional component to model the discontinuities that are a result of the change over to the new design. This extended model is defined as

$$\widehat{\boldsymbol{y}}_t = \mathbf{1}_{[5]}\theta_t + \boldsymbol{\lambda}_t + \boldsymbol{\Delta}_t^1\boldsymbol{\beta}_t^1 + \boldsymbol{\Delta}_t^2\boldsymbol{\beta}_t^2 + \boldsymbol{\delta}_t^{COV}\beta^{COV} + \boldsymbol{\Delta}_t^3\boldsymbol{\beta}_t^3 + \boldsymbol{\varepsilon}_t. \qquad (3)$$

The new component is defined similarly as the third and fourth component of model (1) discussed in Section 4.1. Matrix $\boldsymbol{\Delta}_t^3 = diag(\delta_t^{3,[1]}, \delta_t^{3,[2]}, \delta_t^{3,[3]}, \delta_t^{3,[4]}, \delta_t^{3,[5]})$, denotes a diagonal matrix with level intervention variables $\delta_t^{3,[j]}$ that change from zero to one at the moment that the survey in wave j changes from the old to the new design during redesign. For example, $\delta_t^{3,[1]}$ switches from zero to one in January 2021 since this is the moment that the new design is implemented in the first wave. Similarly $\delta_t^{3,[2]}$ switched from zero to one in April 2021, $\delta_t^{3,[3]}$ in July 2021, etc. Furthermore, $\boldsymbol{\beta}_t^3 = (\beta_t^{3,[1]}, \beta^{3,[2]}, \beta^{3,[3]}, \beta^{3,[4]}, \beta^{3,[5]})'$ contain estimates for the discontinuities in the five waves during the redesign. For the first wave, $\beta_t^{3,[1]}$ is based on the parallel run from October 2020 until June 2021. From January 2021 until June 2021 the estimate for the discontinuity is equal to the monthly observed differences of the two GREG estimates. For the months after the parallel run, the discontinuity in the first wave is equal to the average over the nine monthly discontinuities observed during the parallel run. Therefore $\beta_t^{3,[1]}$ is time dependent as in the case of the previous two redesigns. These estimates are, similarly to the previous redesigns, treated in the time series model as a-priori known values. The discontinuities in the four follow-up waves are estimated with the time series model and assumed to be constant in time.

For the publication of monthly labour force figures from July 2021 until December 2021, $\beta_t^{3,[1]}$ contain the estimated discontinuities for the transition from the old design with capi to the new design without capi. The input series of the first wave contains from January 2021 the GREG estimates obtained with the new design without capi respondents. Model (3) is applied to estimate monthly labour force figures at the level of the old design (including capi).

For the publication of monthly labour force figures from January 2022 on, $\beta_t^{3,[1]}$ contain the estimated discontinuities for the transition from the old design with capi to the new design with capi. From this moment on, the input series of the first

wave contains from January 2021 the GREG estimates obtained with the new design with capi respondents. For the period January 2021 until June 2021, the GREG estimates for the first wave are corrected for the loss of capi (see Section 4.3). Model (3) is applied to estimate monthly labour force figures at the level of the new design (including capi).

5. Results

As explained in Section 4.2, the change over to the new design is extended from January 2021 to July 2021. As a result the first wave is conducted in parallel for a period of nine months, were data collection in the first two quarters of 2021 is without capi. In July 2021, discontinuities from the old design with capi to the new design without capi in the first wave were calculated based on the parallel run from October 2020 until June 2021. A correction is applied to the GREG estimates under the old design for the first two quarters of 2021, which is based on β^{COV} in the fifth component of the time series model (1), see Section 4.1 for details. Results are presented in Table 4.1 for the unemployed labour force, Table 4.2 for the employed labour force, and Table 4.3 for the total labour force. Results are presented for the figures published at a monthly basis, i.e. the national level and the six domains based on the classification of gender and age in three classes. These estimates are used in Model (3) to identify $\beta_t^{3,[1]}$ for the period from July 2021 to December 2021 to produce official monthly labour force figures at the level of the old design. For the period January 2021 until June 2021, $\beta_t^{3,[1]}$ is equal to the observed discontinuity for that particular month. From June 2021, $\beta_t^{3,[1]}$ is equal to the average of the discontinuities over the nine months, specified in the last column of Tables 4.1, 4.2 and 4.3. During July 2021 until December 2021, the input series of the first are, from Januari 2021 on, the GREG estimates without capi. The model uses the discontinuity estimates from Tables 4.1 until 4.3 to account for the discontinuity from the old design with capi to the new design without capi, to publish monthly labour force figures at the level of the old design.

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	Average
National	96	105	62	191	90	167	97	74	92	108
	(38)	(39)	(39)	(40)	(46)	(38)	(44)	(44)	(39)	(15)
M15-24	16	30	-3	38	-18	46	19	26	49	23
	(15)	(14)	(17)	(17)	(19)	(15)	(17)	(21)	(16)	(6)
W15-24	35	28	0	31	9	14	16	25	17	20
	(16)	(15)	(16)	(16)	(17)	(16)	(17)	(19)	(16)	(6)
M25-44	22	-5	-27	7	48	-4	-3	-17	-20	0
	(17)	(18)	(20)	(17)	(23)	(16)	(20)	(18)	(17)	(7)
W25-44	5	12	43	57	27	32	27	1	24	25
	(19)	(17)	(16)	(18)	(18)	(18)	(17)	(20)	(17)	(7)
M45-74	6	15	13	35	30	31	11	25	21	21
	(14)	(18)	(15)	(15)	(21)	(14)	(15)	(14)	(16)	(6)
W45-74	13	24	36	24	-5	46	27	13	1	20
	(15)	(14)	(14)	(17)	(16)	(15)	(22)	(15)	(14)	(6)

Table 4.1: Discontinuities unemployed labour force from old design with capi to new design without capi with standard errors in brackets. Abbreviations: m: men, w: women, numbers refer to age class.

