Labor Supply and Demand Shocks in Brazil During Covid-19 Period

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Abstract

Covid-19 has impacted the labor market, not only by reducing the level of occupancy but also by altering real effective earnings and hours effectively worked. We measure labor demand and supply shocks using data from the Continuous PNAD - Continuous National Household Sample Survey. The estimated shocks are interpreted as exogenous shifts in the labor supply and demand curves and are empirically measured by the estimation of a Bayesian Structural Autoregressive Vector model. We use sign restrictions to identify labor demand and supply shocks. Our results show, in the second quarter of 2020, adverse and significant effects of both shocks on hours worked, with greater relevance of demand shocks and greater impacts on activities related to the service sector. About 70% of the decline in hours worked in the latter sector was explained by demand shocks. In the third quarter of 2020, the signal of the shocks was reversed and the increase in hours worked was again sustained by demand shocks, although some activities in the service sector registered an increase in the importance of labor supply shocks. In the following quarters, shocks converge to their historical patterns.

Keywords: Labor Market, Covid-19, Bayesian SVAR, Structural Shocks.
JEL Classification: E24, E30, J20

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1 Introduction

The Brazilian economy was affected by the Covid-19 outbreak at the beginning of 2020. The impacts caused negative economic growth. Monetary and fiscal policies were implemented trying to sustain financial liquidity, access to credit, and the preservation of income, employment, and production of various economic activities. However, uncertainty regarding SARS-Cov-2 was present. Forecasts were estimated and often revised in the light of new information. Therefore, as long as firms' employment decisions (labor demand curve) were affected, households' work decisions (labor supply curve) were also influenced.

The Brazilian Institute of Geography and Statistics (IBGE) started on May 4, 2020, to publish important and complementary results to the Continuous PNAD - Continuous National Household Sample Survey, to reduce the pandemic information gap and monitor the impacts of the COVID-19 pandemic on the Brazilian labor market. These results are known as PNAD Covid-19. The survey showed the pandemic caused many people to lose their jobs and discouraged thousands of workers, who would like to offer work, not searching for jobs. The underutilization of the labor force was also present. It should be noted the pandemic not only affected the level of occupancy but also generated changes in the dynamics of real effective earnings and hours effectively worked. During the period under analysis, some activities came to partially or completely close their doors (restaurants, hotels, gyms, among others), while some benefited from an increase in demand (super and hypermarkets, pharmacies, construction materials, etc.). However, for certain sectors, it is unclear whether the shock of the first wave of the pandemic was mainly demand or supply one.

The labor market across the country was affected by the fluctuation in activity economic. GDP fell 8.8% in the second quarter of 2020 compared to the previous quarter. Despite the fall, the recovery of economic activity was significant. The performance of GDP stands out as it recorded a growth of 1.4% in the first quarter of 2021 in a seasonally adjusted comparison with the previous quarter, even in the face of the second wave of the pandemic as of November and the end of emergency aid in December. In the second quarter of 2021, GDP increased by 12.3% compared to the same quarter of 2020 and decreased by 0.1% compared to the last quarter of 2019. Considering these ups and downs in economic activity, there are significant effects on the labor market and across different sectors of the economy. Among the sectoral dynamics, the recovery of retail sales and industry stands out with activities at the end of 2020 quickly reaching their pre-pandemic levels or even above. However, the service sector as a whole, more sensitive to the formal and informal restrictions of

social isolation, persisted in a slow recovery.

Due to these effects of Covid-19 on the labor market and attempting to contribute to the literature in this area, we investigate (i) how much of the change in hours effectively worked can be empirically explained by changes in labor supply and labor demand, and (ii) whether these changes are similar across economic activities. We present estimates of sectoral labor supply and demand shocks in Brazil, benefiting from the study for the American economy by Brinca *et al.* (2021).[1] We make use of data from the Continuous PNAD and a Bayesian SVAR model with informative prior *à la* Baumeister & Hamilton (2015), where we establish sign constraints to identify and estimate sequences of demand and supply shocks. Then, we obtain the empirical historical decomposition, with focus on the second quarter of 2020, considered the quarter with the greatest impact on the labor market. We move forward with the analysis to the first quarter of 2021.

Labor supply shocks, following Brinca *et al.* (2021), are defined as unforeseen changes in workers' willingness to supply hours of work according to the observed wage while labor demand shocks are considered as unforeseen changes in employers' willingness to hire hours of work based on the observed wage. Labor supply and demand shocks are interpreted as shifts in supply and demand curves, respectively. Some factors that may have resulted in changes in the labor supply curve during the impacts of the pandemic are increased health risk when going to work, unemployment insurance policy, emergency aid, legal restrictions on non-essential work, or mandatory restrictions during the COVID-19 period, between others. On the other hand, changes in the labor demand curve can be generated by a shortage of demand, interruptions in the production of goods and services by firms, and fiscal and monetary policies during COVID-19 that affect the willingness of companies to hire at a certain real wage, etc.

Our results go in the opposite direction of those obtained by Brinca *et al.* (2021) for the US economy. While the authors found that two-thirds of the decrease in the monthly variation of hours worked was due to supply shocks, we found that the drop in the growth of hours worked in the second quarter of 2020 in Brazil was caused largely by demand shocks, mainly in activities related to the service sector. In the third quarter of 2020, the sign of shocks was reversed, and the recovery was again sustained by demand shocks, although some activities in the service sector registered an increase in the importance of labor supply shocks. In the following quarters, the shocks were closer to the historical pattern.

[1]The authors sought jointly model the dynamics of real earnings and hours worked for various American sectors between March and May 2020, as this period represents a controlled closure and subsequent reopening of parts of the US economy.

Therefore, this work contributes to the literature that deals with the Brazilian economy facing the impacts of Covid-19, especially with the investigation of adverse effects on the labor market. To place the article in the literature, it is important to highlight the study by Masri *et al.* (2021), which examines the behavior of the labor market during the pandemic. These authors also used data from the Continuous PNAD, by activity, to assess the short-term impact of the Covid-19 pandemic on the Brazilian labor market. Based on the Alfaro *et al.* (2020) methodology, they calculated, among other analyses, jobs at risk *ex-ante* among sectors and decomposed the shocks between demand and supply factors for goods and services. Then, the conceptual difference is that we decompose the shocks between labor demand and supply factors.

This paper is organized as follows. Section **2** presents the Bayesian SVAR model with sign restrictions; Section **3** shows the data taken from the Continuous PNAD and describes the Brazilian labor market briefly; Section **4** presents and discusses the empirical results from our historical decomposition exercise; and Section **5** concludes with suggestions for future research.

2 Bayesian SVAR Model with Sign Restrictions

According to Baumeister & Hamilton (2015, 2018, 2022), the traditional approach to identifying VAR models can be considered a special case of Bayesian inference in which some parameters are fixed as exact, often in the form of exclusion restrictions, and the remaining parameters have no information available. Baumeister & Hamilton's (2015) methodology can help to overcome this dichotomy of the traditional approach by recognizing uncertainty about the identification hypotheses. The authors propose to specify an uncertain identification hypothesis instead of establishing an exact identification hypothesis, as exclusion restrictions. This inexact identification can be modeled by using a probability distribution in which a prior information about the economic structure is formed. Therefore, the credibility intervals reflect uncertainty arising from both the finite sampling and the identifying hypotheses of the economic structure.

An identification strategy that is used as an alternative to traditional approaches of identification based on exclusion restrictions is the identification by sign restrictions, which allows the identification of a set of parameters for the structural model. In this case, point estimates or confidence intervals are not justifiable, as certain parameter values cannot be considered more likely than others. In the model by Baumeister & Hamilton (2015), the sign restrictions are inserted through an asymmetric t-distribution, for example. Using a distribution, there is a justification for

highlighting a given value as a best estimate of the structural magnitude of interest and for reporting credibility intervals that express confidence in such estimates.

Hence, the measurement of labor demand and supply shocks is based on the approach proposed by Baumeister & Hamilton (2015). Bayesian estimation and inference are conducted such that priors are explicitly established on the coefficients of the structural model. As Kilian & Lütkepohl (2017) pointed out, the approach of Baumeister & Hamilton (2015), although general, is appealing for bivariate models where the sign restrictions imposed on the impact coefficients are the only identification hypotheses. In the present study, we estimate a structure with these two characteristics. First, it is a standard bivariate model in which real effective earnings and hours worked are driven by labor demand and supply shocks. Second, these shocks are identified by sign constraints on the impact coefficients.

Demand and supply price elasticities of labor are assumed to be linear functions of the coefficients of the structural model. Therefore, it is possible to establish priors on these elasticities. In the methodology used here, the specification of the prior in the SVAR model, identified by sign restrictions, is performed through an exogenous source related to the structural parameters of the model. This information may be obtained from both macro and micro econometric literature. Therefore, these parameters play a key role in the supply and demand model.

According to Baumeister & Hamilton (2015), we can consult the specific literature to define informative priors on the demand and supply elasticities of labor. We also establish the constraint of positive and negative signs for the coefficients of the elasticities. This reflects our prior belief that the slopes of demand and supply are standard. However, values that obey these signs are not equally likely. Then, we assume probability distributions that capture the uncertainty about those magnitudes and are consistent with estimations presented in the literature.

Specifically, consider $\boldsymbol{y}_t = (\Delta w_t, \Delta h_t)$ as a vector with two observable time series defined as the growth rates of real effective earnings and hours effectively worked, respectively. It is assumed the data generating process for $\boldsymbol{y}_t$ can be approximated by an autoregressive vector of order p. Therefore, we can summarize the structural model by:

$$\boldsymbol{B}_0\boldsymbol{y}_t = \boldsymbol{B}_1\boldsymbol{y}_{t-1} + \cdots + \boldsymbol{B}_p\boldsymbol{y}_{t-p} + \boldsymbol{\omega}_t, \tag{1}$$

where $\boldsymbol{\omega}_t$ denotes zero-mean serially uncorrelated structural shocks. Suppose $\boldsymbol{\omega}_t = (\omega_t^d, \omega_t^s)$, (d = demand, s = supply). Then, the first equation corresponds to labor demand and the second to labor supply. Writing the relationship between VAR residuals in reduced form and structural shocks as $\boldsymbol{u}_t = \boldsymbol{B}_0^{-1}\boldsymbol{\omega}_t$, the impact of an exogenous shift in demand or supply curve, u_t^w or u_t^h, respectively, depends on

the slope of the curves. For example, a supply shock represented by a shift to the left of the supply curve along the demand curve would reduce the number of hours effectively worked and increase real wages (real effective income). These implications of economic theory, related to the signs of the responses of wages and hours worked to shocks, can be used to identify the structural parameters. In particular, we can assume:

$$\begin{pmatrix} u_t^w \\ u_t^h \end{pmatrix} = \begin{pmatrix} + & - \\ + & + \end{pmatrix} \begin{pmatrix} \omega_t^d \\ \omega_t^s \end{pmatrix}. \tag{2}$$

It is also assumed the contemporary relationship matrix has the following form:

$$\boldsymbol{B}_0 = \begin{pmatrix} -\beta & 1 \\ -\alpha & 1 \end{pmatrix}, \tag{3}$$

where β is the elasticity of demand for labor and α is the elasticity of supply for labor. As can be seen in Brinca *et al.* (2021), the relative magnitude of demand and supply shocks on hours worked and earnings depends on the relationship $\frac{\alpha}{\beta}$.

Regarding the VAR representation, we write the SVAR model as follows:

$$\boldsymbol{y}_t = \boldsymbol{A}_1 \boldsymbol{y}_{t-1} + \cdots + \boldsymbol{A}_p \boldsymbol{y}_{t-p} + \boldsymbol{u}_t, \tag{4}$$

where $\boldsymbol{A}_i = \boldsymbol{B}_0^{-1}\boldsymbol{B}_i$; $i = 1, \ldots, p$; $\boldsymbol{u}_t = \boldsymbol{B}_0^{-1}\boldsymbol{\omega}_t$; $\Sigma_{\boldsymbol{u}} = \mathbb{E}(\boldsymbol{u}_t\boldsymbol{u}_t') = \boldsymbol{B}_0^{-1}\mathbb{E}(\boldsymbol{\omega}_t\boldsymbol{\omega}_t')\boldsymbol{B}_0^{-1'}$; and $\mathbb{E}(\boldsymbol{\omega}_t\boldsymbol{\omega}_t') = \boldsymbol{D}$ is a diagonal matrix containing the variances of the shocks.

Following Brinca *et al.* (2021), we assume that the prior values of the structural parameters are represented by the joint density $p(\boldsymbol{B}_0, \boldsymbol{D}, \boldsymbol{B})$, with the belief revised when confronted with the sample data, and the update process following the methodology of Baumeister & Hamilton (2015).

With regard to priors, Barros *et al.* (2015) estimate values of the elasticity of demand for labor in Brazil between -0.4 and -0.2, for the short term. For the long term, these authors estimate values between -0.4 and -0.8. In turn, Vick (2017) estimates supply elasticity values ranging from 1.638 to 2.175 for employed men and in the range from 1.22 to 1.502 for employed women. Based on these studies, we assume the same parameterization as Brinca *et al.* (2021), that is, a truncated t distribution for the elasticities with location, scale, and degrees of freedom parameters of (-0.6 - demand; 0.6 - supply); 0.6; and 3, respectively. This implies assuming with 90% probability that the elasticity of demand is in the range $[-2.2; -0.1]$ and the elasticity of supply in the range $[0.1; 2.2]$. Another implication is that unitary demand or supply shocks have the same effects on hours worked.

