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Unveiling the dynamic job-matching landscape in the post-COVID-19 labour market through the lens of the Beveridge curve

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ABSTRACT

Objective: The objective of the article is the identification and assessment of labour market operation efficiency and stability of matching mechanisms from the microstructure perspective of labour market dynamics via the relationship between distortions in the level and slope of the Beveridge curve. We studied the US labour market dynamics and identified potential structural changes in the job matching mechanisms. The long-term relationship between the level and slope of the Beveridge curve suggested that the underlying level of unemployment matched the labour market's elasticity in response to changes in job vacancies.

Research Design & Methods: The main design of our article was a quantitative analysis of the Beveridge curve shifts. We used a data set consisting of monthly information on job vacancies and the unemployment rate of the US labour market from 2000 to 2022. Using a dynamic rolling scheme with a fixed window size, we extracted time series parameters of the Beveridge curve. We then proceed to apply the VECM(1) model to establish the relationship between these parameters.

Findings: We have found the stability of the matching mechanism in the long term and the relatively weaker or instantaneous adjustment mechanisms in the short term. We also addressed the absence of evidence regarding Granger causality and its implications.

Implications & Recommendations: The identification of elasticity of the Beveridge curve should guide policymakers towards integrated and adaptive strategies that address both structural and dynamic aspects of the labour market. Regular monitoring and evaluation will be crucial to ensuring that policies remain effective in the evolving economic landscape.

Contribution & Value Added: Unlike previous literature on the subject, which primarily relied on static analyses and limited time frames, we took a pioneering step by incorporating monthly data on job vacancies and unemployment rate spanning over two decades, from 2000 to 2022. This inclusion allowed us to encompass the period of the COVID-19 outbreak, providing a comprehensive understanding of the matching mechanism's behaviour as a cornerstone for entrepreneurship during times of extraordinary economic stress.

Article type:	research article
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INTRODUCTION

In recent years, the study of labour market dynamics and its underlying mechanisms has garnered significant attention from researchers, policymakers, and economists worldwide. As economies face continuous transformations and challenges, understanding the matching process between job vacancies and unemployed individuals becomes of paramount importance. The labour market's functioning is crucial for overall economic stability and growth, making it a subject of intense interest and relevance. The labour market serves as the backbone of any economy, and its efficiency plays a pivotal role in determining economic growth and stability. With the ever-changing dynamics of the global economy and the recent unprecedented disruptions brought about by the COVID-19 outbreak, understanding the mechanisms that govern labour market dynamics has become more crucial than ever before. In this context, our research delves into the matching mechanism that underpins the interaction between job vacancies and the unemployment rate, seeking to shed light on its stability and responsiveness from both short-term and long-term perspectives.

This article aims to shed light on the matching mechanism in the US labour market and its impact on the Beveridge curve, which is a fundamental tool for assessing labour market efficiency. Unlike previous studies that focus solely on pre-COVID-19 data, we delved into the 2000-2022 period, explicitly including the COVID-19 outbreak data. This temporal extension was vital as it allowed us to explore the unique dynamics introduced by this unprecedented global event.

The novelty of our article lies in the development of a microstructural model that not only captures the intricacies of the labour market's matching mechanism but also establishes a clear connection between this mechanism and the level and slope of the Beveridge curve. By adopting a dynamic rolling scheme to extract Beveridge curve parameters as a time series, we could uncover valuable insights into the evolving nature of the labour market.

Our primary objective was to investigate the stability and flexibility of the matching mechanism over different time horizons. We examined the long-term trends and the short-term adjustment mechanisms to understand how the labour market responds to various shocks and influences. Furthermore, we explored the possible relationship between the extracted parameters using the VECM(1) model. In this spirit, we formed the following research questions.

1. How does the matching mechanism evolve over time in the US labour market, considering data from 2000 to 2022, including the impact of the COVID-19 outbreak?
2. What is the relationship between the parameters of the Beveridge curve and the underlying dynamics of the labour market matching process? What are the characteristics of short-term adjustment mechanisms in the labour market and how do they affect the Beveridge curve?
3. How stable is the matching mechanism in the long term, and how does it respond to short-term adjustments, particularly in the face of external shocks such as the COVID-19 pandemic?
4. Is there any evidence of Granger causality between the extracted parameters describing hidden processes of job creation, job leave, and the matching mechanism?