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	Average
National	173	211	183	145	127	264	368	324	39	204
	(76)	(84)	(88)	(83)	(88)	(87)	(91)	(94)	(98)	(33)
M15-24	59	92	113	64	146	51	91	99	-46	74
	(29)	(30)	(31)	(30)	(32)	(29)	(33)	(38)	(35)	(12)
W15-24	78	89	107	118	83	127	104	112	90	101
	(27)	(28)	(30)	(29)	(31)	(30)	(31)	(32)	(35)	(11)
M25-44	-12	42	72	50	-33	80	101	11	15	36
	(27)	(33)	(31)	(29)	(32)	(30)	(34)	(37)	(33)	(12)
W25-44	46	20	-56	-42	-5	18	27	15	-4	2
	(34)	(36)	(38)	(35)	(39)	(35)	(40)	(40)	(40)	(14)
M45-74	30	-7	-37	-27	-88	-43	22	-40	12	-20
	(44)	(48)	(46)	(46)	(49)	(51)	(51)	(50)	(56)	(18)
W45-74	-29	-25	-16	-18	23	31	22	127	-28	10
	(42)	(50)	(51)	(46)	(51)	(46)	(53)	(54)	(56)	(19)

Table 4.2: Discontinuities employed labour force from old design with capi to new design without capi with standard errors in brackets. Abbreviations: m: men, w: women, numbers refer to age class.

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	Average
National	269	317	245	337	218	431	465	398	131	312
	(73)	(82)	(87)	(80)	(87)	(85)	(91)	(91)	(96)	(32)
M15-24	75	123	110	102	128	97	110	125	3	97
	(27)	(29)	(30)	(28)	(30)	(28)	(31)	(35)	(33)	(11)
W15-24	113	118	107	149	93	141	121	138	107	121
	(25)	(27)	(29)	(27)	(29)	(28)	(30)	(30)	(34)	(11)
M25-44	10	37	44	58	15	75	98	-6	-5	36
	(24)	(29)	(26)	(26)	(26)	(27)	(30)	(34)	(30)	(11)
W25-44	51	32	-13	14	22	51	54	16	20	27
	(31)	(33)	(36)	(32)	(36)	(33)	(38)	(37)	(38)	(13)
M45-74	36	8	-24	8	-58	-11	33	-15	33	1
	(43)	(47)	(46)	(46)	(48)	(50)	(50)	(50)	(55)	(18)
W45-74	-16	-2	21	6	17	78	49	140	-27	30
	(42)	(49)	(51)	(46)	(50)	(46)	(54)	(53)	(55)	(19)

Table 4.3: Discontinuities total labour force from old design with capi to new design without capi with standard errors in brackets. Abbreviations: m: men, w: women, numbers refer to age class.

In the last two quarter of 2021 capi data collection was started up again. The data collected in the first wave under the new design in the period October 2020 until December 2020 and July 2021 until December 2021 are used to make an estimate for the systematic effect of the loss of capi. This is done by recalculating the monthly labour force figures without capi respondents and subsequently calculate the average over the difference between the monthly GREG estimates with and without capi responses. A similar correction is applied to the GREG estimates under the old design, but this correction is based on β^{COV} in the fifth component of the time series model (1). These differences are used to correct the

discontinuities in the parallel run during the period January 2021 until June 2021, to obtain discontinuity estimates that are the result of the change over from the old design with capi to the new design with capi. Results are presented in Table 4.4 for the unemployed labour force, Table 4.5 for the employed labour force and Table 4.6 for the total labour force. The results in these tables are based on the observations obtained until October 2021 and are therefore subject to revisions, once the data of November and December become available.

The correction for the loss of capi is very small, which can be seen if the discontinuity estimates in Tables 4.1, 4.2 and 4.3 are compared with the estimates in Tables 4.4, 4.5 and 4.6. This is in line with the results for the corrections for the loss of capi respondents under the old design in the time series, i.e. β^{COV} in the fifth component of model (1) and (3), see Van den Brakel at al. (2021) for details.

From January 2022 on, monthly labour force figures are published at the level of the new design. From this moment on, the discontinuity estimates from Tables 4.4, 4.5 and 4.6 will be used in Model (3) to identify $\beta_t^{3,[1]}$. From this moment on, the input series of the first are, from Januari 2021 on, the GREG estimates with capi. It is understood that for the first two quarters of 2021 an adjustment is applied to correct for the loss of capi during this period. This is the similar correction that is used for the loss of capi respondents under the new design in the analysis of the parallel run described above. The model use the discontinuity estimates from Tables 4.4 until 4.4 to account for the discontinuity from the old design with capi to the new design with capi, to publish monthly labour force figures at the level of the new design.

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	Aver.
Nat.	83	141	52	189	86	163	93	70	97	108
	(36)	(39)	(39)	(40)	(46)	(38)	(44)	(44)	(39)	(15)
M15-24	22	41	-4	40	-16	48	21	28	55	26
	(15)	(15)	(17)	(17)	(19)	(15)	(17)	(21)	(16)	(6)
W15-24	23	33	-4	29	7	12	14	23	13	16
	(15)	(15)	(16)	(16)	(17)	(16)	(17)	(19)	(16)	(6)
M25-44	19	11	-27	8	49	-3	-2	-16	-13	3
	(16)	(19)	(20)	(17)	(23)	(16)	(20)	(18)	(17)	(7)
W25-44	-4	20	43	54	25	30	25	-1	21	24
	(17)	(17)	(16)	(18)	(18)	(18)	(17)	(20)	(17)	(7)
M45-74	13	14	11	35	30	32	11	26	18	21
	(14)	(18)	(14)	(15)	(21)	(14)	(15)	(14)	(15)	(6)
W45-74	9	22	33	21	-7	44	25	11	2	18
	(14)	(14)	(13)	(17)	(16)	(15)	(22)	(15)	(15)	(6)

Table 4.4: Discontinuities unemployed labour force from old design with capi to new design with capi with standard errors in brackets. Abbreviations: m: men, w: women, numbers refer to age class.