In specifying the priors for the conditional distributions $p(\boldsymbol{D}|\boldsymbol{B}_0)$ and $p(\boldsymbol{B}_1,\ldots,\boldsymbol{B}_p|\boldsymbol{B}_0,\boldsymbol{D})$, we follow Baumeister & Hamilton (2015). The confidence in prior information about the variance of structural errors in $\boldsymbol{D}$ is given by the shape parameter κ of a gamma distribution with scale parameter τ. We established $\kappa = 2$, implying the weight of the prior information is equivalent to 4 observations of the total data. The prior for each element of the diagonal of $\boldsymbol{D}$, d_{ii}, is chosen to be equal to the reciprocal of the i-th element of the diagonal of $\boldsymbol{B}_0\hat{\boldsymbol{S}}\boldsymbol{B}_0^{'}$, where $\hat{\boldsymbol{S}}$ denotes the sample covariance matrix of the residuals of the VAR model in the reduced form, that is, $\tau_i = \kappa\boldsymbol{b}_{0,i}^{'}\hat{\boldsymbol{S}}\boldsymbol{b}_{0,i}$ and $d_{ii}^{-1} = \kappa/\tau_i$. Regarding the coefficients of the lagged variables of the structural model, $\boldsymbol{B}_1,\ldots,\boldsymbol{B}_p$, the prior is established on the coefficients of the reduced form of the VAR, $\boldsymbol{A}_1,\ldots,\boldsymbol{A}_p$ ($\boldsymbol{A}_i = \boldsymbol{B}_0^{-1}\boldsymbol{B}_i$), similar to prior from Minnesota developed by Doan *et al.* (1984). In this case, the hyperparameters λ_0, λ_1 and λ_3 control, respectively, how concentrated the prior is in general, the rate of contraction of the prior as the lags increase, and the weight of the prior related to the constant. The values used are as follows: $\lambda_0 = 0.2$, $\lambda_1 = 1$ and $\lambda_3 = 100$ (which makes irrelevant the prior over the constant). The number of iterations of the algorithm is 6×10^6, with an initial discard of 1×10^6.[2]

Given the limited number of observations available for each activity analyzed, as well as for the total, we used only one lag in the SVAR, based on Schwarz's Bayesian criterion (BIC). We also observed other information criteria for the choice of lags, such as the Akaike criterion. The test result for the choice of lags is in appendix (**A**) in Table **A2**. Based on VAR models with a maximum of 4 lags, we can see there is no discrepancy between the criteria, but some activities require higher lags to generate model residuals well-behaved. Then, we evaluated the model with 2 and 4 lags and did not verify significant changes in the results presented below. The historical decomposition of the growth rate of hours worked for the model with 4 lags is reported in Figure **B4**, appendix **B**.

We assume the parameters of the model do not change over time. Therefore, structural breaks could be a limitation of the present study, and the results for the historical decomposition of hours worked must be seen with caution because the model parameters are obtained from historical data and may not be valid for the Covid-19 period. That is, changes in equilibrium values may be due to variations in parameters rather than structural shocks. Given the parsimonious structure of the model and the limitations of the data, the task of decomposing the shocks via a model with structural breaks is beyond the scope of this work.

[2]The model was estimated through the package **BHSBVAR** of Richardson (2021), written in R (R Core Team (2020)). More details about the model and the algorithm can be found in the aforementioned references, Baumeister & Hamilton (2015, 2018, 2019) and Richardson (2021).

Although the estimation for the parameters does not directly cover structural breaks, Brinca *et al.* (2021) emphasize the methodology of identification by signs allows one taking into account both the uncertainty related to sample size and the lack of knowledge regarding the true structural parameters of the economy. This is because the identification strategy does not generate a point estimate but a plausible set of values for the parameters. In the methodology of structural VAR by Baumeister & Hamilton (2015), priors reflect the reasonableness of values for the elasticities, so assigning probability to each point of this set. Then, the unpredictable economic effects caused by the coronavirus pandemic are somehow addressed in the model used below.

3 Real Earnings and Hours Worked

3.1 Data

The Covid-19 pandemic has had relevant impacts on the labor market, especially on the level of occupation and the hours effectively worked.[3] Then, the choice of the labor factor measure could be the total hours effectively worked in all jobs in the week of reference, given by the product between the average working hours per week and the total number of employed persons in the economy, or the series of employed persons. We use effective hours as the labor factor because there is a trend observed in several countries, including Brazil, of reducing working hours, as can be seen in Barbosa Filho & Pessôa (2014) and Veloso *et al.* (2019). In Table 1, we can verify that the correlation between the logarithmic differences of the Brazilian GDP (Value Added at Basic Prices, without Product Taxes Net of Subsidies) and the hours effectively worked is slightly higher than the correlation between the same rates for GDP and the employed population for the period 2012 to 2019. Furthermore, working hours was more sensitive during the pandemic. Figure 1 shows that the total effective hours and the employed population behaved similarly until 2019. Then, at first, the effective hours had a more pronounced fall in the second quarter of 2020 and a stronger recovery in the following quarter, while the employed population fell less in 2020Q2 and did not react much in the following quarters. Looking specifically at the third quarter of 2020, there is a deceleration in the declines both in GDP and in total hours effectively worked, in contrast to a worsening in the evolution of the number of employed persons. Thus, we assume that the greater flexibility of the hours effectively worked captures more accurately the labor supply and demand

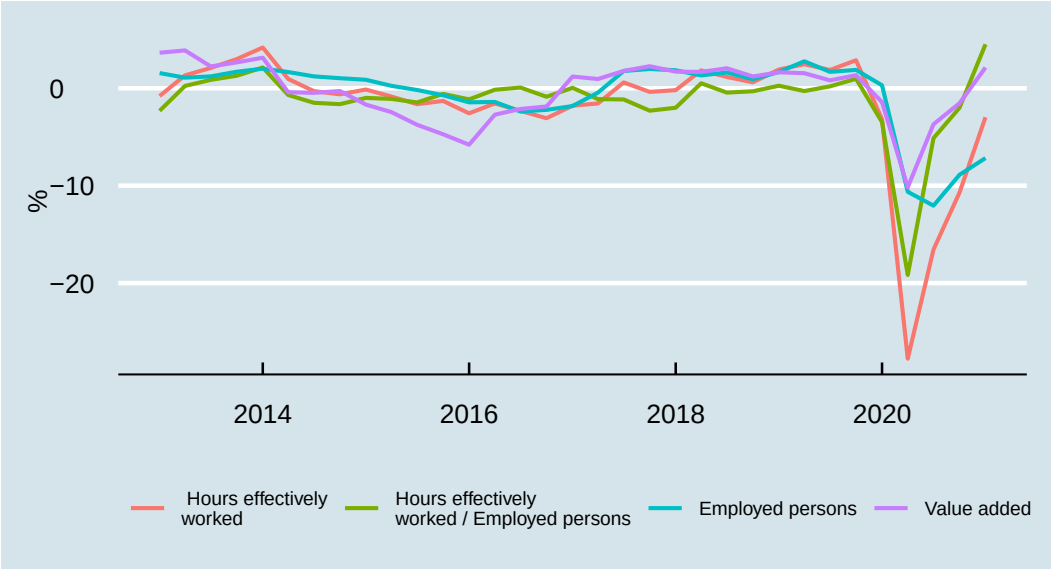
[3]The hours effectively worked are those that the person effectively dedicated to working in the reference week. These hours may include reductions due to illness, holiday, voluntary absence, delay, or other reasons, as well as increases due to peak production and compensation for hours not worked in another period.

shocks for the period in which we are trying to decompose them. As highlighted by Veloso *et al.* (2021), the discrepancy between the labor factor measures may be partly a result of the adoption of the formal employment protection program, which made it possible to maintain employment with a reduction in working hours or suspension of the employment contract, and of emergency support, which, by supplementing the income of informal workers, may have significantly reduced their working hours.[4]

Table 1 - Correlations between the growth rates of hours effectively worked, employed persons, and value added for the economy aggregate - % variations in relation to the previous quarter calculated for the period 2012Q2 to 2019Q4

	Effectively hours	Employed persons	Average hours	Add value
Effectively hours	1.00			
Employed persons	0.65	1.00		
Average hours	0.87	0.19	1.00	
Add value	0.63	0.55	0.45	1.00

Figure 1 - Growth rate of value added, employed persons, and hours effectively worked for the economy as a whole (% compared to the same quarter of the previous year, seasonally adjusted) - 2013Q1 to 2021Q1



[4]Another series that could be used as a labor factor is one that contains data on hours usually worked in all jobs. Until the beginning of the pandemic, the relationship between the hours usually worked in all jobs and those effectively worked was quite stable. However, because of social distancing measures, that were seen as unavoidable to contain the effects of the pandemic, data from the Continuous PNAD indicates the pandemic caused a drop in the hours effectively worked, quite robust in the second quarter of 2020, but did not affect the hours usually worked. Thus, we use the hours effectively worked as a measure of the labor factor.

The other fundamental variable for the present study is wage income. There are two measures available in the Continuous PNAD, i.e., the average usual earnings and average effective earnings. We also choose to use the average effective earnings. It is important to note there was a detachment of the effective earnings from work relative to the usual earnings, as observed through both the PNAD COVID19 and the Continuous PNAD. In 2020, usual earnings grew and, in contrast, effective earnings dropped significantly.[5] Therefore, using the same reasoning as discussed above, the choice of effective real earnings to assess the income situation throughout the pandemic is also justified.

We extracted the microdata[6] of Continuous PNAD for the period 2012Q1 to 2021Q1 (see Table **A**1 and Appendix **A**). The data are i) total effective monthly earnings from all jobs for the population aged 14 years and over, deflated by the IPCA[7] and divided by the employed population, and ii) total hours effectively worked in the reference week from all jobs, by main activity groups, for the following activities: "Public administration, defense and social security"; "Agriculture, forestry, fishing and aquaculture"; "Lodging and food services"; "Trade; repair of motor vehicles and motorcycles"; "Construction"; "Education, human health and social services"; "Overall industry"; "Information, communication and financial, real estate, professional and administrative activities"; "Other services"; "Domestic services"; and "Transportation, storage and mailing".[8] Quarterly series were seasonally adjusted using the X-13 ARIMA-SEATS method.[9] Then, the growth rate is obtained through the percentage change between two consecutive quarters. Finally, the percentage changes of the variables were demeaned. Table 2 and Figure **A**1 provide some descriptive statistics of the data.

[5]For more information, see Carta de Conjuntura, IPEA. Available at: https://www.ipea.gov.br/cartadeconjuntura/index.php/category/job-market/. Accessed on: 07/12/2021.

[6]To import the microdata from the Continuous PNAD, the package **PNADcIBGE** by Braga & Assuncao (2021) was used in R, R Core Team (2020). The total values in real terms were obtained through the package **survey** by Lumley (2020).

[7]To calculate earnings in real terms, see the IBGE note available at: Deflating in moving quarters in Continuous PNAD.

[8]"Poorly-defined activities" were not included in the list of this group because they presented very high variation in terms of income, but their values were used in the calculation of the aggregate. In the first quarter of 2021, this activity represented 0.05% of total hours worked and 0.02% in the second quarter of 2020.

[9]The seasonal model was estimated with the option of automatic detection of outliers for the irregular component of the seasonal adjustment, namely, AO = additive outliers, TC = temporary change outliers, LS = level shifts. The atypical percentage change in hours effectively worked in the second quarter of 2020 was duly captured by the seasonally adjusted method.

Table 2 - Percentage change in hours worked and earnings, seasonally adjusted

Activities	Variable	2020		Mean	Standard deviat.	Max	Min
		Q2	Q3				
Public administration, defense and social security	hours worked	-7.66	9.33	-0.30	2.52	9.33	-8.05
	earnings	0.02	1.25	0.61	1.15	3.38	-1.30
Agriculture, forestry, fishing and aquaculture	hours worked	-4.69	8.50	-0.46	3.00	8.50	-8.22
	earnings	-4.86	-0.90	0.44	3.00	6.14	-4.86
Lodging and food services	hours worked	-45.46	26.63	0.06	9.26	26.63	-45.46
	earnings	-18.62	1.47	-0.56	3.71	4.04	-18.62
Trade; repair of motor vehicles and motorcycles	hours worked	-25.89	18.37	-0.11	5.68	18.37	-25.89
	earnings	-9.93	6.54	-0.17	2.33	6.54	-9.93
Construction	hours worked	-25.79	19.09	-0.38	6.39	19.09	-25.79
	earnings	-2.61	-2.33	-0.27	1.18	2.37	-2.61
Education, human health and social services	hours worked	-22.95	21.27	1.14	6.02	21.27	-22.95
	earnings	0.35	2.88	0.53	2.12	5.33	-4.59
Overall industry	hours worked	-23.34	16.08	-0.34	5.57	16.08	-23.34
	earnings	0.73	2.15	0.05	2.37	4.23	-8.62
Information, communication and financial, real estate, professional and administrative activities	hours worked	-17.57	11.18	0.37	4.56	11.18	-17.57
	earnings	-3.12	0.71	0.05	1.15	1.81	-3.12
Other services	hours worked	-45.67	39.69	0.67	10.43	39.69	-45.67
	earnings	-15.37	2.42	-0.29	3.17	4.42	-15.37
Domestic services	hours worked	-36.16	18.50	-0.46	7.57	18.50	-36.16
	earnings	-7.62	1.00	0.10	1.76	3.80	-7.62
Transportation, storage and mailing	hours worked	-27.14	14.78	0.23	5.65	14.78	-27.14
	earnings	-6.46	-1.85	-0.50	1.95	3.17	-6.46
Aggregate	hours worked	-22.38	16.39	-0.09	5.04	16.39	-22.38
	earnings	-0.82	0.52	0.20	0.61	1.32	-1.35

3.2 Earnings and Hours Worked During the Pandemic

We highlight the not seasonally adjusted real effective earnings because it declined by more than 10% in the second quarter of 2020 and then partially recovered in the next quarter. In turn, seasonally adjusted real effective earnings decreased

0.82% in 2020Q2 and increased 0.52% in the third quarter, as one can see in Table 2 (Aggregate). However, they dropped again in subsequent quarters probably due to the impact caused by the pandemic. Many workers in several activities faced falling earnings, and those employed in jobs linked to the service sector were most affected by the pandemic. The decline in earnings in "Lodging and food services" for example, was 18.62% in the second quarter of 2020, compared to the previous quarter. The "Other services" activity was another example of the impact on services.[10] The decrease in real effective earnings in this activity was 15.37%, which was, in absolute terms, the largest quarterly change since 2012. The losses in wage were also the largest for almost all activities analyzed in this paper. In the following quarter, 2020Q3, in general wage increased. However, this improvement was not as high as the decrease in the previous quarter, particularly in activities of the service sector. In this quarter, the major increase was 6.54% in "Trade; repair of motor vehicles and motorcycles".