We wanted to test the following research hypotheses, which provided a framework for further research and analysis to explore the dynamics of the labour market, the impact of the COVID-19 pandemic, and the implications for entrepreneurs and policymakers.

1. The Beveridge curve parameters, specifically parameter '*a*,' which represents the rate of unfilled job places when the unemployment rate is infinite, did not experience a significant change during the COVID-19 pandemic. The Beveridge curve parameters – specifically parameter '*b*' responsible for the speed of the job matching process – did not experience a significant change during the COVID-19 pandemic. The matching mechanism's stability in the long term suggests that the fundamental interaction between job vacancies and the unemployment rate remained intact during the pandemic, despite challenges posed by the economic conditions.
2. The COVID-19 pandemic had a disruptive impact on the short-term dynamics of the job-matching mechanism, leading to slower adjustments in the labour market during periods of economic fluctuations. While the short-term adjustment process of the matching mechanism is flexible, the relatively weak adjustment process in the short run compared to the long run may present challenges for entrepreneurs in addressing sudden economic shocks.

The article is organized into several sections to address our research questions systematically. We will present an overview of the existing literature on labour market dynamics and matching mechanisms to establish the foundation for our study. In the next section, we will discuss the conceptual framework that connects the unobserved matching process to the shape of the Beveridge curve, providing crucial insights into labour market efficiency. The subsequent section will include empirical results. We will describe our dataset, comprising US market monthly data on vacancy and unemployment rates from 2000 to 2022. Using the dynamic rolling scheme, we will extract Beveridge curve parameters as a time series and explore the relationships between them using the VECM(1) model. We will then delve into a detailed analysis of our findings, highlighting the stability of the matching mechanism in the long term and the responsiveness of short-term adjustment mechanisms. In the final section, we will offer a discussion of our results, drawing meaningful conclusions and implications for policymakers, economists, and researchers alike. In conclusion, we will endeavour to deepen our understanding of labour market dynamics, unravel the complexities of the matching mechanism, and provide valuable insights into the behaviour of the US labour market amidst the extraordinary circumstances posed by the COVID-19 outbreak.

LITERATURE REVIEW

The job matching process plays a crucial role in the labour market, as it aims to connect job seekers with suitable employment opportunities. The Beveridge curve, a graphical representation of the relationship between job vacancies and unemployment rates, provides insights into this process. Traditionally, the curve demonstrates an inverse relationship, suggesting that as job vacancies increase, unemployment decreases, and vice versa. However, the outbreak of the COVID-19 pandemic has introduced unprecedented challenges. With the economic impact and disruptions caused by the pandemic, the Beveridge curve's shape has changed. Entrepreneurship, which is typically a dynamic driver of job creation, has also been significantly affected. Many start-ups and small businesses faced tremendous difficulties and had to close their doors due to the pandemic's adverse effects on the economy. As a result, the Beveridge curve experienced distortions, with increased unemployment rates despite existing job vacancies. Policymakers and stakeholders are now tasked with developing strategies to support job matching and entrepreneurship to navigate the complex dynamics introduced by the COVID-19 outbreak. In our approach, we treated a matching process as directly unobservable and to tackle this problem we focus on studying changes in the shape of the Beveridge curve. We propose to look at the Beveridge curve dynamics by looking at the relations between the Beveridge curve slope and level parameter relationship. For this purpose, we used the time-varying version of the Beveridge curve and analysed causal relationships between them. In this light, we formulated our research hypotheses, that a long-term matching mechanism was not abrupted by the COVID-19 outbreak. The changes only occurred in a short-term adjustment mechanism.

To understand these hypotheses a little deeper, imagine the labour market as a single, unified market, we could use a standard framework of supply and demand. This means that we measured the quantity of labour on a horizontal axis and real wages on a vertical axis. When real wages are too high, the result can be unemployment. The unemployment rate $u \in (0,1)$ is a fraction of unemployed workers divided by the size of the labour force. The vacancy rate $v \in (0, \infty)$ is the number of vacancies divided by the size of the labour force. We also assumed that unemployment and vacancy rates are related by a Beveridge curve $v(u)$ *i.e.* differentiable and strictly decreasing convex function of the unemployment rate as defined by Michaillat and Saez (2021). We were interested in the elasticity of this function and the distortion and adjustment processes. As indicated by Dutu *et al.* (2016), Holmes and Otero (2020), and Michaillat and Saez (2021), change in the Beveridge curve's shape gives insights into the stability of labour market matching mechanisms and their operational efficiency.