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	Aver.
Nat.	171	112	164	115	97	234	337	293	-33	165
	(75)	(83)	(88)	(83)	(88)	(87)	(91)	(94)	(97)	(33)
M15-24	48	64	108	50	132	372	77	85	-66	59
	(29)	(30)	(32)	(30)	(32)	(29)	(33)	(38)	(35)	(12)
W15-24	79	76	112	117	83	126	104	112	92	100
	(27)	(28)	(30)	(29)	(31)	(30)	(31)	(32)	(35)	(11)
M25-44	-10	11	54	42	-41	71	93	3	-11	24
	(27)	(33)	(31)	(29)	(32)	(30)	(34)	(37)	(33)	(12)
W25-44	28	-7	-62	-53	-15	8	17	5	-35	-13
	(33)	(36)	(38)	(35)	(39)	(35)	(40)	(40)	(40)	(14)
M45-74	24	-6	-41	-29	-90	-45	20	-42	12	-22
	(43)	(47)	(46)	(46)	(49)	(51)	(51)	(50)	(56)	(18)
W45-74	2	-25	-8	-13	27	36	27	131	-24	17
	(42)	(50)	(50)	(46)	(51)	(46)	(53)	(54)	(55)	(19)

Table 4.5: Discontinuities employed labour force from old design with capi to new design with capi with standard errors in brackets. Abbreviations: m: men, w: women, numbers refer to age class.

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	Aver.
Nat.	253	253	216	302	183	396	430	363	64	273
	(73)	(82)	(87)	(80)	(87)	(85)	(91)	(91)	(96)	(32)
M15-24	70	105	104	89	116	85	91	112	-11	85
	(26)	(29)	(30)	(28)	(30)	(28)	(31)	(35)	(33)	(11)
W15-24	102	108	108	146	90	138	117	135	105	117
	(25)	(27)	(28)	(27)	(29)	(28)	(30)	(30)	(34)	(11)
M25-44	9	21	27	51	8	68	91	-13	-24	27
	(23)	(29)	(27)	(26)	(26)	(27)	(30)	(34)	(30)	(11)
W25-44	24	13	-19	2	10	38	41	3	-14	11
	(31)	(33)	(36)	(32)	(36)	(33)	(38)	(37)	(38)	(13)
M45-74	37	8	-29	6	-60	-13	31	-17	30	-1
	(42)	(47)	(45)	(46)	(48)	(50)	(50)	(50)	(55)	(18)
W45-74	11	-3	25	8	20	80	51	142	-23	35
	(41)	(49)	(50)	(46)	(50)	(46)	(54)	(53)	(54)	(19)

Table 4.6: Discontinuities total labour force from old design with capi to new design with capi with standard errors in. Abbreviations: m: men, w: women, numbers refer to age class.

Estimates for the discontinuities for the follow-up waves are obtained with the time series model. Filtered estimates for the discontinuities for wave 2 and 3 for the unemployed labour force at the national level are given in Figures 4.1 and 4.2 for the period from January 2021 until December 2021. It can be seen that directly after the change over to the new design (April 2021 for the second wave and July 2021 for the third wave) the filtered estimates for the discontinuities are instable. As a result the filtered estimates are substantially revised if a new observations becomes available. For the second wave, it appears that the discontinuity estimate tends to stabilize around a value of 100,000. The size and direction of the

discontinuity in the second wave is comparable with the discontinuity of the first wave. The discontinuity of the third wave is somewhat smaller.

Similar plots are provided for the discontinuity estimates in the second and third wave of the employed labour force in Figures 4.3 and 4.4. The discontinuities have the same direction as the discontinuity estimates in the first wave. The values are, however, smaller. Similar interpretations hold for the discontinuity estimates for the second and third wave of the total labour force, which are presented in Figures 4.5 and 4.6 respectively.

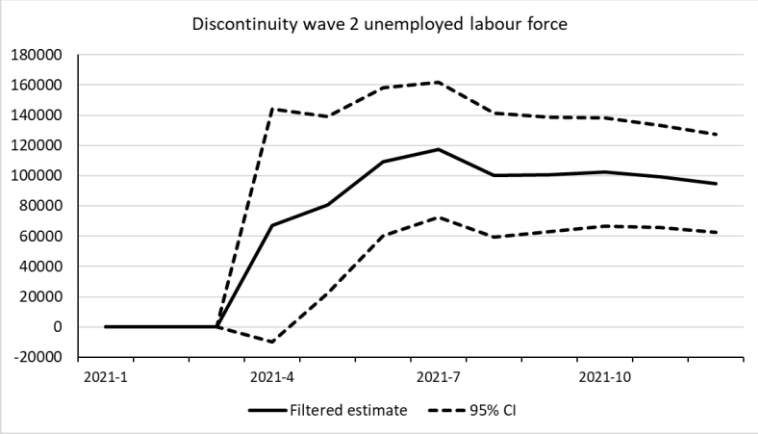

Figure 4.1: Kalman filter estimate discontinuity in wave 2 for the unemployed labour force at the national level with a 95% confidence interval from January 2021 until December 2021