The negative effects of the pandemic on the labor market were not just limited to the level of occupation and earnings. We can observe changes in the behavior of hours and absences from work. In the first two quarters of 2020, especially in the second, we can see a sharp drop in the hours effectively worked.[11] These hours decreased by 22.38% in the second quarter of 2020 in aggregate, compared to the first period of the same year, see Table 2 above and Figure **A**1 in Appendix **A**. The average of effect working hours was 30.7 hours per week (not reported) in 2020Q2, with or without a seasonal effect. Its average was 38.2 hours (not reported) from 2012 until 2021 for comparison purposes. Once again, the largest impact in hours worked was observed in activities linked to the service sector, with emphasis for the decline in "Other services", "Lodging and food services" and "Domestic services" reaching 45.67%, 45.46% and 36.16%, respectively. Aggregate recovery was 16.39% in 2020Q3 relative to 2020Q2, and it was positive for all activities. This result returned much of the decline seen in the second quarter. Both the decrease in the second quarter and the increase in the third one were the largest changes observed since 2012, with exceptions for "Public administration, defense and social security" and "Agriculture, forestry, fishing and aquaculture" in 2020Q2.

This impact on hours effectively worked was mainly caused by the greater

[10] According to Carvalho (2021), self-employed-persons were the most affected workers by the pandemic. Carvalho highlights that in the second quarter of 2020 compared to the same quarter of the previous year, effective earnings had dropped by 17.2% and, as a result, self-employed workers received only 76% of the usual earnings, and they still received only 90% in the last quarter of 2020. Finally, private workers without a formal contract received 87% of their usual earnings in the second quarter.

[11] The pandemic did not affect the hours usually worked significantly, which during 2020 remained around 39.5 hours per week, as one can see in Carvalho (2021).

absence from work due to the pandemic, with implications for the supply and demand for work. Labor supply was adversely affected by individuals' decision to avoid social contact and by legal economic restrictions imposed to prevent contagion. The impact of the pandemic on mobility, associated with other shocks, also fell on the demand side. According to World Bank (2020), in addition to not being able to consume some goods and services due to lockdown measures, consumers also reduced consumption due to three other effects: reduced labor income (reduced purchasing power), reduced confidence (increased precautionary savings), and reduced wealth (due to volatility in financial markets). Consequently, an abrupt and strong decline in aggregate demand for goods and services could lead to a negative shift in the labor demand curve.

The dynamics of earnings and hours worked described above, in aggregate and across activities, suggest some interpretations in terms of a labor supply and demand model. "Aggregate" hours worked contracted significantly in the second quarter of 2020, but earnings reduced relatively less. Therefore, considering labor supply and demand curves with standard slopes and low elasticities, the decrease in hours and earnings could be explained by shifts to the left of both the labor demand and supply curves, potentially in greater proportion for demand, given the small decrease in earnings. In the case of many activities in the service sector, the retractions in both hours and earnings were significant, which also opens up the possibility of a shift in labor demand greater than a shift in supply. As for the recovery in the third quarter of 2020, in certain activities the hours returned significantly but the earnings did not, that is, it is possible that the labor supply shifted to the right in a greater proportion than did the demand.

Therefore, to interpret and quantify the results of Table 2, in terms of labor supply and demand shocks, an econometric model is needed to allow the decomposition of the shocks. At the same time, this model allows one to take into account the uncertainty about recovery and growth that arose because the reduction of the pandemic depended on the advance of mass vaccination, which could facilitate the return of economic and social activities to a certain degree of normality. While this can be challenging to estimate, it is important to identify from the beginning of the pandemic how much of the decline in hours worked can be attributed to changes in the supply curve and how much can be associated with variations in the labor demand curve. Likewise, it is interesting to investigate whether there is heterogeneity in our results among the selected activities. In this sense, the next section intends to disentangle the results in a unique way, as far as we know, for the Brazilian economy.

4 Results

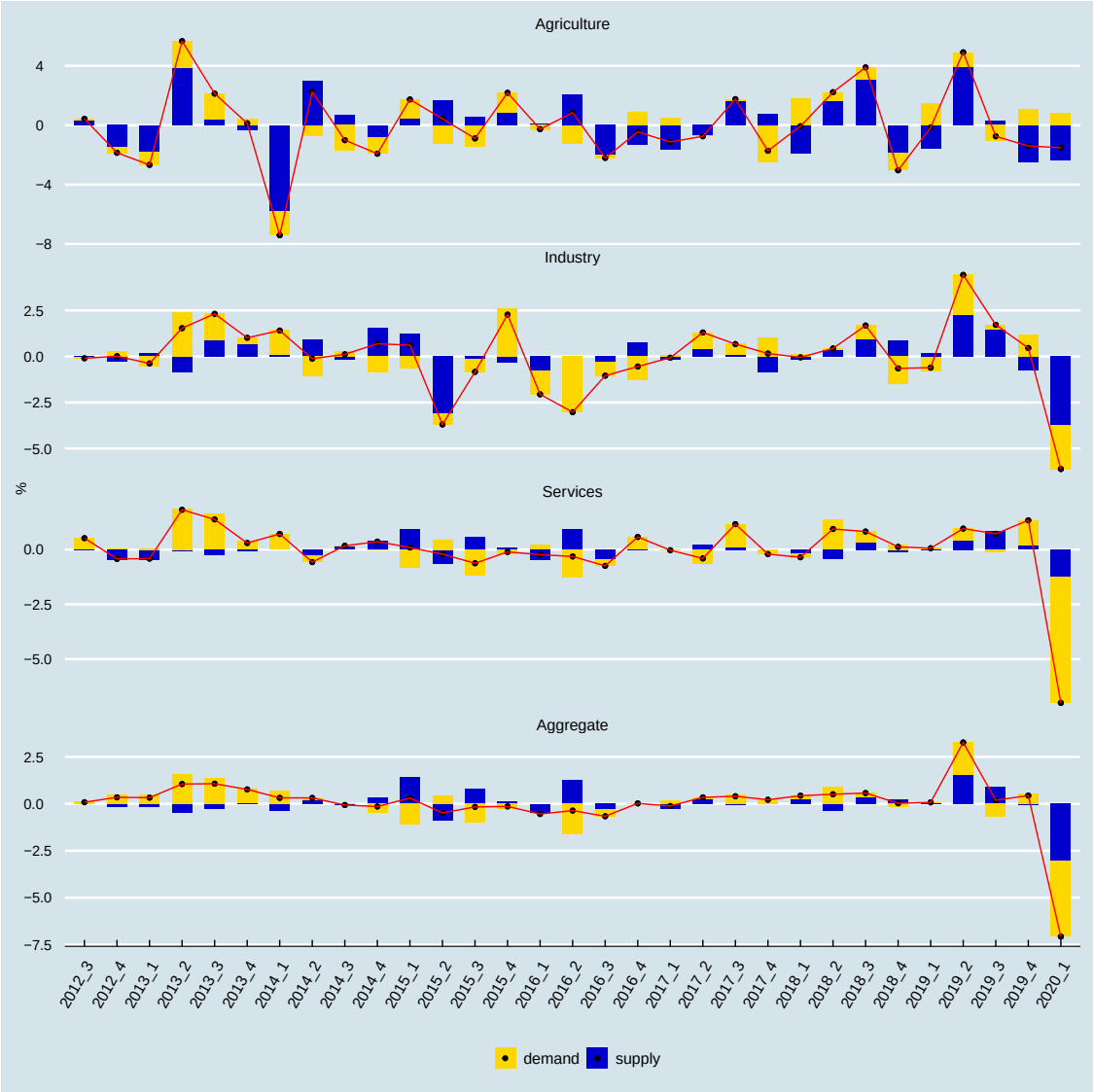
In this section, we proceed with the analysis of the historical decomposition of shocks in labor supply and demand. Then, we evaluate those shocks from the second 2020 quarter onwards. It is worth noting we estimated the labor supply and demand model with data from 2012 to the first quarter of 2020. Based on this estimation, we generate the historical decomposition of the hours worked over this period and extrapolate the analysis, without reestimating the model's parameters, from the second quarter of 2020 to the first quarter of 2021

Before presenting the results, we note that the additional information provided by the available data leads us to revise the prior density of the elasticities towards an absolute value that is a little higher than the estimates found in the literature. The most recurrent review is on the supply side, highlighting the aggregate and the activities "Construction" and "Information, communication and financial, real estate, professional and administrative activities". Figure C1, Appendix C, contains the prior density and posterior one for the activities and aggregate.

4.1 Historical Decomposition Before the Covid-19

Beginning with a more general analysis, Figure 2 presents the historical decomposition of hours worked for the aggregate economy and activities grouped together in sectors, specifically: Agriculture ("Agriculture, forestry, fishing and aquaculture"); Industry ("Overall industry" + "Construction"); and Services (other activities). The model by which the historical decomposition was estimated has the first quarter of 2020 as a cut-off point, which we are arbitrarily calling the initial period of Covid-19 to expose the results. Thus, the model parameters were obtained from the sample ranging from 2012Q2 to 2020Q1. The cutoff choice reflects the less intense economic effects of the pandemic in the first months of 2020, although they were already perceptible. As seen in the section **3**, abrupt changes occurred in the second quarter of 2020, which actually started in March and deepened in April and over the following months. Corroborating this point, Masri *et al.* (2021) show a drop in social mobility rates of approximately 50% when, at the end of March and beginning of April, most state and municipal governments, supported by a judicial decision, determined the closure of schools and established restrictions on the operation of economic activities considered non-essential.

Figure 2 - Historical decomposition of the growth rate of pre-Covid-19 hours worked for activities grouped in sectors: percentage change, median of shocks, and total change



Having defined the estimation period of the structural model, we proceed to analyze the results shown in Figure 2. From 2012 to 2019, we can observe labor supply and demand shocks follow a relatively stable pattern in the composition of the growth rate of hours worked. However, the Industry had a notable fluctuation in 2015-2016 and the aggregate of activities showed more relevant shocks in demand and supply in the first quarter of 2020. The 2020Q1 shock hit more intensively Services and Industry, while Agriculture did not register different fluctuations from previous periods. The greater fluctuation in the service sector can be explained by Masri *et al.* (2021). These authors showed at-risk employment is significantly concentrated in sectors with greater difficulties in carrying out remote work and with greater social contact, for example, commerce, transport and accommodation

and food. The 95% credible intervals can be seen in Figures B1 and B2 (Appendix B). Even though activities are modeled with different prior elasticities, one can see the intervals do not change significantly.

In summary, the econometric model captures well the adverse movement of the labor supply and demand curves that began in the first quarter of 2020. This fall will intensify in the following quarter and will reverse itself later, in a heterogeneous way in both cases, as we will see next.

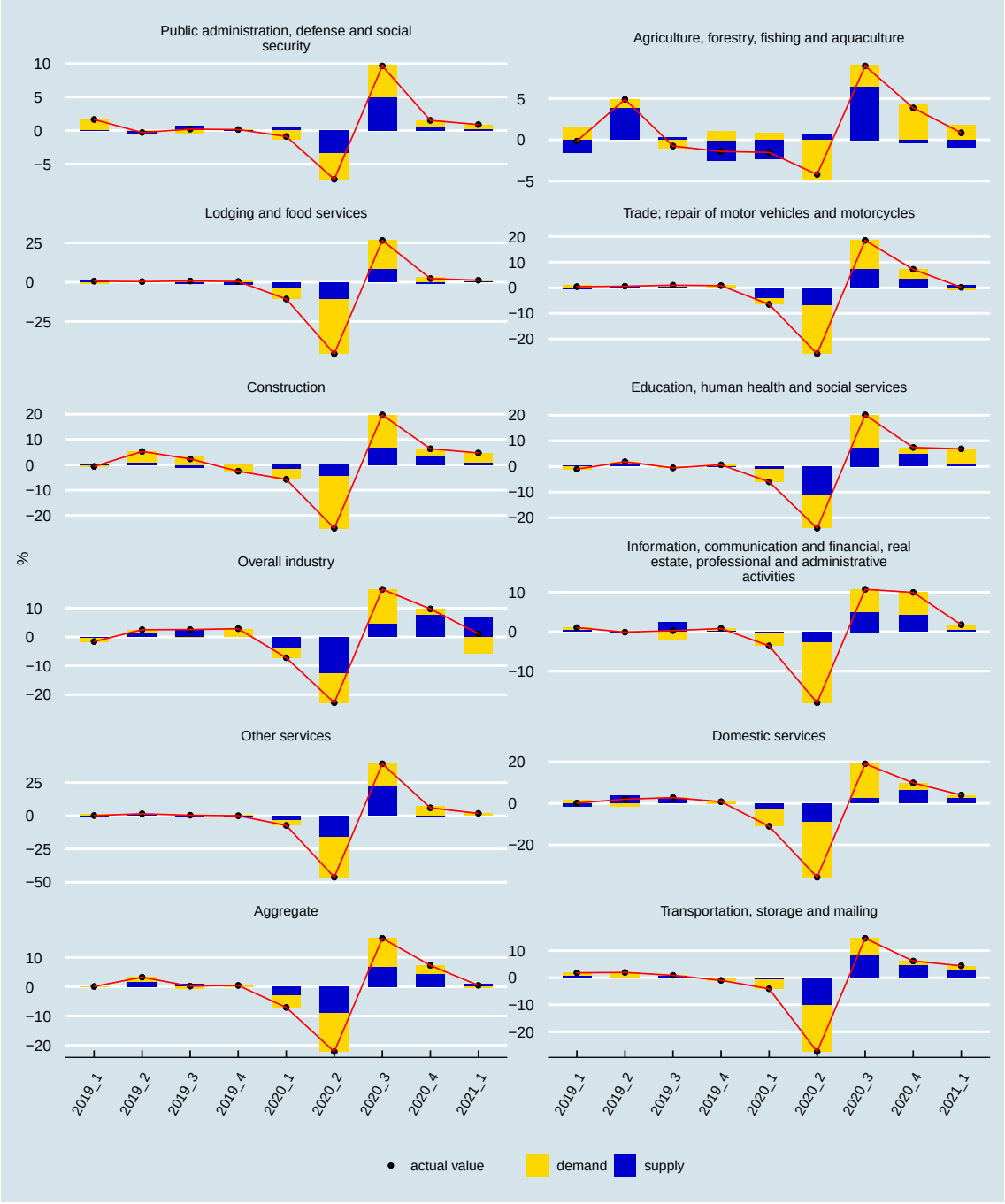
4.2 First Wave Impacts: 2nd & 3rd quarter 2020

As previously reported, the impacts of Covid-19 on hours worked were strongly negative in 2020Q2, both in specific sectors and in the aggregate. These effects are noted in Figure 3, showing the median of the historical decomposition of the growth rate of hours worked from the first quarter of 2019 to the first quarter of 2021.[12] In aggregate, the decline in hours was 22.4% in 2020Q2, 59.5% of which was due to demand shock and the 40.5% remaining was explained by a supply shock. We can relate labor demand shocks to restrictions on the normal functioning of various economic activities, reductions in consumption of various types of goods and services, and to growing macroeconomic uncertainties that, by causing production to fall sharply, induced entrepreneurs to review their demands for labor. Supply shocks, on the other hand, can be associated with people moving away from their occupations, either by reducing their hours worked accordingly or even by leaving the workforce in part due to discouragement or even because of incentives generated by the emergency aid grant.[13]

[12]The Table B1, Appendix B, reports the median and 68% credibility interval for these shocks.