The Beveridge curve originates from microfoundations (Elsby *et al.*, 2015) like matching mechanisms and their variants (Pissarides, 2009; Shimer, 2005; Hall, 2005b; Hall & Milgrom, 2008; Elsby & Michaels, 2013; Michaillat, 2012). Some of the other microstructural mechanisms for the Beveridge curve include stock-flow matching (Ebrahimy & Shimer, 2010) or mismatch (Shimer, 2007). Most of those matching models surprisingly assume that the Beveridge curve holds at all times (Pissarides, 2009; Hall, 2005a,b; Elsby *et al.*, 2009; Michaillat & Saez, 2021). On the other hand, over the business cycle, unemployment and vacancy rates tend to move along the Beveridge curve and distortions in its shape arise. This causes high changes in the elasticity of the Beveridge curve and shifts in the labour market tightness mechanism (Michaillat & Saez, 2021). In this article, we allowed the parameters of the Beveridge curve to evolve and we were interested in the relationship between these parameters, frictions in both the employment and vacancy and the adjustment processes (Dutu *et al.*, 2016).

Our approach to understanding the labour market and unemployment dynamics consisted in recognizing that it is not a single, organized market in a steady state, but rather made up of various segmented markets based on factors like location, industry, and worker skills which fluctuate over time. This means that both workers and firms must make decisions under uncertainty and adjustment in these markets can be slow, resulting in mismatch and ultimately, unemployment (Herz & van Rens, 2020).

The idea of the natural rate of unemployment is formulated by Abraham and Katz (1986) given the labour market is not a single, well-organized market, but instead consists of many segmented markets. This is a crucial aspect of the labour market that all economists acknowledge. Even simple facts, like the coexistence of unemployment and job vacancies, cannot be explained without considering the heterogeneity of the labour market. Pissarides (2009) emphasizes market segmentation and incomplete information. Abraham and Katz (1986) conducted a study to clarify two possible explanations regarding the relationship between unemployment and job offers fluctuations. This implies that the Beveridge curve, which represents the relationship between unemployment and job vacancies, frequently shifts up and down. Abraham and Katz (1986) found that movements along a stable Beveridge curve dominate. This is consistent with Beveridge's definition of full employment, where unemployment is no greater than job vacancies. The movement along a particular Beveridge curve causes changes in cyclical or Keynesian unemployment, whereas a shift in the Beveridge curve leads to changes in natural or frictional unemployment. In this article, we took a dynamic perspective on changes in the wage and natural unemployment mechanism and change $e_{it} \to e_{it+1}$ (Aoki & Yoshikawa, 2007).

RESEARCH METHODOLOGY

The Concept of Labor Market Dynamics

To model the labour market evolution, we examined an economy consisting of K sectors, where each sector employed n_i workers (for $i = 1, \dots, K$). Productivity levels varied across sectors, and each sector could operate under two statuses: 'normal time' or 'overtime.' These statuses were represented by binary variables v_i, which could be either 0 or 1. During the normal time (when $v_i = 0$), n_i workers in each sector produced an output given by $Y_i = c_i n_i$, where c_i is a constant specific to the sector. During overtime (when $v_i = 1$), n_i workers in each sector produce an output given by $Y_i = c_i(n_i + 1)$.

Each sector had the flexibility to adjust both the number of workers n_i and the status $v_i$it operates under. By changing the hours of work and the number of workers, a firm can modify its production level. The labour productivity in a sector operating under overtime conditions $(v_i = 1)$ was higher than that in a sector operating under normal time conditions $(v_i = 0)$. We based this assumption on the possibility of labour underutilization. According to Okun (1973), this phenomenon can be explained by the fixed costs associated with labour, such as contractual commitments, indivisibility, or complementarity with capital, transaction costs of hiring and firing, and the value of acquired job skills. In periods of economic recession or slack, labour input may exceed the technological requirement to produce the prevailing output level. When demand strengthens, output can be expanded without a proportional increase in labour input, leading to increased productivity.

The total output (GDP) was the sum of outputs from all sectors, given by $Y = \sum_{i=1}^{K} Y_i$. The demand for goods produced by sector i was determined by $s_i Y$, where, s_i represents the share of the total output Y attributable to goods produced by sector i. The shares of all sectors summed up to 1: $\sum_i s_i = 1$.