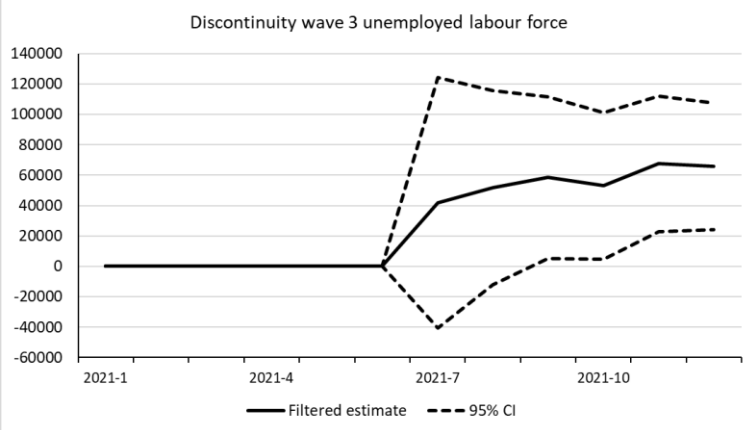

Figure 4.2: Kalman filter estimate discontinuity in wave 3 for the unemployed labour force at the national level with a 95% confidence interval from January 2021 until December 2021

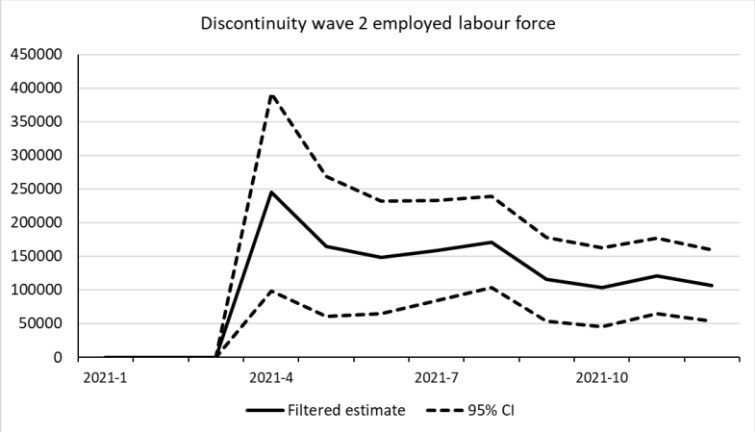

Figure 4.3: Kalman filter estimate discontinuity in wave 2 for the employed labour force at the national level with a 95% confidence interval from January 2021 until December 2021

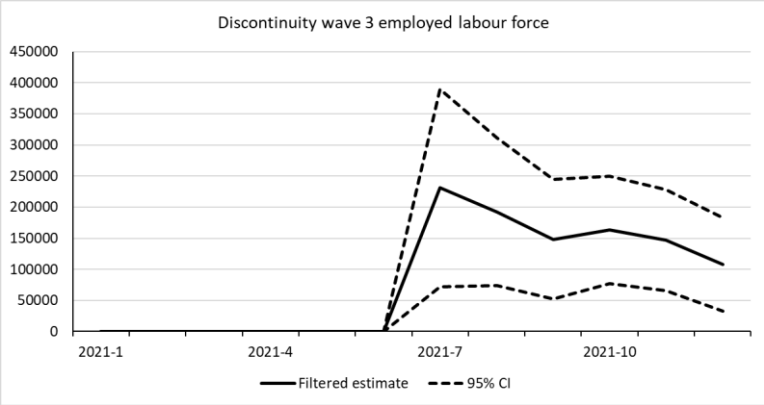

Figure 4.4: Kalman filter estimate discontinuity in wave 3 for the employed labour force at the national level with a 95% confidence interval from January 2021 until December 2021

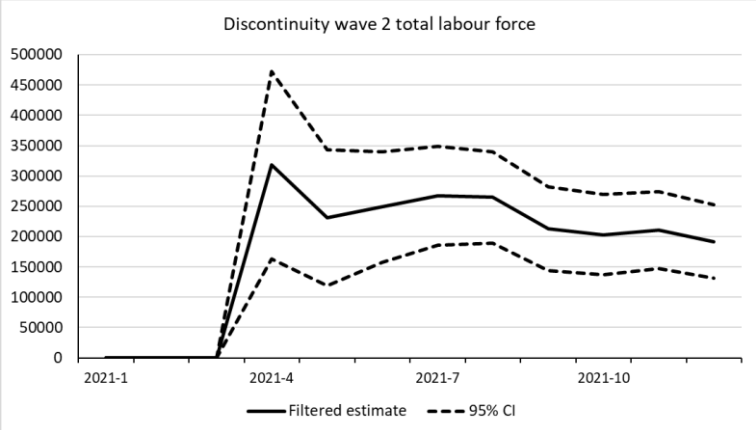

Figure 4.5: Kalman filter estimate discontinuity in wave 2 for the total labour force at the national level with a 95% confidence interval from January 2021 until December 2021

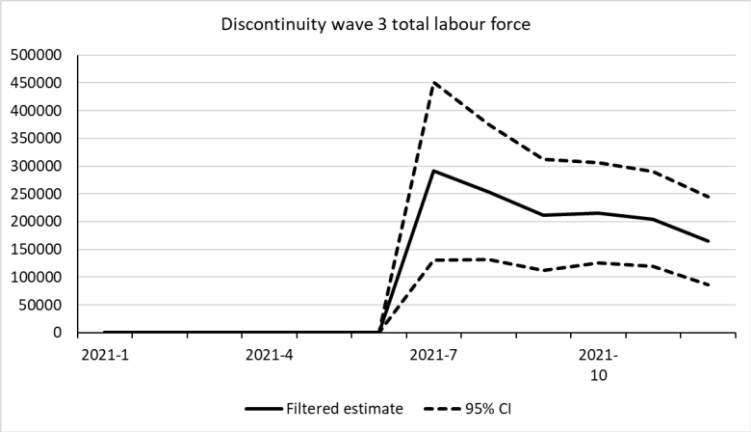

Figure 4.6: Kalman filter estimate discontinuity in wave 3 for the total labour force at the national level with a 95% confidence interval from January 2021 until December 2021

Monthly estimates for trend and signal are now obtained with Model (3). Estimates for trend and signal at the level of the old design (i.e. the survey process that is used from 2012 until the end of 2020) are defined as $L_t + \beta_t^{1,[1]} + \beta_t^{2,[1]}$ and the signals as $L_t + S_t + \beta_t^{1,[1]} + \beta_t^{2,[1]}$. Estimates for trend and signal at the level of the new design (i.e. the survey process that is used from January 2021) are defined as $L_t + \beta_t^{1,[1]} + \beta_t^{2,[1]} + \beta_t^{3,[1]}$ and the signals as $L_t + S_t + \beta_t^{1,[1]} + \beta_t^{2,[1]} + \beta_t^{3,[1]}$.