[13]Employed population and number of hours worked decreased by 10.7% and 27.6%, respectively, compared to the second quarter of 2019. According to Duque *et al.* (2020), the average working day was therefore responsible for 2/3 of the total reduction of the labor factor in the economy.

Figure 3 - Historical decomposition of the growth rate of hours worked, by activity, 2019Q1 to 2021Q1



The decline of the growth rate of hours worked was greater than the decreases registered in previous periods in absolute terms, except for "Public administration, defense and social security" and "Agriculture, forestry, fishing and aquaculture", the latter highlighting the countercyclical role of agricultural products aimed at exports and the stimulus triggered by the depreciation of the real effective exchange rate (WORLD BANK, 2020). Still referring to the work of World Bank, the growth of

the agricultural sector as a whole does not mean that workers employed in family farming have not been significantly impacted by the pandemic. As it represents the majority of rural producers and is important for the country's food security, family farming was helped by government measures such as the purchase of food that would be used for school meals and the payment of emergency aid.

Despite the significant decline in hours worked in most activities, we can observe heterogeneous fluctuations among them, and the service sector is the most negatively impacted one. As seen in Carvalho *et al.* (2020, p. 3), activities in this sector "[...] are segments where the participation of informal and self-employed workers is higher than the participation of one seen in another sector of the economy." Thus, measures adopted to control the contagion of the coronavirus seem to have affected more this sector. Retail sales is an example of what was said above.[14]

In the "Other services" activity more than 25% of employment relationships are informal. The decline in hours worked in this sector exceeded 45% and approximately 2/3 of this effect is due to a negative demand shock and the other part is explained by an adverse labor supply shock.[15] The negative impact of the combination of unfavorable supply and demand shocks on "Lodging and food services" activity was 45.5% with 76.5% of it attributed to the demand shock in hours worked. In "Domestic services", 74.9% of the 36.2% drop came from a demand shock. "Education, human health and social services" also registered a reduction of over 20%, with 48.1% coming from a supply shock, potentially because the interruption of education, with the replacement by distance learning, was not integral and health care decreased by the spontaneous withdrawal of users. The "Transportation, storage and mailing" activity, influenced by the cut in airline services and the drop in the number of passengers in urban public transport, suffered a retraction of 27.1% in hours worked; 62.7% due to labor demand shock. The effect on "Public administration, defense and social security" was the least intense among those experiencing negative supply and demand shocks, being close to 8%.

Apart from the service sector, the "Overall industry", in turn, dropped 23.3%,

[14]Using data from the Annual Report of Social Information (RAIS), the World Bank (2020) survey classified the exposure of sectors to the shock of lockdown according to the degree of face-to-face human contact required and the difficulty of performing the work remotely. The estimate shows the most vulnerable activities are concentrated in the service sector, including restaurants, financial services, travel agencies, etc.

[15]As Duque (2021, p. 28), "[...] half of all non-registered workers in the country are in this activity, which concentrates the largest share of vulnerable people in the Brazilian labor market. For this reason, the other services stand out not only because of their economic relevance, as they represent 15% of the country's GDP, but also because of the social impact that the activity has via the labor market". In this case, other services are subdivided into six activities: (i) accommodation and food; (ii) services provided to companies; (iii) services provided to families; (iv) private education; (v) private health and; (vi) domestic services.

but it was the only activity in which the supply shock, 54.9%, exceeded the demand shock. Finally, "Agriculture, forestry, fishing and aquaculture", in addition to being the least impacted activity, also had a slight increase in labor supply.

If, on the one hand, the shocks were quite adverse in the second quarter, on the other hand, estimates indicate that positive shocks on both sides of market forces characterized the beginning of the second half of 2020, as can be seen in Figure 3. This situation is consistent with PNAD-Covid data. It reveals the return of workers to their occupations from July 2020 in all segments, shortly after the relaxation of social distancing measures and the reopening of non-essential commercial activities.[16] The same heterogeneity observed in the second quarter occurs in the following period, but with the opposite sign. Thus, the service sector started to show the most significant positive variations. One aspect to highlight, compared to 2020Q2, is the weight of shocks in certain activities in this sector. The supply shock increased its relative importance: in "Lodging and food services", 31.4% against 23.5%; "Trade; repair of motor vehicles and motorcycles", 39.3% against 27.3%; "Information, communication and financial, real estate, professional and administrative activities", 46.2% against 15.3%; "Other services", 58.6% against 34.3%; and "Transportation, storage and mailing", 57.3% against 37.3% in the second quarter. On the other hand, the importance of demand shocks increased for "Education, human health and social services" activities and, significantly, "Domestic services".

Outside the services sector, "Construction" activity also registered an increase in the importance of the labor supply shock. On the side of the acquisition of labor services by firms, the labor demand shock favored the recovery of "Overall industry", with a relative importance of 71.2% of the total variation, compared to 45.1% of the decomposition of the decrease observed in the previous period. In the aggregate of activities, the greater weight of demand shocks, with 59.2%, can still be observed.

4.3 Return of Shocks to Historical Pattern: 2020Q4 and 2021Q1

Despite effective working hours declined in the fourth quarter of 2020 by about 10% compared to the pre-crisis situation (fourth quarter of 2019), Figure 3

[16] According to Duque *et al.* (2020, p. 30), "In May 2020, more than 15 million workers were busy but away from their work due to the pandemic, of which more than 6.8 million were paid and almost 8.9 million were not. On the other hand, in July, these numbers were, respectively, 4.2 and 2.6 million, while in September they were 2.4 million (largely corresponding to those who still received benefits related to the Emergency Program for the Maintenance of Employment and Income (BEm, in Portuguese)) and only 575,000, showing a sustained drop in workers on leave, mainly without pay".

shows three signs of recovery. First, a positive rate of change in hours worked for activities. Second, these values are still slightly higher than the historical records before the pandemic, at least for most activities.[17,18] Finally, except for "Lodging and food services", the positive variation in growth rates in the third and fourth quarters of 2020 largely offsets the decline in the second quarter.

Continuing the recovery that started in the third quarter, the fourth quarter of 2020 presents positive demand and supply shocks, where, in aggregate, 60.2% of the fluctuation is due to supply. Note the increase in the weight of the supply shock, which was 40.8% in the third quarter. It can be conjectured that this result can be explained by the continuity of the processes of easing restrictions on socioeconomic activities, the recovery of economic activity, and the reduction of emergency aid. These larger supply shocks are consistent with the decomposition performed in Duque (2021, p. 13), in which the increase in labor force participation also played an important role in the increase in hours worked: "[...] in the last quarter, the average working hours accounted for half of the recovery - more moderate -, for which the rise in labor force participation also played an important role."

"Information, communication and financial, real estate, professional and administrative activities" is the activity that has the largest positive shocks, followed by "Domestic services", "Overall industry" and then "Education, human health and social services". In the latter activity, positive labor supply shocks were relevant, 69.3% of the 7.4% fluctuation. This result is supported by the progressive expansion of face-to-face classes, even in the hybrid modality, in some states and municipalities. The impact of the positive labor supply shock on "Overall industry" activity was also significant, 78.2% of the 9.7% change. The faster recovery of the manufacturing sector, as it is less intensive in direct contact between people and, in some cases, helped by exports, has also been repeated in other countries, as highlighted in World Economic Forum (2021). In some activities, however, labor demand shocks are still predominant.

Figure 3 also shows fluctuations in the first quarter of 2021 were even closer to the historical pattern. However, there is a more pronounced negative demand shock in the activity "Overall industry" which, using the ratios of Duque (2021),

[17]Total hours for "Lodging and food services", "Other services" and "Domestic services" were, in fourth quarter of 2020, more than 20% below the level in 2019Q4; 34%, 23% and 27% lower, respectively. On the same basis of comparison, "Agriculture, forestry, fishing and aquaculture" and "Public administration, defense and social security" had the same level of hours effectively worked.

[18]As seen in Figure 3, the recovery of the labor market still has some heterogeneity between activities. Just for the record, this return to normality pattern is not restricted to domestic activities and sectors but is also heterogeneous in other countries. According to World Economic Forum (2021), only 2/3 of the workers who lost their jobs at the beginning of the pandemic in Brazil, Chile, Colombia, Mexico and Peru had been employed again at the end of 2020.

may eventually be associated with the resurgence of the pandemic and an increase in cases and deaths, as well as the lagged effect resulting from the reduction in the value of emergency aid, with negative impacts on consumption. Although the labor market improved at the end of March 2021, the number of employed workers was still below pre-pandemic levels.[19]

4.4 Additional Analysis

Some factors can change the results above. For example, the measure of labor and earnings used in SBVAR, the truncation point of the data incorporated in the model estimation, the specification of seasonality, and the number of variables involved in the model. There would still be other aspects, such as the composition effect as an example, but which are outside the scope of the work and, for the purpose of a brief robustness assessment, the following analysis is limited to the first four topics listed above.

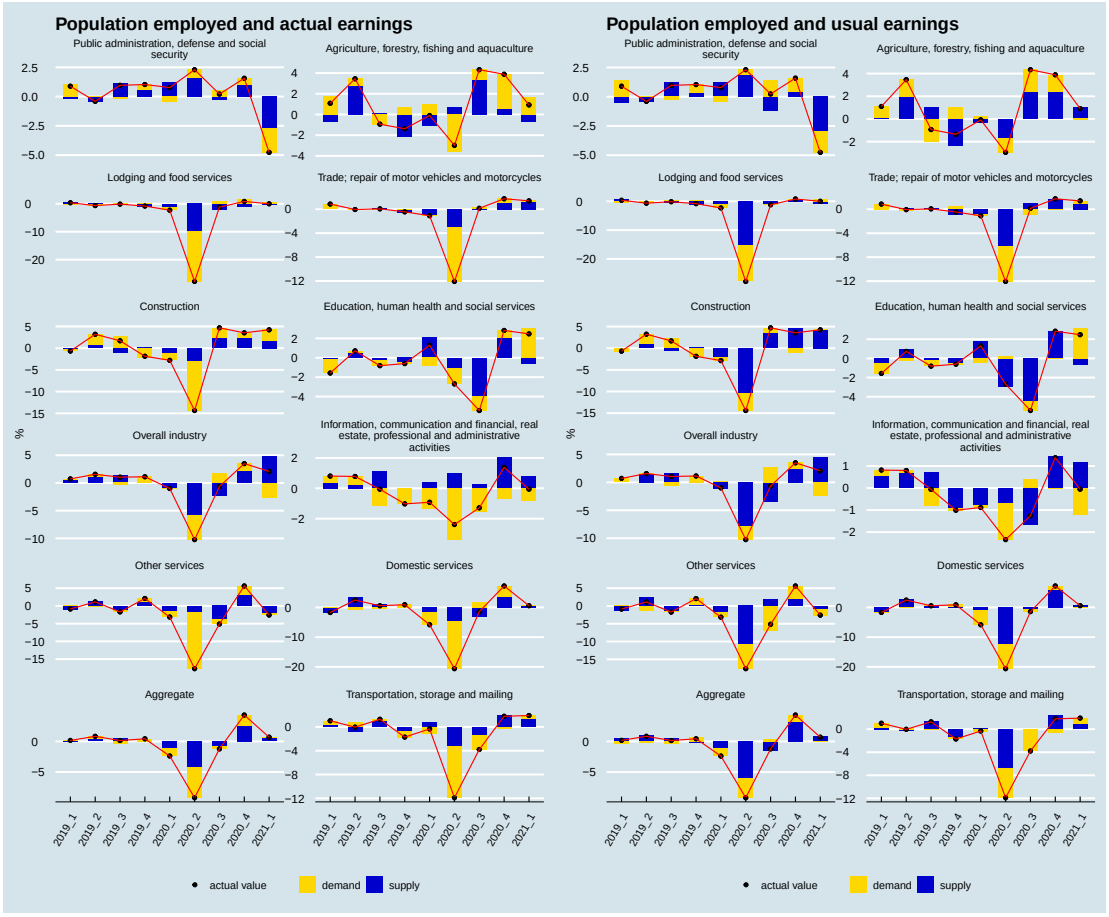
Another measure of labor factor that we could have used is the employed population instead of the product of this by the average hours. The hours worked can be measured by the hours effectively or usually worked. Table B2 contains the decomposition of labor supply and demand shocks for different combinations of labor and earnings variables, which were inserted in the SBVAR model. Maintaining effective earnings as the variable of wage and using the employed population as a proxy for labor, one obtains the same results discussed above for the second quarter of 2020, that is, the adverse variation in labor factor is mostly due to demand shocks for work. In the other quarters, there were no considerable movements in the employed population, which means the recovery described above is the result of the increase in the effective average working hours. On the other hand, the average usual working hours remained stable, which means the application of the total usual hours in the model generates the same results as the use of the employed population.

If we combine the possibilities of the labor measurement with the usual earnings, there is an important change: the variation in the labor factor is determined by labor supply shocks. This result could be linked to the detachment of the usual and effective earnings of the workforce. The usual earnings increased while the effective ones decreased in 2020Q2. Then, labor demand and supply shocks affect the labor market depending on which earning series is used in the model. However, as discussed before, a more appropriate variable for measuring the impact of the pandemic on the labor market seems to be effective earnings. For robustness results, Figure 4 presents the result of the historical decomposition in models where the

[19] According to World Economic Forum (2021), countries that have implemented job retention schemes, such as Brazil, had a less sharp drop in employment, but the recovery has been slower.

labor factor is measured by the employed population and remuneration is based on effective and usual earnings.