Hence, each sector had an excess demand defined as $f_i = s_i Y - Y_i$, where, f_i represents the difference between the demand for goods produced by the sector i and its actual output. Changes in the total output Y resulting from changes in any sector affected the excess demands of all sectors. Similarly, changes in the distribution of shares s_i also impacted the excess demands of all sectors.

In the article, we applied an approach assuming that an outcome of interactions of numerous agents facing such incessant distinctive shocks cannot be adequately described by a response of the representative agent, and calls for a relevant model of stochastic processes. To model the time evolution of this economy, we employed a continuous-time Markov chain. At any given time, each sector belongs to one of two groups: those with positive excess demand for their products (profitable sectors) and those with negative excess demand (unprofitable sectors). We denoted the sets of sectors with positive and negative excess demands as $I_+ = \{i: f_i \geq 0\}$ and $I_- = \{i: f_i < 0\}$, respectively. Profitable sectors aim to expand their production, while unprofitable sectors seek to reduce their production levels.

The profitable sectors represent highly developed sectors, while unprofitable sectors represent the other ones. In the article, we tried to notice the shift between the sectors reflected by the moves of the Beveridge curve, and thus to describe the transition of the US economy toward economy after the fourth industrial revolution.

In the stationary equilibrium states of this model, all sectors operated under normal time conditions with zero excess demand. This equilibrium condition may be expressed as the product of the share of the sector i in total output (s_i) and the equilibrium output (Y_e) equals the product of the productivity level (c_i) and the equilibrium number of workers in the sector $i(n_i^e)$. This relation holds for all sectors, represented by the equation:

$$s_i Y_e = c_i n_i^e, i = 1,2, \dots, K \tag{1}$$

We denoted the total equilibrium employment as L_e, which is the sum of the equilibrium number of workers in all sectors:

$$L_e = \sum_{i=1}^{K} n_i^e \tag{2}$$

We can further express L_e in terms of the equilibrium output Y_e using the relation:

$$L_e = \left(\sum_{i=1}^{K} \frac{s_i}{c_i}\right) Y_e = \kappa Y_e \tag{3}$$

in which κ is defined as: $\kappa = \sum_{i=1}^{K} \frac{s_i}{c_i}$.

The equation (3) represents the relationship between the equilibrium level of GDP (Y_e) and the corresponding level of employment (L_e). Since both Y_e and L_e can take any arbitrary values, this model exhibited a continuum of equilibria. Concentrating on the two sector groups enabled us to obtain a more profound insight into the relationship between unemployment and job vacancies. In this economy, there exists a coexistence of unemployment u and job vacancies v. The relationship between u and v is represented by the Beveridge curve of the form

$$v = a + b/u \tag{4}$$

The hyperbolic form is popular, because it can reflect certain theoretical assumptions about the labour market, such as assuming that there is a natural rate of unemployment that can be achieved over the longer term and that the more job vacancies there are, the easier it is to find employment, and vice versa. The hyperbolic form has some intuitive properties. When the number of job vacancies is high, the unemployment rate is low, which aligns with intuitive expectations. Furthermore, the hyperbolic form allows for easy reversibility of the equation to calculate the unemployment rate based on the number of job vacancies, which is useful in labour market analysis and the description of the job search process. The more job vacancies are available, the easier it is for the unemployed to find work. However, as the number of job vacancies decreases, competition increases, which can lead to higher unemployment rates. The hyperbolic model reflects this dynamic.

To properly understand the curve parameters, imagine $u \to +\infty$, then $v \to a$, in other words, if there is labour oversupply then a reflects the natural propensity to hire. Meanwhile, b may be interpreted as a marginal hiring speed. Studying the relationship between the parameters in the Beveridge curve is related to the matching mechanism in the labour market. The matching mechanism refers to the process where employers and employees are in the labour market and try to match their requirements and qualifications with available job openings. It is an important aspect of the labour market that impacts the dynamics of unemployment and job vacancies. Parameter *a* in the Beveridge curve represents factors affecting job vacancies independently of the unemployment rate, such as structural changes in the economy, seasonality, or long-term trends. In the context of the matching mechanism, parameter *a* can reflect a constant supply of job openings related to specific sectors, occupations, or locations. If parameter *a* is large, it indicates a significant number of job openings available regardless of the current unemployment level, suggesting the existence of stable labour markets. Parameter *b* in the Beveridge curve represents the impact of the unemployment rate on job vacancies. In the context of the matching mechanism, parameter *b* can reflect the flexibility of the labour market in response to economic fluctuations. If parameter *b* is large, it means that changes in the unemployment rate have a significant impact on the number of job openings, suggesting that the labour market is more responsive to cyclical changes. Studying the relationship between parameters *a* and *b* in the Beveridge curve can help us understand how the matching mechanism operates in the labour market. A large parameter *a* indicates labour market stability and strong structural factors, while a large parameter *b* suggests greater labour market variability in response to cyclical changes. This can be useful for both theoretical analysis of the matching mechanism and practical policymaking related to the labour market.