Figure 4.7 compares the filtered trend under the old and new design for the unemployed labour force at the national level, together with the input series of the five waves for the period January 2003 until December 2021. During the period 2010 until the end of 2020, the trend under the old design is at the level of the GREG series of the first wave (solid black line). The resign in 2010 resulted in a positive discontinuity of about 50,000 for the unemployed labour force and an additional small positive discontinuity as a result of the redesign in 2012. Therefore the trend under the old design is higher than the input series during the period 2003 until 2010. After the change-over to the new design in January 2021, a large positive discontinuity occurs in the GREG series of the first wave. It is clearly visible in the Figure 4.7 that from this moment on, the trend under the old design is smaller than the GREG series of the first wave. The trend under the new design, however, is in line with the level of the GREG series of the first wave for the period after January 2021. The sudden increase of the unemployed labour force at the beginning of 2020 is the result of the corona crisis. In order to give the model sufficient flexibility to capture this strong turning point, the variance of the trend disturbance terms was temporarily increased by multiplying the maximum likelihood estimate for the variance of the trend disturbance terms with a factor larger than one, which value is determined outside the model. This was necessary to avoid temporal misspecification of the time series model. See Van den Brakel et al. (2021) for more details.

Figure 4.8 compares the standard errors of the filtered trends under the old and new design for the period January 2003 until December 2021. During the period 2003 until 2009 there is steady decrease of the standard error, which is the result of accumulating information under the sample design used before 2010. The turning point in 2009 is a result of a reduction of the monthly sample size. The increased uncertainty between 2010 and 2011 is the result of the change-over to a new survey design. In this period the first set of level interventions is activated, i.e. component $\boldsymbol{\Delta}_t^1\boldsymbol{\beta}_t^1$ in Model (3), which resulted in an increased uncertainty of the level of the trend. In April 2011 the implementation of the first redesign was finished. During the period 2011 until 2012 the standard errors gradually decrease, which is the result of accumulating information under this survey design. In 2012 the implementation of the second redesign starts. In this period the second set of level interventions is activated, i.e. component $\boldsymbol{\Delta}_t^2\boldsymbol{\beta}_t^2$ in Model (3), which again resulted in a substantial increase of the uncertainty of the level of the trend. After finalizing the implementation of the second redesign, there is a period of seven years, were the standard error gradually decreases as a result of accumulating information under the survey design that is used between 2012 and 2020. The strong peak in the standard errors in 2020 are the result of increasing the flexibility of the trend model at the start of the corona crisis. In January 2021, the implementation of the new design started, which implies that the third set of level interventions is activated, i.e. component $\boldsymbol{\Delta}_t^3\boldsymbol{\beta}_t^3$ in Model (3). This again results in a strong increase of the uncertainty of the level of the trend.

The same plots are provided for the employed labour force at the national level in Figures 4.9 and 4.10 and for the total labour force at the national level in Figures 4.11 and 4.12.

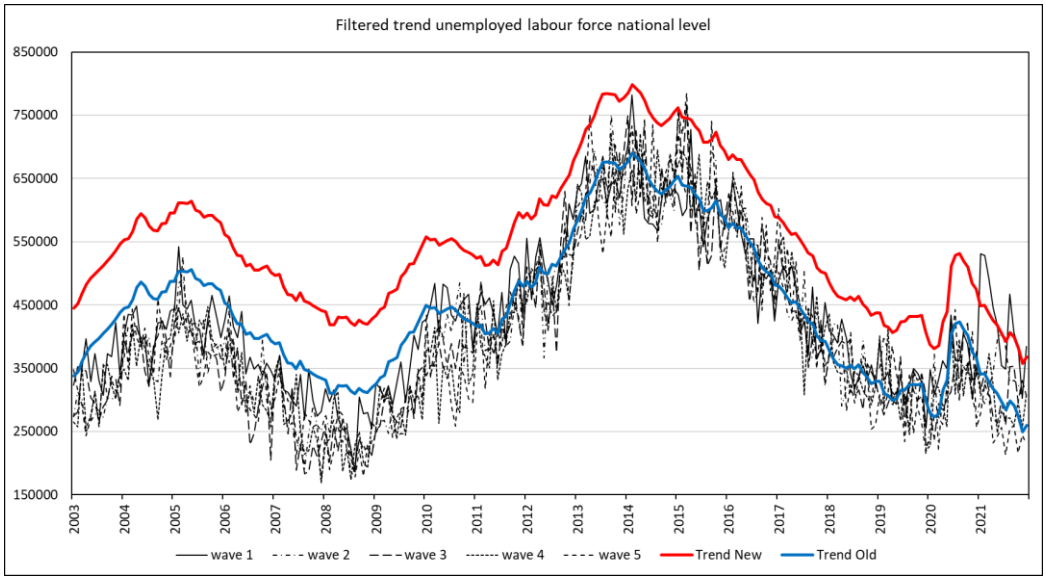

Figure 4.7: Filtered trend under the old and new design with the five input series of GREG estimates observed in the five waves of the panel for the unemployed labour force at the national level for the period January 2003 until December 2021