Figure 4 - Historical decomposition of the variation of the employed population for the supply and demand model with effective and usual earnings



To analyze the influence of the point where to break the data for the reason of estimating the model, one question that could be asked is whether it would be better to use data up to the first quarter of 2020 or use data only up to 2019Q4, since some impacts of the pandemic on the labor market were visible in the beginning of 2020. To answer this question, Figure B5 depicts the results of the model estimated with data until 2019Q4. However, as can be seen in the figure, this estimation did not significantly alter the responses of the base model (total effective hours were used as the labor factor and effective earnings as wage). In other words, the conclusion is still that more adverse demand shocks caused the fall in 2020Q2, and the recovery process brought an increase in the proportion of labor supply shocks.

Regarding seasonality, other specifications were tested for the series previously used in the standard model (hours effectively worked and actual earnings). In general, the ends of the series are problematic for seasonal methods, as it is more

difficult to distinguish and allocate the seasonal term and other components of the series. In the current case, this problem is even more significant given the expressive variations at the end of the series. It is precisely these points that are the main interest of the analysis. For simplicity, one of the alternatives researched was to use the annual variation method, that is, to show the decomposition of the variation of total effective hours worked in a model in which the variation is concerning the same quarter of the previous year for the series without seasonal adjustment. Although more informal and with some disadvantages, the merit of this method is the implicit seasonal adjustment and the direct comparison between 2020 and 2019. The result of this approach is presented in Figure B6. While there is some change in the magnitude of the shocks, the central point is that the conclusion does not alter in terms of the labor demand shock being the most important factor in explaining the variations in total effective hours and, from 2020Q3, the recovery being helped by positive movements in the labor supply curve. Compared to the previous case in which we analyzed a quarter concerning the immediately previous one, the reversal observed in that one connects with the case analyzed here in the sense that the drops in 2020Q3, 2O2OQ4, and 2021Q1 are much smaller than those observed in 2020Q2. In addition, supply shocks generally become less adverse compared to demand shocks (in some activities a positive shock in the 1st quarter of 2021), which maintains the finding of the increased importance of labor supply in the recovery process.

Finally, to assess the relationship between labor market variables and economic activity, we included the Brazilian GDP (Value Added to Basic Prices, excluding Taxes on Products Net of Subsidies) in the dynamic structural system, thus increasing the size of the SBVAR so that $\boldsymbol{y}_t = (\Delta w_t, \Delta h_t, \Delta gdp)$. This advance, however, is restricted to the aggregate of the economy and the extension of activities remains a proposal for future research. In terms of identification, we imposed a null impact of the shock linked to the GDP equation on the labor supply and the sign restriction that supply and demand shocks for labor have a positive contemporary impact on GDP growth. Figure B7 shows the historical decomposition of hours actually worked resulting from this model. The inclusion of GDP does not qualitatively change the relationship between supply and demand shocks for labor in terms of the historical decomposition for the period 2020Q2 to 2021Q1.

5 Conclusion and Final Considerations

Sars-CoV-2, the cause of Covid-19, had a strong impact on the Brazilian economy and its labor market, not only reducing the level of occupation but also

changing the dynamics of actual earnings and hours effectively worked. Within this context, with emphasis on the second quarter of 2020, seen as the point of abrupt change in economic indicators, two concerns drew attention and were explored. First, in what proportion to allocate the drop in hours worked between supply shocks and labor demand shocks? Second, what is the degree of heterogeneity of these shocks on the activities considered? Labor supply and demand shocks are interpreted as changes in the supply and demand curves, respectively.

To address the above issues, we employed a Bayesian SVAR model with informative prior *à la* Baumeister & Hamilton (2015) and established sign constraints to identify and estimate sequences of demand and supply shocks using quarterly data from the Continuous PNAD. The largest negative effect of Covid-19 on the labor market occurred in the second quarter of 2020. On aggregate, our estimates indicated negative shocks in labor demand could explain almost 60% of the drop in the growth rate of hours effectively worked in 2020Q2. Activities related to the service sector were the most affected by negative demand and supply shocks, with a proportion of almost 70% for demand shocks. Negative supply shocks affected various activities, except "Agriculture, forestry, fishing and aquaculture". The signal of recovery were already noticeable in the third quarter of 2020, with activities having significantly positive shocks in demand and labor supply. This process was not just a change in sign from the previous period, since a slight increase in the importance of supply shocks in relation to labor demand shocks was observed in many activities in the service sector. In the fourth quarter of 2020, the recovery process continued, but with positive supply and demand shocks closer to their historical records. The last period of the sample was the first quarter of 2021 and positive shocks still predominate in it, but the magnitudes were even smaller than in previous quarter. "Overall industry" was the exception in 2021Q1 because of a pronounced negative demand shock.

In general, the results for the Brazilian economy are supported by the exposure of workers to the effects of the pandemic. An important share of the impact of the pandemic affected informal jobs, which are not only more flexible in terms of exit and entry of workers in the market but can also be more malleable to formal restrictions of social isolation. And since, conceptually, the measure of labor supply shocks adopted here is directly related to the state of the public health crisis (and the public health policy response), workers begin to offer more work as the pandemic continues to show improvements and the risk of contamination drops, as restrictions on social mobility are reduced and economic recovery proves to be more consistent. On the other hand, labor demand shocks reflect economic forces that may persist beyond the public health crisis, as highlighted by Brinca *et al.* (2021).

Although the decomposition of shocks allows us to identify which sectors were most affected by changes in demand and/or supply of labor, it is worth noting some limitations that are present in this study and that can be addressed in future research. Two obvious constraints are sample size and periodicity. Certainly, a larger sample has its recognized benefits and monthly data could better identify the drops in hours worked. Seasonality is another problem and here we carried out an exercise with interannual data to evaluate the robustness of the results. However, a more detailed look at the seasonality problem present in quarterly data would be recommended, mainly because in the pandemic the fluctuations were abnormal, and the decomposition of interest uses the data from the end of the sample. Finally, the inclusion of other variables of economic activity can help in the identification of demand and supply shocks, as well as contribute to a *à la* Okun's law relationship. In this article, we added GDP data in the structural model of supply and demand for labor for the aggregate economy. Despite the lack of qualitative differences in terms of the decomposition of shocks in the period of the pandemic with the addition of the GDP in the model, the extension for each of the activities analyzed throughout the article is an open question.

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Appendix

A Data Description and Evolution

Table A1 - Data Description

Variable	Description
VD4002	Employment status in the reference week by persons aged 14 years and over.
VD4010	Groups of main activity of the company of the main job of the reference week by persons aged 14 years and over.
VD4019	Income from all jobs, usually earned per month, by persons aged 14 years and over (only for people who received in cash, goods or merchandise in any job).
VD4020	Income from all jobs, effectively earned per month, by persons aged 14 years and over (only for people who received in cash, goods or merchandise in any job).
VD4031	Usual weekly hours worked on all jobs for persons aged 14 years and over.
VD4035	Actual weekly hours on all jobs for persons aged 14 years and over.

Figure A1 - Percentage change in weekly hours and earnings, seasonally adjusted

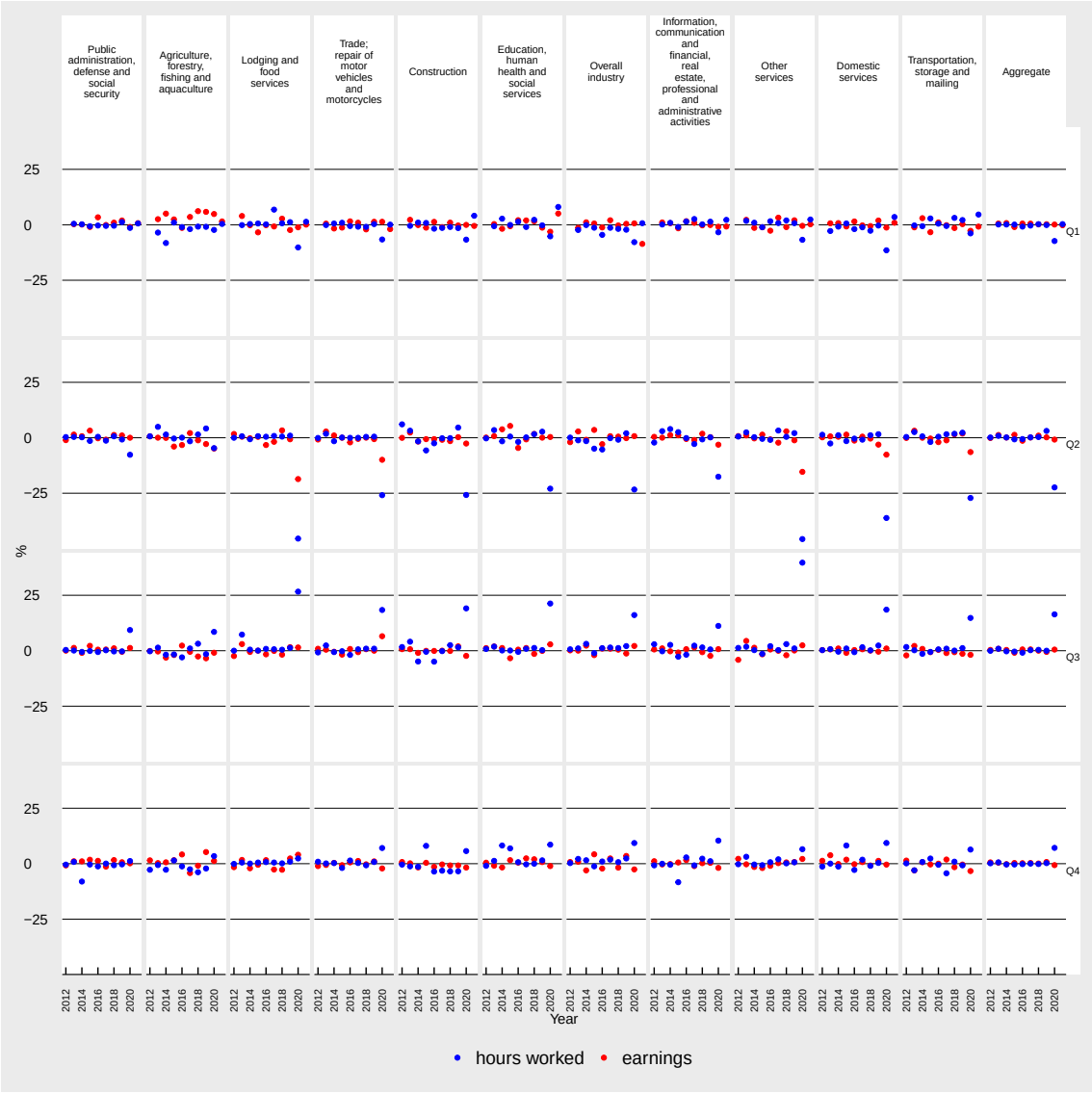


Table A2 - Alternative lag order selection criteria for the VAR model

Sector	AIC	HQ	SC	FPE
Public administration, defense and social security	1	1	1	1
Agriculture, forestry, fishing and aquaculture	1	1	1	1
Lodging and food services	1	1	1	1
Trade; repair of motor vehicles and motorcycles	4	4	4	4
Construction	1	1	1	1
Education, human health and social services	1	1	1	1
Overall industry	1	1	1	1
Information, communication and financial, real estate, professional and administrative activities	1	1	1	1
Other services	3	2	3	3
Domestic services	1	1	1	1
Aggregate	2	1	2	2
Transportation, storage and mailing	3	3	3	3

Note:
Based on VAR(4) model with intercept.
Criteria: AIC = Akaike; HQ = Hannan-Quinn; SC = Schwarz, FPE = final prediction error.

B Historical Decomposition

Figure B1 - Historical decomposition pre-Covid-19 of the growth rate of hours worked for selected activities: percentage change, median and 95% credible interval

Figure B2 - Historical decomposition of the growth rate of hours worked by activity, until the first quarter of 2020

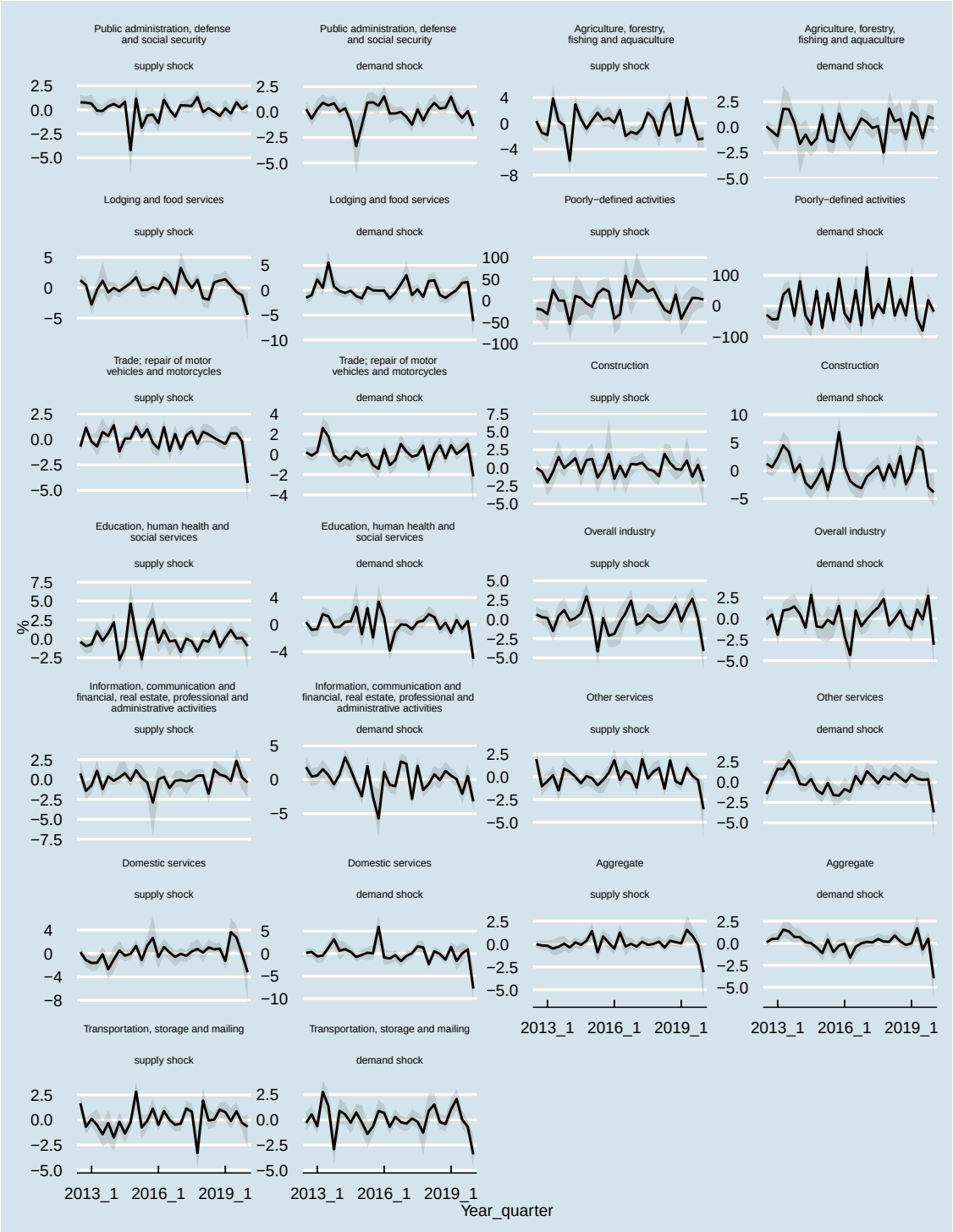


Figure B3 - Historical decomposition of the growth rate of hours worked by activity, for the entire sample