RESULTS AND DISCUSSION

The main aim of this article was to assess the US labour market dynamics and identify potential structural changes in the job matching mechanisms due to the forced evolution of labour market conditions associated with the shift to a remote model during the COVID-19 pandemic and the pressure to increase productivity and entrepreneurship. Since the matching mechanism is not directly observable and measurable, and instead follows only changes in the level of unemployment and the number of new unfilled vacant positions, we decided to look at the Beveridge curve dynamics by examining the relationships between the Beveridge curve parameters. In this article, we described the structure of the US labour market by the moving Beveridge curve for consecutive months between 2000 and 2022, giving 276 initial observations. We downloaded the data from the Federal Reserve Economic Database, and the size of the sample matched the long-term cyclicality of the US labour market. The starting point of our empirical procedure was equation (5) describing the linear relationship between the vacancy rate and the inverse of the unemployment rate for which we allowed the parameters to vary in time. We call this equation the dynamic Beveridge curve:

$$v_t = a_t + \frac{b_t}{u_t} + \epsilon_t \quad \epsilon_t \sim iiN(0,1). \tag{5}$$

In the first step, we used the moving ordinary least squares regression to calculate the estimates of the parameters a_t and b_t. For this purpose, we used a moving window of the length of twelve months. This assumption is convenient to control for seasonality in the labour market. Finally, we were left with 264 observations. Figure 1 presents the evolution of the parameters of the Beveridge curve (right panel) along with the evolution of the vacancy and unemployment rate (left panel). Shaded areas represent recessions as defined by NBER (National Bureau of Economic Research). When looking directly at the vacancy rate and the inverse of the unemployment rate as presented in Figure 1, we observed that until the COVID-19 outbreak both the vacancy rate and the inverse of unemployment followed each other in a balanced manner.

During periods of recession, vacancies fell and unemployment rose. Starting in 2015, we observed a faster decline in unemployment (an increase in the inverse of unemployment) than an increase in vacancies. During the pandemic period, unemployment in the U.S. rose sharply, which was not followed by an equal increase in vacancies. From then until mid-2022, the vacancy rate in the labour market exceeded the inverse of the unemployment rate, which can be read as a significant change in the labour market caused by the change in the labour model and the shift to a remote work model, and the emphasis of public policies on supporting entrepreneurship and protecting jobs. In mid-2022, with the gradual easing of pandemic restrictions and the reduction of support, we could observe a return of the labour market to the dynamics seen before 2015. This empirical observation suggests that U.S. government-led efforts to counteract the effects of pandemic restrictions may have disrupted the natural process of connecting job seekers with employers. Therefore, we decided to look into the relationship between the parameters of the Beveridge curve and further investigate the matching process presented graphically in the right panel. The relationship between a_t, which represents the rate of unfilled job places when the unemployment rate is infinite, and b_t which represents the speed of the job matching process represents slightly different dynamics. The parameter *a* related to the rate of vacancies in the labour market decreases during recessions. At the same time, the value of the parameter b, responsible for the speed of adjustment of the matching process, increased during periods of recession. To better understand these empirical observations, the next stage of the study presents basic descriptive characteristics of the analysed processes. Table 1 summarises these data.