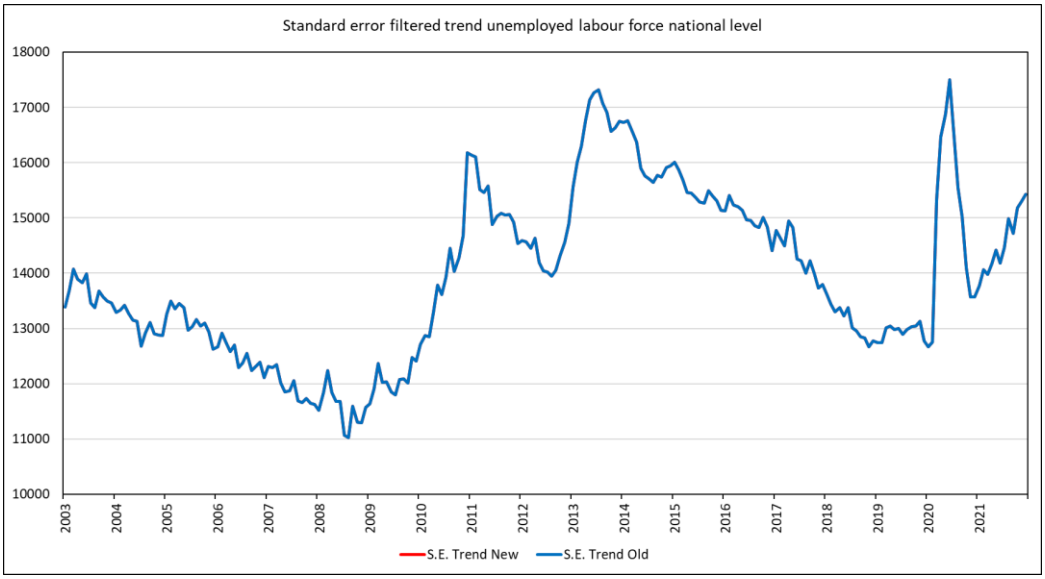

Figure 4.10: Standard errors filtered trend under the old and new design for the unemployed labour force at the national level for the period January 2003 until December 2021

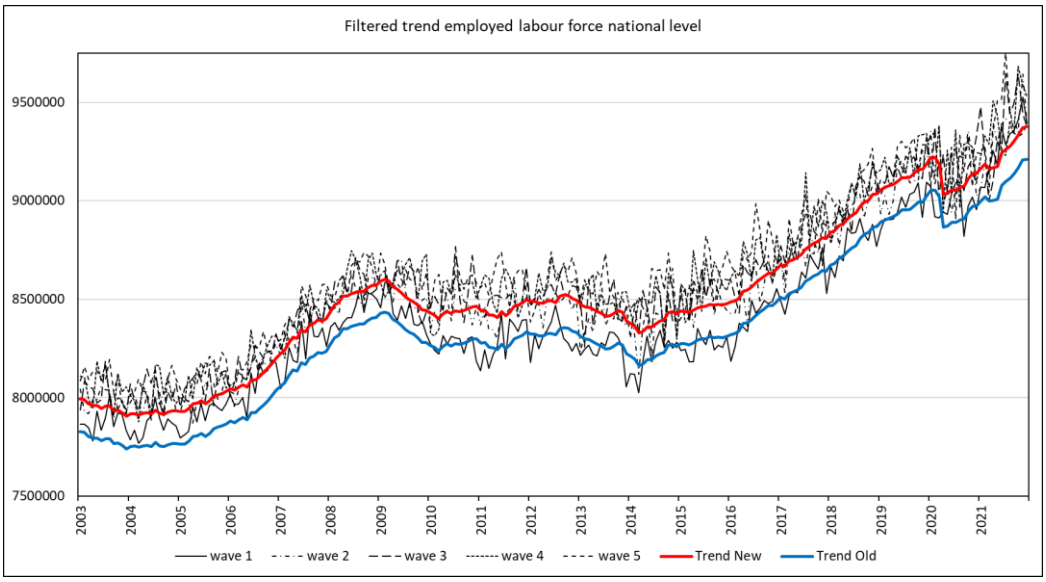

Figure 4.9: Filtered trend under the old and new design with the five input series of GREG estimates observed in the five waves of the panel for the employed labour force at the national level for the period January 2003 until December 2021

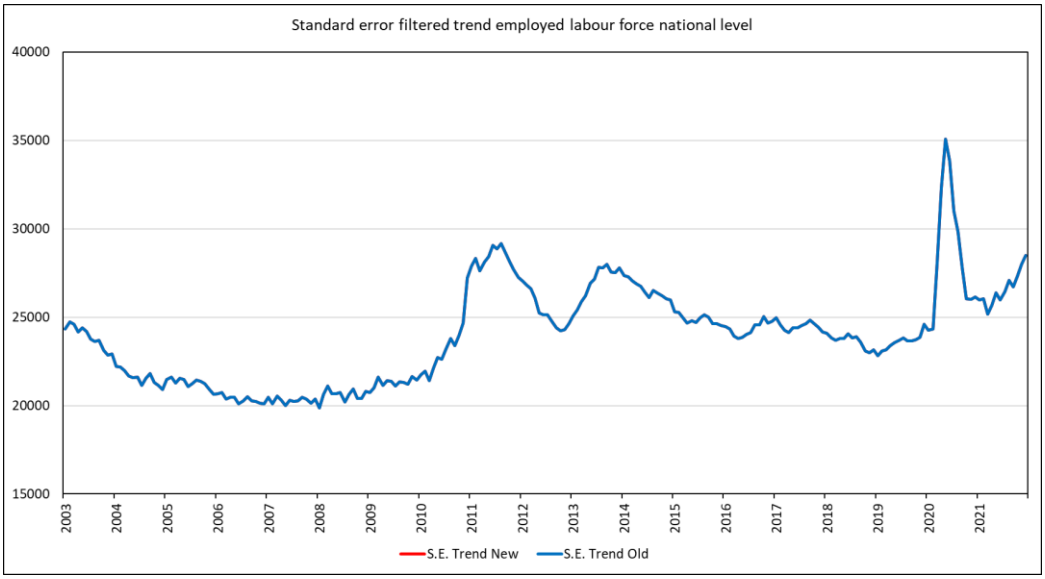

Figure 4.12: Standard errors filtered trend under the old and new design for the employed labour force at the national level for the period January 2003 until December 2021