Table B1 - Historical decomposition of the growth rate of hours worked for the period 2020Q1 to 2021Q1: median and percentiles 16% and 84%

		2020Q1			2020Q2			2020Q3			2020Q4			2021Q1		
Activities	Shock	16%	50%	84%	16%	50%	84%	16%	50%	84%	16%	50%	84%	16%	50%	84%
Public administration, defense and social security	D	-1.75	-1.36	-0.95	-5.26	-3.90	-2.50	2.48	4.72	6.92	-0.09	0.80	1.74	0.14	0.60	1.11
	S	0.11	0.47	0.78	-4.80	-3.39	-2.06	2.75	4.95	7.19	-0.17	0.72	1.61	-0.14	0.29	0.77
Agriculture, forestry, fishing and aquaculture	D	0.18	0.83	1.48	-6.17	-4.77	-2.76	0.15	2.53	4.89	2.53	4.21	5.75	1.12	1.79	2.61
	S	-3.04	-2.35	-1.67	-1.46	0.58	1.95	4.08	6.43	8.82	-1.86	-0.34	1.37	-1.75	-0.93	-0.26
Lodging and food services	D	-8.30	-6.23	-4.10	-42.27	-34.76	-25.39	10.91	18.22	24.23	1.19	3.01	4.98	-0.07	0.81	1.70
	S	-6.60	-4.45	-2.43	-20.12	-10.75	-3.24	2.36	8.38	15.70	-2.63	-0.68	1.13	-0.29	0.46	1.34
Trade; repair of motor vehicles and motorcycles	D	-3.65	-2.19	-0.92	-23.89	-18.73	-12.52	5.40	11.22	16.36	1.19	3.67	6.16	-1.72	-0.82	0.06
	S	-5.56	-4.27	-2.83	-13.25	-7.04	-1.89	2.14	7.28	13.10	1.05	3.52	6.01	0.14	1.02	1.94
Construction	D	-5.16	-3.87	-2.11	-23.97	-20.66	-13.97	6.23	12.70	16.86	0.17	3.13	5.70	1.26	3.60	5.74
	S	-3.55	-1.87	-0.87	-11.10	-4.40	-1.20	2.97	7.04	13.48	0.77	3.20	6.13	-0.88	1.10	3.40
Education, human health and social services	D	-6.11	-5.06	-3.70	-17.62	-12.52	-7.41	7.60	12.50	17.15	-0.35	2.27	4.87	3.95	5.64	7.10
	S	-2.36	-0.96	0.07	-16.71	-11.59	-6.49	2.94	7.60	12.52	2.54	5.12	7.76	-0.23	1.21	2.92
Overall industry	D	-4.52	-3.10	-1.78	-15.12	-10.30	-5.72	7.44	11.78	15.74	-0.57	2.13	4.98	-7.19	-5.56	-4.01
	S	-5.49	-4.10	-2.70	-17.09	-12.49	-7.69	0.79	4.74	9.09	4.76	7.60	10.35	5.13	6.71	8.38
Information, communication and financial, real estate, professional and administrative activities	D	-3.88	-3.21	-2.35	-17.47	-15.25	-11.18	2.25	5.78	8.48	2.68	5.74	8.40	-0.10	1.22	2.63
	S	-1.21	-0.37	0.08	-6.81	-2.74	-0.54	2.27	4.94	8.47	1.60	4.21	7.26	-0.79	0.53	1.83
Other services	D	-5.42	-3.73	-2.03	-39.78	-30.45	-19.54	5.08	16.26	27.35	3.12	6.84	11.18	-0.01	1.34	2.64
	S	-5.26	-3.57	-1.93	-26.75	-15.83	-6.52	11.77	22.86	34.04	-5.21	-0.88	2.82	-0.79	0.42	1.80
Domestic services	D	-9.75	-7.80	-5.06	-33.08	-26.55	-16.99	11.25	16.56	20.24	-0.10	3.17	6.36	-0.32	1.20	2.76
	S	-5.98	-3.21	-1.26	-18.55	-8.97	-2.44	-1.19	2.48	7.83	3.53	6.70	10.00	1.29	2.81	4.42
Aggregate	D	-5.71	-3.99	-1.99	-18.43	-13.18	-6.84	4.49	9.77	14.29	0.43	2.89	5.39	-1.42	-0.46	0.43
	S	-5.09	-3.08	-1.38	-15.36	-9.02	-3.77	2.27	6.78	12.07	1.91	4.39	6.87	0.03	0.92	1.92
Transportation, storage and mailing	D	-4.22	-3.44	-2.45	-22.43	-17.16	-11.31	1.95	6.24	10.43	-0.34	1.55	3.79	0.41	1.63	3.05
	S	-1.68	-0.67	0.07	-16.06	-10.21	-4.94	4.14	8.33	12.63	2.39	4.60	6.49	1.37	2.76	4.00

Note:
D = demand; s = supply

Table B2 - Historical decomposition of the growth rate of labor factor (Population Employed / Hours), by activity and earnings (Actual/Usual) - 2020Q2 to 2021Q1

	2020Q2			2020Q3			2020Q4			2021Q1		
Activity	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D
POPULATION EMPLOYED												
ACTUAL												
Lodging and food services	-27.8	34.9	65.1	-1.2	167.2	-67.2	0.8	-116.1	216.1	0.0	NA	NA
Domestic services	-20.6	22.6	77.4	-1.4	234.2	-134.2	7.2	49.3	50.7	0.6	74.0	26.0
Other services	-17.7	10.3	89.7	-5.1	77.3	22.7	5.6	55.0	45.0	-2.6	81.8	18.2
Construction	-14.4	20.8	79.2	4.7	51.1	48.9	3.5	69.5	30.5	4.2	39.3	60.7
Trade; repair of motor vehicles and motorcycles	-12.1	24.3	75.7	0.1	-83.2	183.2	1.7	60.9	39.1	1.4	86.3	13.7
Transportation, storage and mailing	-11.9	28.0	72.0	-3.8	37.9	62.1	1.8	111.8	-11.8	1.9	70.0	30.0
Overall industry	-10.2	56.1	43.9	-0.6	353.5	-253.5	3.5	63.1	36.9	2.1	225.3	-125.3
Aggregate	-9.2	45.3	54.7	-1.2	63.0	37.0	4.3	59.8	40.2	0.7	92.3	7.7
Agriculture, forestry, fishing and aquaculture	-3.0	-22.8	122.8	4.3	76.7	23.3	3.9	13.4	86.6	0.9	-78.9	178.9
Education, human health and social services	-2.7	41.1	58.9	-5.4	71.7	28.3	2.8	74.3	25.7	2.5	-25.3	125.3
Information, communication and financial, real estate, professional and administrative activities	-2.4	-41.7	141.7	-1.3	-19.3	119.3	1.4	150.1	-50.1	-0.1	NA	NA
Public administration, defense and social security	2.3	68.8	31.2	0.2	-144.3	244.3	1.6	66.8	33.2	-4.8	56.0	44.0
USUAL												
Lodging and food services	-27.8	55.1	44.9	-1.2	91.7	8.3	0.8	98.3	1.7	0.0	NA	NA
Domestic services	-20.6	60.5	39.5	-1.4	36.3	63.7	7.2	82.7	17.3	0.6	105.1	-5.1
Other services	-17.6	60.7	39.3	-5.1	-33.3	133.3	5.6	38.9	61.1	-2.6	33.3	66.7
Construction	-14.4	72.5	27.5	4.7	76.9	23.1	3.6	128.3	-28.3	4.3	99.8	0.2
Trade; repair of motor vehicles and motorcycles	-12.1	51.3	48.7	0.2	NA	NA	1.7	100.4	-0.4	1.4	73.0	27.0
Transportation, storage and mailing	-11.9	56.8	43.2	-3.8	3.4	96.6	1.8	137.0	-37.0	1.9	48.5	51.5
Overall industry	-10.2	76.6	23.4	-0.7	NA	-421.4	3.5	68.1	31.9	2.1	218.8	-118.8
Aggregate	-9.2	65.7	34.3	-1.2	130.2	-30.2	4.3	75.8	24.2	0.7	122.2	-22.2
Agriculture, forestry, fishing and aquaculture	-2.9	57.2	42.8	4.3	54.6	45.4	3.9	62.2	37.8	0.9	110.1	-10.1
Education, human health and social services	-2.7	109.0	-9.0	-5.4	81.3	18.7	2.8	100.9	-0.9	2.5	-28.9	128.9

Table B2 - Historical decomposition of the growth rate of labor factor (Population Employed / Hours), by activity and earnings (Actual/Usual) - 2020Q2 to 2021Q1 *(continue)*

	2020Q2			2020Q3			2020Q4			2021Q1		
Activity	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D
Information, communication and financial, real estate, professional and administrative activities	-2.3	30.2	69.8	-1.3	130.0	-30.0	1.4	102.6	-2.6	-0.1	NA	NA
Public administration, defense and social security	2.3	81.1	18.9	0.2	NA	NA	1.6	29.5	70.5	-4.8	62.0	38.0
AVERAGE ACTUAL HOURS												
ACTUAL												
Other services	-31.1	47.7	52.3	40.7	53.7	46.3	2.0	131.1	-31.1	2.5	88.1	11.9
Lodging and food services	-29.2	29.4	70.6	32.0	39.3	60.7	7.0	51.8	48.2	-0.9	-4.8	104.8
Education, human health and social services	-21.6	48.6	51.4	27.7	41.5	58.5	3.8	88.2	11.8	3.1	-12.4	112.4
Domestic services	-17.4	27.1	72.9	21.4	36.1	63.9	2.2	170.3	-70.3	1.7	49.8	50.2
Transportation, storage and mailing	-16.8	51.3	48.7	20.0	61.7	38.3	2.0	99.0	1.0	1.7	84.3	15.7
Aggregate	-15.8	44.3	55.7	18.1	38.3	61.7	3.4	107.4	-7.4	1.5	90.6	9.4
Trade; repair of motor vehicles and motorcycles	-15.7	23.0	77.0	18.6	38.8	61.2	3.2	53.0	47.0	0.8	136.1	-36.1
Construction	-13.7	38.5	61.5	14.7	61.6	38.4	3.4	36.5	63.5	1.0	-19.3	119.3
Overall industry	-13.3	55.3	44.7	16.1	35.8	64.2	3.4	123.5	-23.5	1.9	205.9	-105.9
Information, communication and financial, real estate, professional and administrative activities	-12.9	37.6	62.4	14.1	39.7	60.3	3.3	104.6	-4.6	1.1	103.2	-3.2
Public administration, defense and social security	-10.2	42.6	57.4	11.8	45.8	54.2	3.8	43.4	56.6	1.5	32.1	67.9
Agriculture, forestry, fishing and aquaculture	-0.8	-87.0	187.0	3.1	58.4	41.6	0.2	-170.0	270.0	0.6	25.8	74.2
USUAL												
Other services	-31.0	51.0	49.0	40.8	45.4	54.6	2.0	83.0	17.0	2.5	74.5	25.5
Lodging and food services	-29.2	59.8	40.2	32.0	48.4	51.6	7.0	93.5	6.5	-0.9	156.1	-56.1
Education, human health and social services	-21.6	55.5	44.5	27.7	42.9	57.1	3.8	87.5	12.5	3.1	-23.3	123.3
Domestic services	-17.4	52.4	47.6	21.4	45.0	55.0	2.2	170.6	-70.6	1.7	79.4	20.6
Transportation, storage and mailing	-16.8	60.8	39.2	20.0	59.9	40.1	2.0	87.0	13.0	1.7	73.4	26.6
Aggregate	-15.8	60.7	39.3	18.1	43.5	56.5	3.4	121.0	-21.0	1.5	88.9	11.1
Trade; repair of motor vehicles and motorcycles	-15.7	51.2	48.8	18.6	44.5	55.5	3.2	86.4	13.6	0.8	143.3	-43.3
Construction	-13.7	65.8	34.2	14.7	80.4	19.6	3.4	20.3	79.7	1.0	53.4	46.6

Table B2 - Historical decomposition of the growth rate of labor factor (Population Employed / Hours), by activity and earnings (Actual/Usual) - 2020Q2 to 2021Q1 *(continue)*