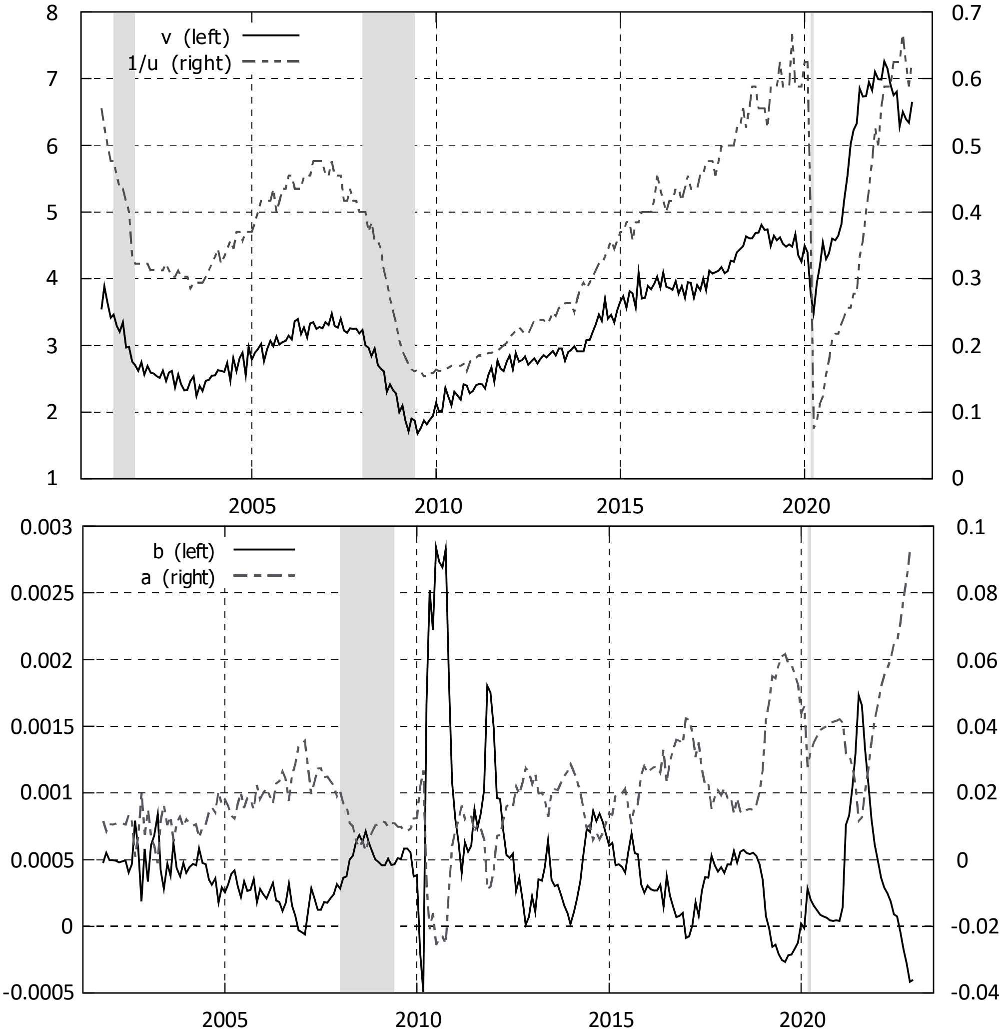

Figure 1. The evolution of the Beveridge curve and the matching mechanism
Source: own elaboration based on data downloaded from the Federal Reserve Economic Database (FRED).

A careful analysis of the results gathered in Table 1 brings a couple of important results. Foremost, the mean value of the v_t is ten times larger than the mean value of $1/u_t$. This suggests that both mean level of vacancy and unemployment rate were quite similar over the whole studied period. Furthermore, focusing on the long-term matching mechanisms, the mean value of a_t equalled 0.0215 and the standard deviation equalled 0.0178. This translates into a p-value equal to 0.8865 for a standard z-significance test. This means, that the mean level of vacancy rate when the unemployment rate is infinite is statistically insignificant and equal to zero. Along similar lines, we can perform analysis for the b_t parameter, which had the mean value $b_t = 0.0005$ and the standard deviation equal to 0.0005 with p-value equal to 0.8414, which we may interpret as the constant pace of the matching mechanism eventually. Focusing on the short-term matching mechanism represented by the first differences of the dynamic Beveridge curve parameters, Δa_t an Δb_t and the values of descriptive statistics gathered in Table 1, we again observed relatively small values of mean statistics followed by relatively large values of standard deviations, which we can interpret as a weak adjustment process of the matching mechanism in the short run. In other words, during periods of economic fluctuations or rapid changes in the labour market, the matching mechanism exhibits limited responsiveness, resulting in slower adaptation to short-term shocks or imbalances. The stability and relative independence of the matching mechanism in the long term underscore its fundamental role in maintaining equilibrium between job vacancies and the unemployment rate. However, the limited short-term responsiveness of the matching mechanism calls for a deeper examination of factors that may hinder its swift adjustment during economic fluctuations.