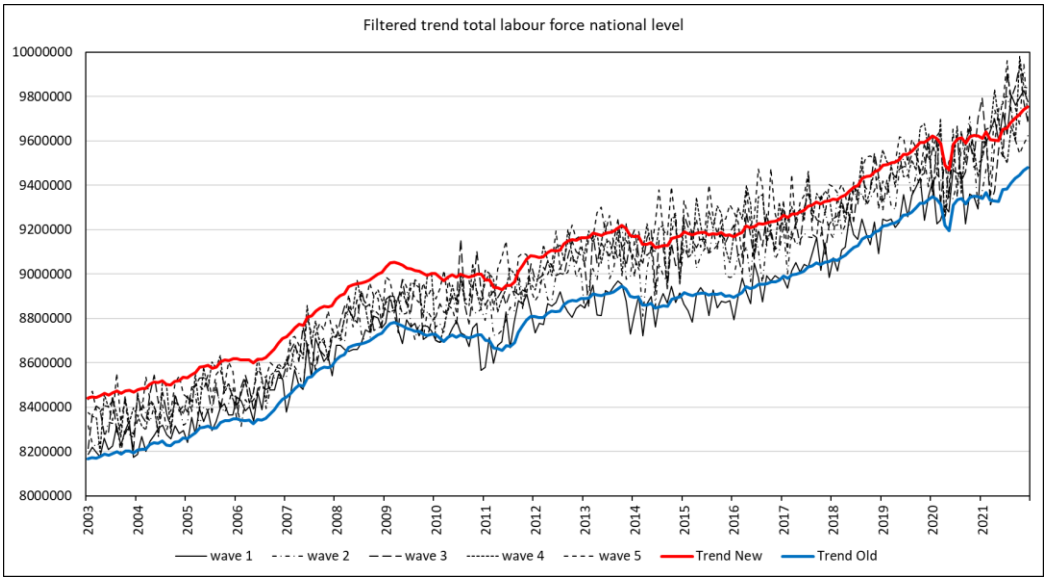

Figure 4.11: Filtered trend under the old and new design with the five input series of GREG estimates observed in the five waves of the panel for the total labour force at the national level for the period January 2003 until December 2021

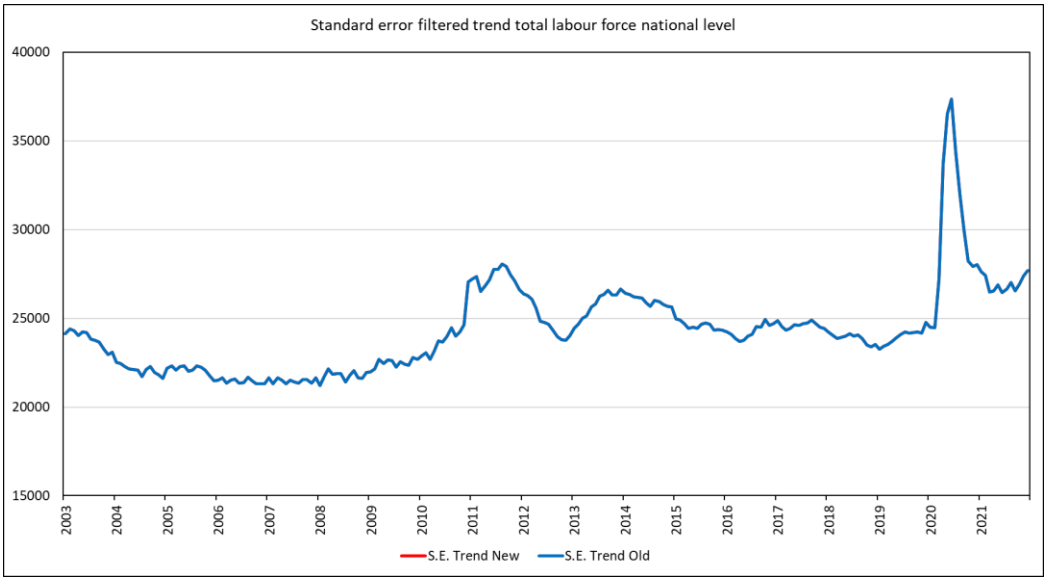

Figure 4.12: Standard errors filtered trend under the old and new design for the total labour force at the national level for the period January 2003 until December 2021

6. Discussion

A consequence of a survey process redesign is the introduction of sudden shocks or discontinuities. They are the result of differences in measurement errors and selection errors due to the introduction of a new questionnaire and field work strategies. To avoid sudden disruption of continuous series and that observed period-to-period changes are partially miss-interpreted as real evolutions of the monthly labour force figures, it is important to quantify these discontinuities. A method based on a parallel run in combination with a time series modelling approach is proposed and implemented to facilitate a smooth transition to a new survey process in the Dutch LFS.