	2020Q2			2020Q3			2020Q4			2021Q1		
Activity	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D
Overall industry	-13.3	67.2	32.8	16.1	34.2	65.8	3.4	136.9	-36.9	1.9	178.2	-78.2
Information, communication and financial, real estate, professional and administrative activities	-12.9	49.3	50.7	14.1	30.2	69.8	3.3	123.2	-23.2	1.1	142.5	-42.5
Public administration, defense and social security	-10.2	39.9	60.1	11.8	40.3	59.7	3.8	28.4	71.6	1.5	20.2	79.8
Agriculture, forestry, fishing and aquaculture	-0.7	45.3	54.7	3.1	52.4	47.6	0.2	55.7	44.3	0.6	124.4	-24.4
AVERAGE USUAL HOURS												
ACTUAL												
Information, communication and financial, real estate, professional and administrative activities	-1.2	-2.4	102.4	0.7	7.4	92.6	0.4	171.5	-71.5	-0.6	25.7	74.3
Lodging and food services	-0.9	-345.2	445.2	-2.4	109.4	-9.4	0.8	-35.6	135.6	-0.9	46.0	54.0
Transportation, storage and mailing	-0.6	-79.9	179.9	0.1	334.8	-234.8	-0.2	-138.0	238.0	0.9	81.9	18.1
Construction	-0.4	-48.4	148.4	-0.4	1.2	98.8	0.2	114.3	-14.3	0.1	17.7	82.3
Public administration, defense and social security	-0.4	60.9	39.1	1.1	54.5	45.5	-0.4	32.8	67.2	0.1	32.7	67.3
Overall industry	-0.1	302.9	-202.9	-0.1	291.5	-191.5	0.0	NA	-467.4	-0.2	-308.9	408.9
Other services	0.0	NA	NA	0.0	221.5	-121.5	-0.5	139.3	-39.3	-0.9	83.8	16.2
Aggregate	0.1	240.9	-140.9	0.0	117.5	-17.5	-0.1	-50.2	150.2	0.0	NA	NA
Education, human health and social services	0.3	49.4	50.6	0.1	-85.1	185.1	-1.1	52.2	47.8	0.2	-135.4	235.4
Trade; repair of motor vehicles and motorcycles	0.4	394.9	-294.9	0.1	NA	NA	0.0	345.3	-245.3	0.0	NA	NA
Domestic services	0.5	453.7	-353.7	-1.6	56.0	44.0	-0.6	69.2	30.8	1.9	38.6	61.4
Agriculture, forestry, fishing and aquaculture	0.8	118.4	-18.4	0.5	68.5	31.5	0.3	31.6	68.4	0.3	20.2	79.8
USUAL												
Information, communication and financial, real estate, professional and administrative activities	-1.2	54.1	45.9	0.7	-23.2	123.2	0.4	215.5	-115.5	-0.6	20.7	79.3
Lodging and food services	-0.9	162.3	-62.3	-2.4	28.3	71.7	0.8	100.0	0.0	-0.9	192.7	-92.7
Transportation, storage and mailing	-0.6	106.9	-6.9	0.1	314.2	-214.2	-0.2	-154.7	254.7	0.9	79.6	20.4
Construction	-0.4	170.0	-70.0	-0.4	-10.1	110.1	0.2	203.2	-103.2	0.1	184.4	-84.4
Public administration, defense and social security	-0.4	38.9	61.1	1.1	21.5	78.5	-0.4	28.5	71.5	0.1	-3.7	103.7

Table B2 - Historical decomposition of the growth rate of labor factor (Population Employed / Hours), by activity and earnings (Actual/Usual) - 2020Q2 to 2021Q1 *(continue)*

	2020Q2			2020Q3			2020Q4			2021Q1		
Activity	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D
Overall industry	-0.1	NA	NA	-0.1	320.2	-220.2	0.0	NA	NA	-0.2	-249.4	349.4
Other services	0.0	NA	NA	0.0	NA	NA	-0.5	26.9	73.1	-0.9	49.7	50.3
Aggregate	0.1	-247.3	347.3	0.0	130.1	-30.1	-0.1	-196.5	296.5	0.0	NA	NA
Education, human health and social services	0.3	-20.5	120.5	0.1	-231.3	331.3	-1.1	26.6	73.4	0.2	-126.1	226.1
Trade; repair of motor vehicles and motorcycles	0.4	32.6	67.4	0.1	-72.9	172.9	0.0	NA	NA	0.0	NA	NA
Domestic services	0.5	-105.2	205.2	-1.6	11.0	89.0	-0.6	-125.7	225.7	1.9	51.5	48.5
Agriculture, forestry, fishing and aquaculture	0.8	53.0	47.0	0.5	32.0	68.0	0.4	125.2	-25.2	0.3	142.5	-42.5
TOTAL ACTUAL HOURS												
ACTUAL												
Other services	-46.3	34.3	65.7	39.1	58.6	41.4	6.0	-14.7	114.7	1.8	23.9	76.1
Lodging and food services	-45.5	23.5	76.5	26.6	31.4	68.6	2.3	-29.3	129.3	1.3	36.0	64.0
Domestic services	-35.5	25.1	74.9	19.1	12.9	87.1	9.9	67.7	32.3	4.0	70.0	30.0
Transportation, storage and mailing	-27.4	37.3	62.7	14.6	57.3	42.7	6.1	74.8	25.2	4.4	62.8	37.2
Trade; repair of motor vehicles and motorcycles	-25.8	27.3	72.7	18.5	39.3	60.7	7.2	48.9	51.1	0.2	NA	-403.4
Construction	-25.1	17.5	82.5	19.7	35.6	64.4	6.3	50.5	49.5	4.7	23.3	76.7
Education, human health and social services	-24.1	48.1	51.9	20.1	37.9	62.1	7.4	69.3	30.7	6.8	17.7	82.3
Overall industry	-22.8	54.9	45.1	16.5	28.8	71.2	9.7	78.2	21.8	1.1	NA	-484.1
Aggregate	-22.2	40.5	59.5	16.6	40.8	59.2	7.3	60.2	39.8	0.5	200.6	-100.6
Information, communication and financial, real estate, professional and administrative activities	-18.0	15.3	84.7	10.7	46.2	53.8	9.9	42.4	57.6	1.8	30.5	69.5
Public administration, defense and social security	-7.3	46.5	53.5	9.7	51.2	48.8	1.5	47.6	52.4	0.9	32.5	67.5
Agriculture, forestry, fishing and aquaculture	-4.2	-13.9	113.9	9.0	71.7	28.3	3.9	-8.7	108.7	0.9	-109.0	209.0
USUAL												
Other services	-46.3	55.5	44.5	39.1	56.2	43.8	5.9	53.8	46.2	1.7	97.6	2.4
Lodging and food services	-45.5	53.1	46.9	26.6	43.9	56.1	2.3	169.1	-69.1	1.3	-144.7	244.7
Domestic services	-35.6	42.1	57.9	19.0	28.2	71.8	9.8	83.3	16.7	4.0	76.4	23.6
Transportation, storage and mailing	-27.4	52.2	47.8	14.6	77.9	22.1	6.2	62.6	37.4	4.4	44.4	55.6

Table B2 - Historical decomposition of the growth rate of labor factor (Population Employed / Hours), by activity and earnings (Actual/Usual) - 2020Q2 to 2021Q1 *(continue)*

		2020Q2			2020Q3			2020Q4			2021Q1		
	Activity	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D
	Trade; repair of motor vehicles and motorcycles	-25.7	49.0	51.0	18.5	44.7	55.3	7.2	65.4	34.6	0.2	419.5	-319.5
	Construction	-25.1	59.0	41.0	19.8	64.0	36.0	6.4	75.9	24.1	4.7	85.6	14.4
	Education, human health and social services	-24.1	61.9	38.1	20.1	39.4	60.6	7.4	83.8	16.2	6.9	21.3	78.7
	Overall industry	-22.8	72.6	27.4	16.5	6.9	93.1	9.7	106.4	-6.4	1.1	NA	NA
	Aggregate	-22.2	65.5	34.5	16.6	43.8	56.2	7.3	92.7	7.3	0.5	252.1	-152.1
	Information, communication and financial, real estate, professional and administrative activities	-18.0	34.5	65.5	10.7	41.1	58.9	9.9	46.8	53.2	1.8	79.8	20.2
	Public administration, defense and social security	-7.3	41.8	58.2	9.7	46.9	53.1	1.5	-34.8	134.8	0.9	18.1	81.9
	Agriculture, forestry, fishing and aquaculture	-4.1	53.7	46.3	9.0	55.1	44.9	3.9	53.9	46.1	0.8	136.3	-36.3
TOTAL USUAL HOURS													
ACTUAL													
	Lodging and food services	-24.2	11.9	88.1	-7.8	92.7	7.3	4.6	-16.1	116.1	-3.1	45.7	54.3
	Domestic services	-21.3	17.2	82.8	-2.7	125.0	-25.0	6.7	39.0	61.0	3.2	51.4	48.6
	Other services	-18.6	22.1	77.9	-2.6	-35.1	135.1	1.6	-10.4	110.4	-1.4	78.4	21.6
	Construction	-14.3	18.1	81.9	4.5	50.1	49.9	3.5	67.4	32.6	3.9	36.9	63.1
	Transportation, storage and mailing	-12.4	28.8	71.2	-3.5	27.8	72.2	1.7	118.6	-18.6	2.6	63.9	36.1
	Trade; repair of motor vehicles and motorcycles	-11.8	15.8	84.2	0.3	-162.6	262.6	2.6	60.2	39.8	0.6	138.3	-38.3
	Aggregate	-10.5	47.5	52.5	-1.5	-9.9	109.9	3.7	62.2	37.8	1.2	50.0	50.0
	Overall industry	-10.2	54.6	45.4	-0.8	261.7	-161.7	3.4	66.7	33.3	2.0	230.9	-130.9
	Information, communication and financial, real estate, professional and administrative activities	-6.9	-6.6	106.6	-1.6	24.5	75.5	5.8	72.9	27.1	0.1	316.5	-216.5
	Agriculture, forestry, fishing and aquaculture	-2.2	-46.2	146.2	4.9	71.4	28.6	4.3	15.3	84.7	1.3	-53.4	153.4
	Education, human health and social services	-0.4	18.2	81.8	-4.8	79.1	20.9	1.2	115.0	-15.0	0.8	-248.4	348.4
	Public administration, defense and social security	1.5	76.8	23.2	-0.7	111.9	-11.9	1.7	72.1	27.9	-2.8	57.2	42.8
USUAL													
	Lodging and food services	-24.2	57.1	42.9	-7.8	37.7	62.3	4.6	70.2	29.8	-3.1	127.2	-27.2
	Domestic services	-21.3	51.9	48.1	-2.8	37.7	62.3	6.7	83.1	16.9	3.2	64.6	35.4

Table B2 - Historical decomposition of the growth rate of labor factor (Population Employed / Hours), by activity and earnings (Actual/Usual) - 2020Q2 to 2021Q1 *(continue)*

	2020Q2			2020Q3			2020Q4			2021Q1		
Activity	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D	%var.	%S	%D
Other services	-18.6	58.5	41.5	-2.6	-78.4	178.4	1.6	77.6	22.4	-1.4	38.8	61.2
Construction	-14.3	72.3	27.7	4.5	84.0	16.0	3.5	129.8	-29.8	3.9	102.2	-2.2
Transportation, storage and mailing	-12.4	56.8	43.2	-3.5	-2.0	102.0	1.7	142.6	-42.6	2.6	48.9	51.1
Trade; repair of motor vehicles and motorcycles	-11.8	50.0	50.0	0.3	389.6	-289.6	2.6	91.4	8.6	0.6	87.9	12.1
Aggregate	-10.5	56.2	43.8	-1.5	41.6	58.4	3.7	76.7	23.3	1.2	76.5	23.5
Overall industry	-10.3	75.1	24.9	-0.8	393.3	-293.3	3.4	73.1	26.9	2.0	225.7	-125.7
Information, communication and financial, real estate, professional and administrative activities	-6.9	28.9	71.1	-1.6	147.7	-47.7	5.8	84.2	15.8	0.1	NA	NA
Agriculture, forestry, fishing and aquaculture	-2.1	58.4	41.6	4.9	52.6	47.4	4.3	57.3	42.7	1.2	87.6	12.4
Education, human health and social services	-0.4	NA	NA	-4.8	85.3	14.7	1.2	199.4	-99.4	0.8	-287.4	387.4
Public administration, defense and social security	1.5	94.2	5.8	-0.7	251.2	-151.2	1.7	35.6	64.4	-2.8	67.7	32.3

Note:

%var. = percentage change in relation to the previous quarter; %D = proportion of the variation attributed to the labor demand shock; %S = proportion attributed to the labor supply shock. NA = % modulus greater than 500.

Figure B4 - Historical decomposition of the growth rate of hours worked by activity, from 2019Q1 to 2021Q1 for the VAR model with 4 lags

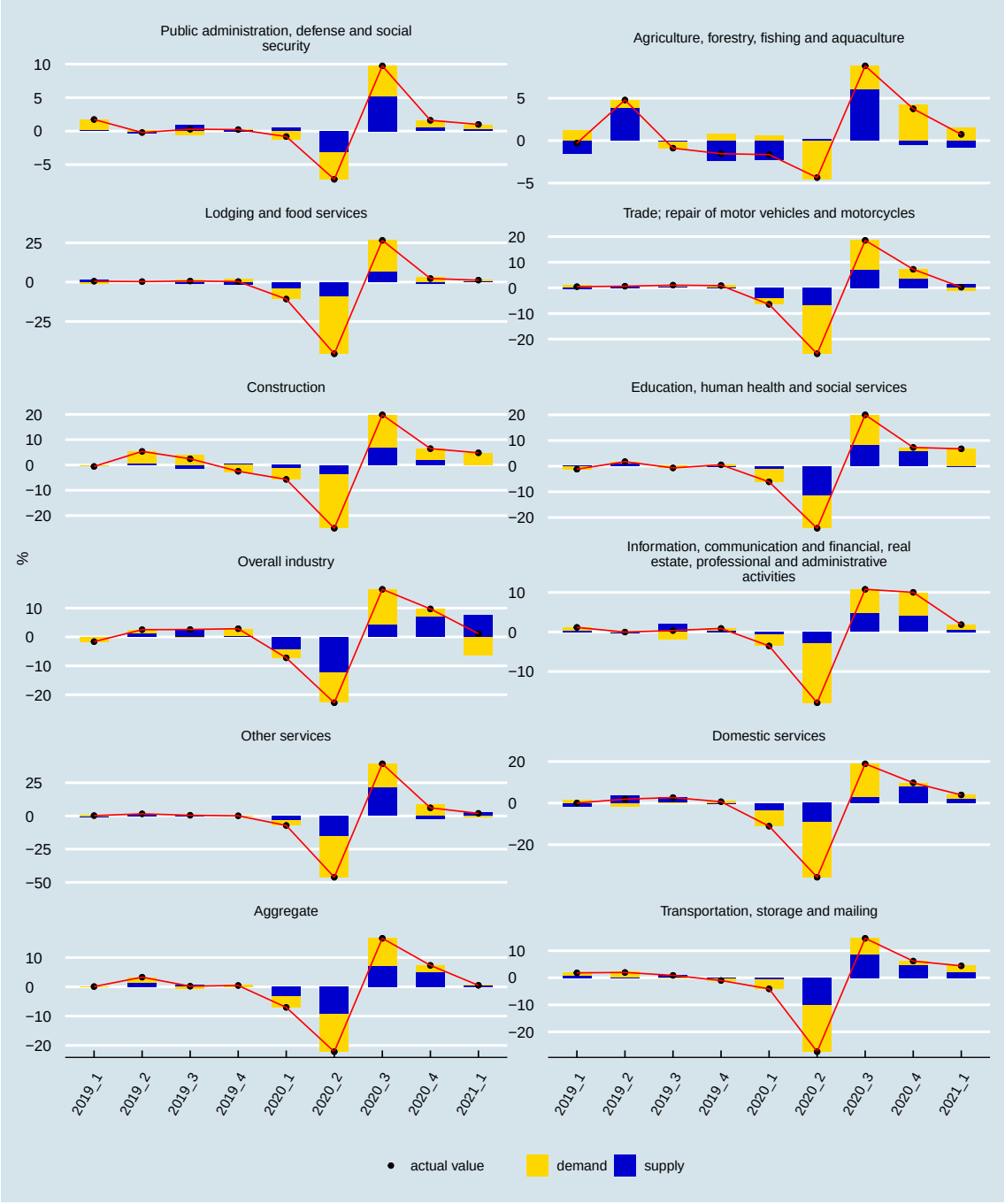


Figure B5 - Historical decomposition of the growth rate of hours worked by activity, 2019Q1 to 2021Q1 (estimated model with data up to 2019Q4)

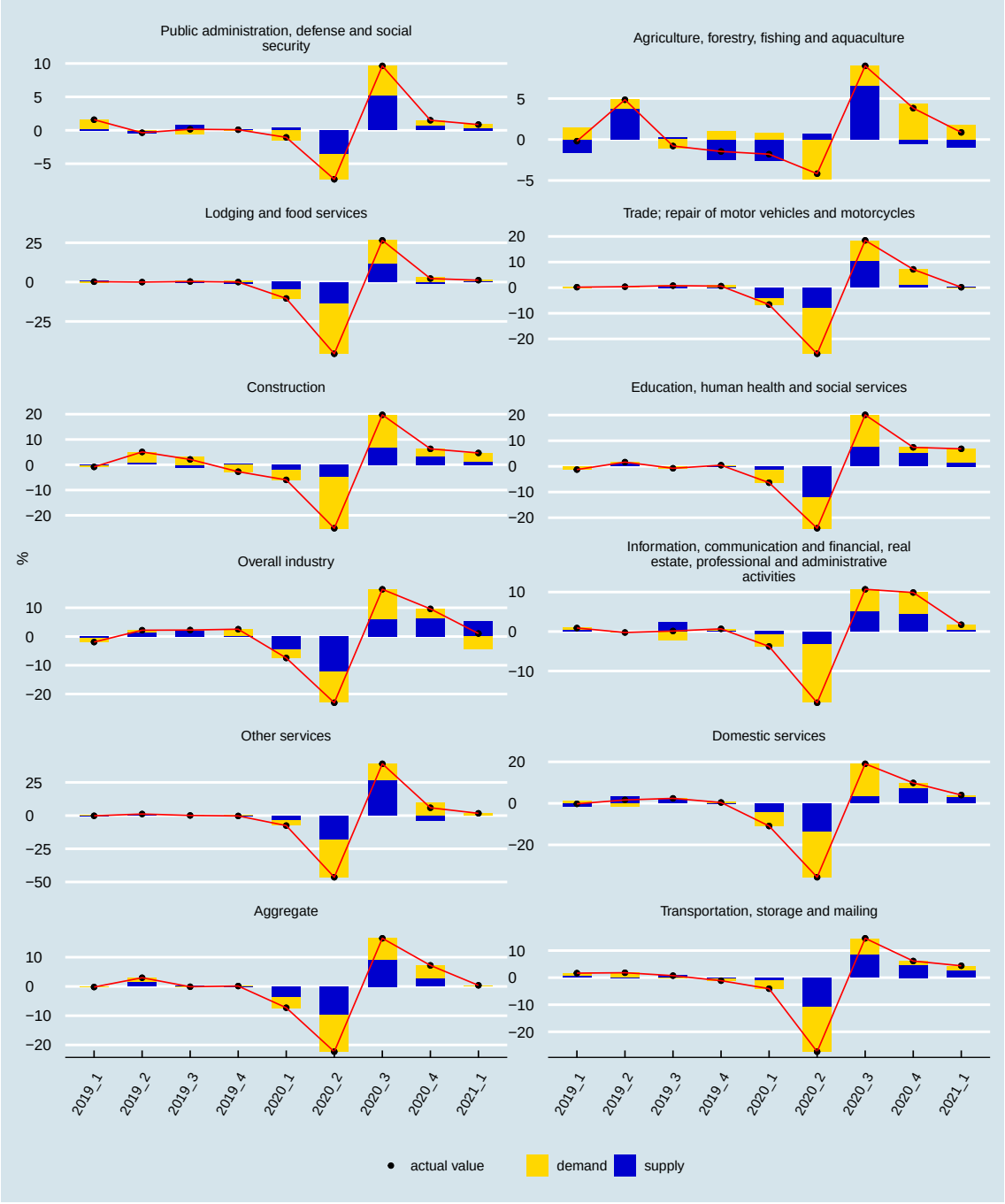


Figure B6 - Historical decomposition of the growth rate of hours worked by activity, 2019Q1 to 2021Q1 (percentage change compared to the same quarter of the previous year)

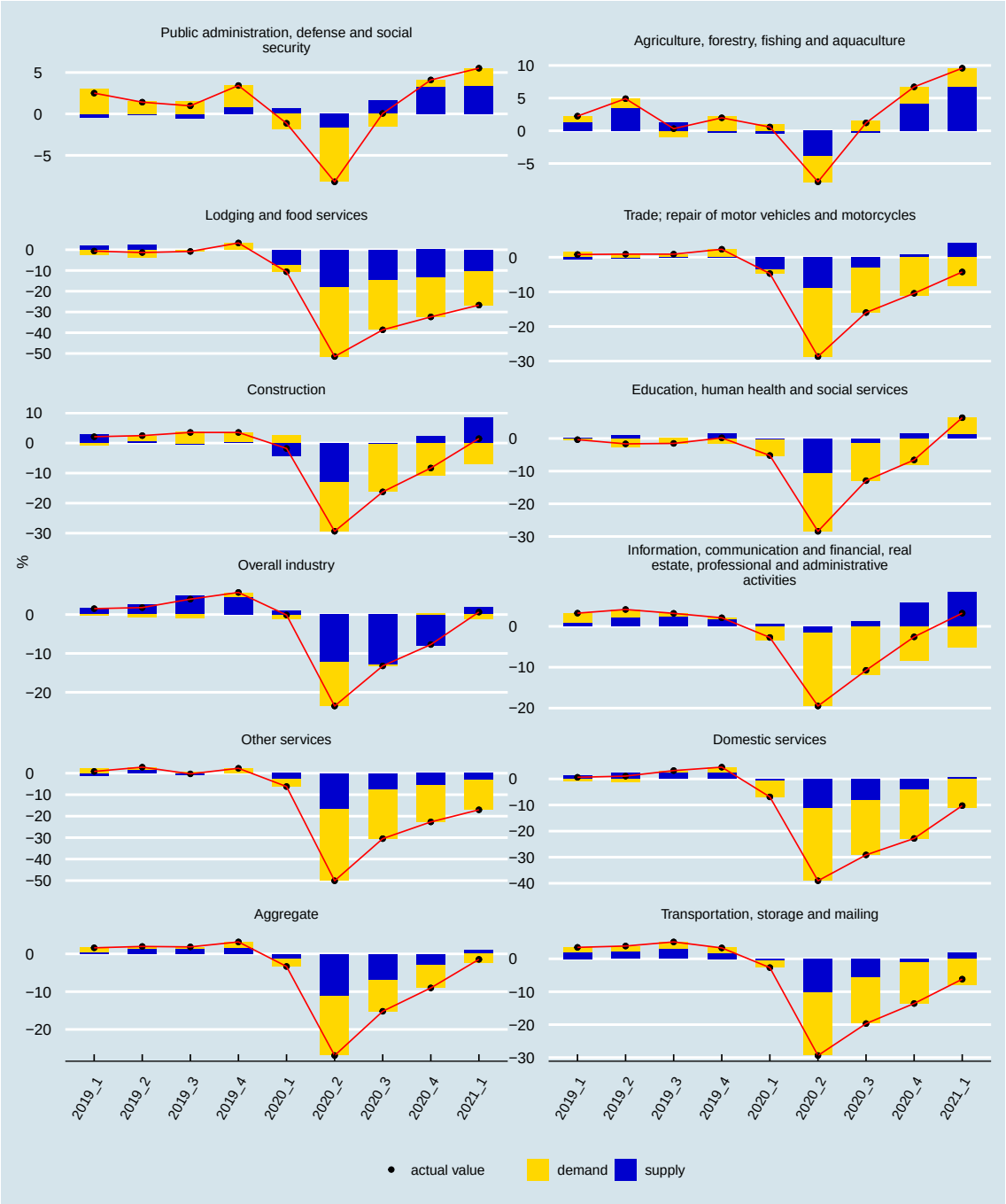
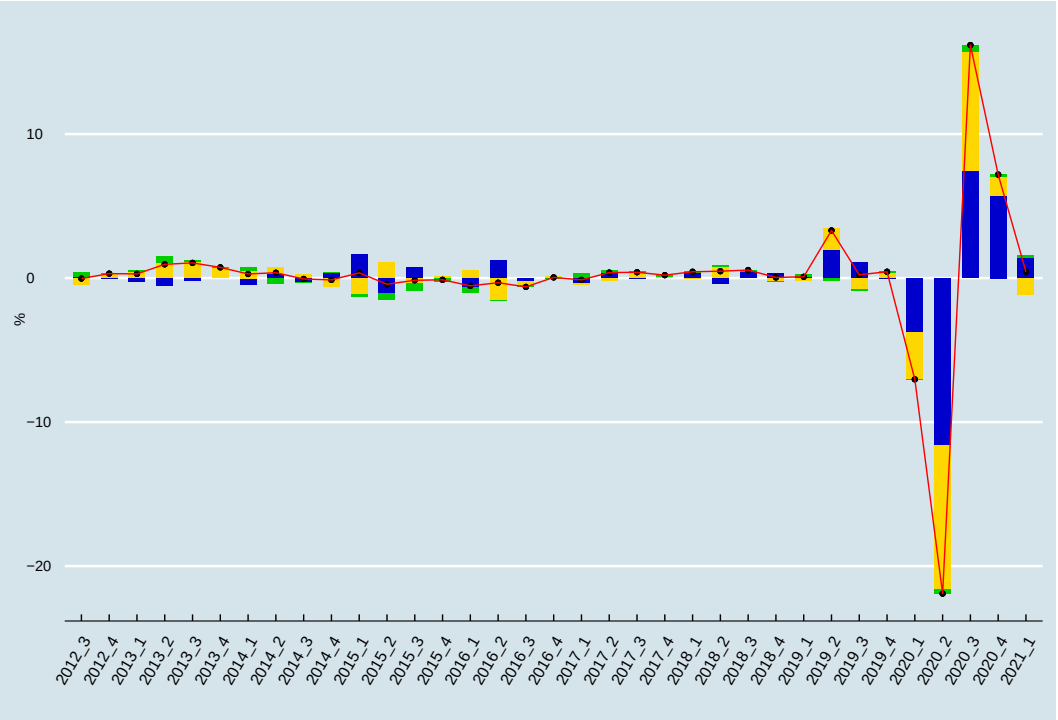


Figure B7 - Historical decomposition of the growth rate of hours worked for the model with GDP included in the system for the aggregate, 2012Q3 to 2021Q1

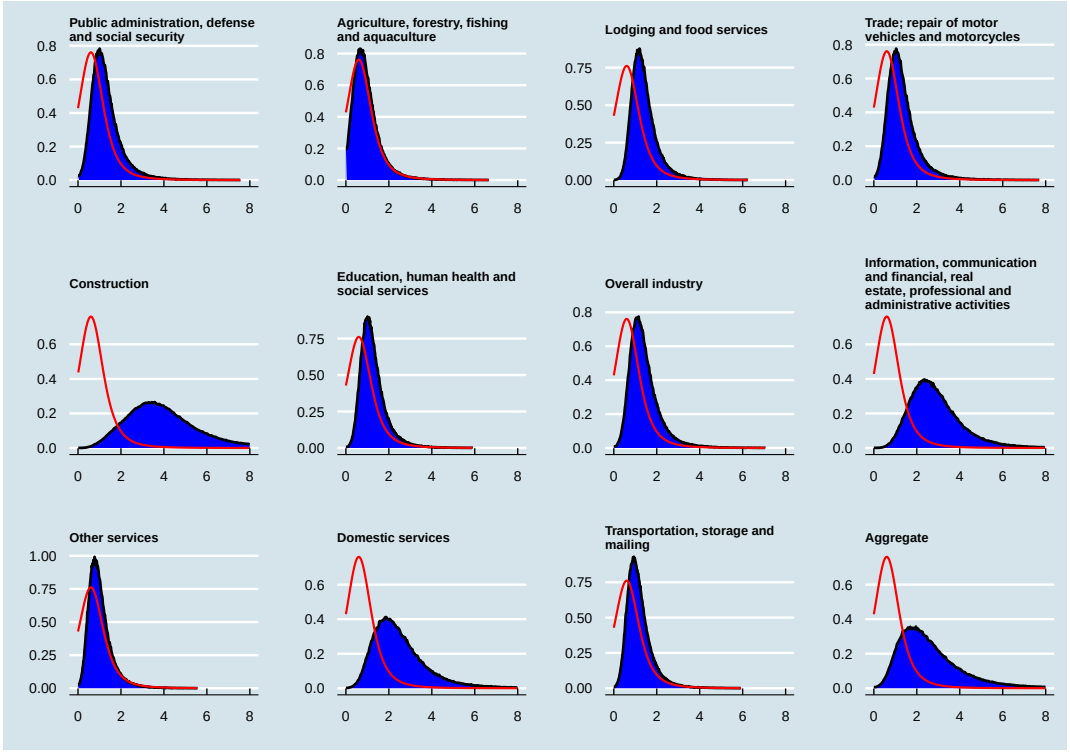


Gold = Demand; Blue = Supply; Green = GDP; Black point = Actual

C Prior and Posterior Distributions

Figure C1 - Prior (solid red line) and posterior (shaded blue area) for activities and aggregate

(a) Supply



(b) Demand