For the transition, a parallel run for the first wave with a length of 3 months in the last quarter of 2020 was initially foreseen. To avoid the risk of confounding turning points that are the result of the corona pandemic with the discontinuities induced by the redesign, the first wave of the old design was extended with a period of six months from January to June 2021. This finally resulted in a parallel run of nine months for the first wave and provided sufficiently precise direct estimates to quantify discontinuities in the first wave by taking differences between the GREG estimates under the old and new design. These estimates are used as a-priori known values in the time series model to accommodate shocks as a result of the discontinuities in the first wave. Discontinuities in the four follow-up waves are estimated with the time series model through level interventions. With this model it is avoided that the monthly labour figures are affected by the implementation of the redesign.

In July 2021, data collection under the old design in the first wave stopped. From this moment on the input series of the first wave are based on the new design, from January 2021 on. The input series for the second wave changed to the new design in April 2021, the third wave in July 2021, the fourth wave in October 2021, and finally the fifth wave in January 2022. During July 2021 until December 2021 the monthly labour figures are estimated at the level of the old design. From January 2022 the publications will shift to the level of the new design.

The sizes of the discontinuities are large. In particular the increase from about 300,000 to 400,000 for the unemployed labour force at the national level is substantial. The employed labour force also increases with about 160,000 people, but at a level of 9000,000 people, this effect is relative small. As a result the total labour force increases with 270,000 at a level 0f 9,400,000 people. It is emphasized that the observed discontinuities are the net result of all factors that changed in the survey process redesign. This is a consequence of the parallel run, which is designed as a two-treatment experiment. Quantifying the contributions of the separate factors that changed in the survey redesign would require a factorial randomized experiment. Given a fixed budget that was planned for a parallel run, this would come at the cost of a less precise estimate for the discontinuities that are the result of the redesign (Van den Brakel et al. 2020). It was therefore decided during the planning of the redesign that the available budget was allocated to

estimate the discontinuities as precise as possible in a two-treatment experiment (Van den Brakel and Das, 2020).

Published monthly labour force figures must obey the following consistency requirements:
- The sum over the estimates for the six domains must be equal to the estimate at the national level. This must hold for the unemployed, employed and total labour force.
- The sum of the estimated unemployed and employed labour force must be equal to the estimated total labour force. This must hold for each domain and at the national level.

These consistency requirements hold for the GREG estimates by definition. Since time series model (3) is applied to each variable separately, the time series estimates will not automatically obey these constraints. Therefore, after obtaining the time series model estimates for all required variables, a Lagrange function is applied to restore the numerical consistency between the unemployed, employed and total labour force and the estimates at the domain level and the national level. See Van den Brakel and Krieg (2015) for details. As a final step, monthly estimates for the unemployment rate at national and domain level are obtained by taking the ratio of the time series model estimates of the unemployed labour force and the total labour force.

A table of monthly time series model estimates for the unemployed, employed and total labour force at the domain levels are used in the weighting scheme of the GREG estimator of the quarterly figures. In this way the corrections for discontinuities of the redesign are incorporated in the quarterly figures (Van den Brakel and Krieg 2015).

References

Bailar, B.A. (1975). The Effects of Rotation Group Bias on Estimates from Panel Surveys. Journal of the American Statistical Association, 70, pp. 23-30.

Doornik, J. (2009). An Object-oriented Matrix Programming Language Ox 6. Timberlake Consultants Press.

Durbin, J. and S. J. Koopman (2012). Time Series Analysis by State Space methods, Oxford University Press.

Koopman, S. (1997). Exact initial kalman filtering and smoothing for non-stationary time series models. Journal of the American Statistical Association 92, 1630–1638.

Koopman, S., A. Shephard, and J. Doornik (2008). Ssfpack 3.0: Statistical algorithms for models in state-space form. Timberlake Consultants, Press London.

Pfeffermann, D. (1991). Estimation and seasonal adjustment of population means using data from repeated surveys. Journal of Business & Economic Statistics, 9, pp. 163-175.

Rao, J. and I. Molina (2015) Small Area Estimation, 2nd edition, Wiley & Sons, New York.

Särndal, C.E., B. Swensson, and J. Wretman. (1992). Model Assisted Survey Sampling, Springer-Verlag, New-York

Van den Brakel, J.A. and S. Das (2020). Transition plan for the redesign of the Dutch Labour Force Survey. Discussion paper June, 2020, Statistics Netherlands, Heerlen.

Van den Brakel, J.A., S. Krieg, (2015). Dealing with small sample sizes, rotation group bias and discontinuities in a rotating panel design. Survey Methodology. Vol. 41, pp. 267-296.

Van den Brakel, J.A. and S. Krieg, (2009). Estimation of the monthly unemployment rate through structural time series modelling in a rotating panel design. Survey Methodology. Vol. 35, pp. 177-190.

Van den Brakel, J.A., M. Souren and S. Krieg (2021). Estimating monthly Labour Force Figures during the COVID-19 pandemic in the Netherlands. Discussion paper, February, 2021, Statistics Netherlands, Heerlen.

Van den Brakel, J.A., X. Zhang and S.M. Tam (2020). Measuring discontinuities in time series obtained with repeated sample surveys. International Statistical Review. Vol. 88, pp.155-175.

Explanation of symbols

Empty cell	Figure not applicable
.	Figure is unknown, insufficiently reliable or confidential
*	Provisional figure
**	Revised provisional figure
2017–2018	2017 to 2018 inclusive
2017/2018	Average for 2017 to 2018 inclusive
2017/'18	Crop year, financial year, school year, etc., beginning in 2017 and ending in 2018
2013/'14–2017/'18	Crop year, financial year, etc., 2015/'16 to 2017/'18 inclusive

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

Colophon

Publisher
Centraal Bureau voor de Statistiek
Henri Faasdreef 312, 2492 JP Den Haag
www.cbs.nl

Prepress
Statistics Netherlands, CCN Creation and visualisation

Design
Edenspiekermann

Information
Telephone +31 88 570 70 70, fax +31 70 337 59 94
Via contactform: www.cbs.nl/information