Table 1. Summary statistics using the observations 2000:12-2022:12 (missing values were skipped)

Variable	Mean	Median	Min.	Max.	St.dev.	Skewness	Kurtosis	IQR
Levels								
v_t	3.4900	3.1888	1.6795	7.2606	1.2194	1.3354	1.5272	1.4273
$1/u_t$	0.3633	0.3571	0.0758	0.6667	0.1344	0.1473	-0.76934	0.2013
b_t	0.0005	0.0004	-0.0005	0.0028	0.0005	2.3521	7.9740	0.0004
a_t	0.0215	0.0184	-0.0256	0.0925	0.0178	1.0004	2.7192	0.0165
first differences (dynamics)								
Δv_t	0.0118	0.0103	-0.6225	0.5233	0.1739	-0.0087	0.6839	0.2161
$\Delta(1/u_t)$	0.0003	0.0000	-0.3089	0.0784	0.0306	-5.7152	52.4050	0.0133
Δb_t	-0.0001	-0.0001	-0.0010	0.0022	0.0002	3.2984	33.0270	0.0001
Δa_t	0.0003	0.0005	-0.0341	0.0164	0.0053	-1.2197	7.3149	0.0054

Source: own elaboration with results rounded up to four significant digits.

To elaborate these findings deeper, the next step of the research included a causality analysis, which included a Johansen cointegration procedure between a_t and b_t and the Granger causality test for the first differences (see Granger (1969); Johansen (1988)).

Having calculated the variables used in the first step, we continue the analysis of the long-term relationships by looking at the results of the cointegration tests. This procedure involved the estimation of a VAR(1) model with the unrestricted constant. We selected the exact form of the model for the procedure based on the information criteria (Log-likelihood $= 3682.42$ (including constant term: 2964.44)). Table 2 presents the results.

Table 2. Results of the cointegration test

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.0567	17.8640	[0.0205]	14.7740	[0.0394]
1	0.0121	3.0900	[0.0801]	3.0900	[0.0788]

Source: own study with results rounded up to four significant digits.

Studying the cointegrating relationship between parameter *a* and parameter *b* in the Beveridge curve is justified for several reasons. Parameters *a* and *b* in the Beveridge curve reflect the long-term characteristics of the labour market. Parameter *a* represents structural and constant factors influencing job availability, which change over an extended period. On the other hand, parameter *b* represents the impact of unemployment levels on job availability in the long run. Investigating cointegrating relationships helps to understand how these long-term factors are related. Cointegrating relationships suggest that there is a long-term equilibrium between parameters *a* and *b*. If these parameters deviate from their equilibrium, a correction process (*e.g.* through intervention or natural changes) may restore balance. This is significant in the context of the labour market, where long-term trends and dependencies can affect market stability and behaviour. If there is a long-term relationship between these parameters, changes in one of them may influence the long-term equilibrium of the labour market. Analysing the cointegration between *a* and *b* can assist in studying long-term trends in the labour market. Understanding how these parameters are interrelated can help forecast long-term changes in the labour market and adapt to them.

A thorough analysis of the results presented in Table 2 leads to the conclusion that we have a single cointegrating relation between the level and the slope of the Beveridge curve. This means that the matching mechanism was not disrupted in the long term due to the pandemic. This pivotal discovery bears profound implications for our understanding of the labour market dynamics, particularly in the context of the COVID-19 pandemic. The presence of a cointegrating relationship signifies a stable and resilient matching mechanism in the long term. It provides compelling evidence that despite the unprecedented challenges posed by the pandemic, the fundamental interaction between job vacancies and the unemployment rate remained intact. This persistence indicates that the labour market's essential functioning, which revolves around effectively connecting job seekers with available job opportunities, managed to withstand the disruptive impact of the pandemic. The identification of a single cointegrating relation between the Beveridge curve's level and slope signifies the mechanism's resilience in the face of unprecedented challenges. Furthermore, considering the role of entrepreneurship our approach offers a comprehensive understanding of the labour market's dynamics and highlights the importance of supporting innovative ventures.

Given the results of the cointegration test, the next step included the calculation of the VECM(1) model to properly understand the matching mechanism adjustments. The VECM(1) had the form:

$$\begin{aligned} \Delta a_t &= \alpha_0^1 + \alpha_1^1 \Delta b_{t-1} + \gamma_1^1 \Delta a_{t-1} + \tau_1^1 EC_{t-1}\epsilon_1 \\ \Delta b_t &= \alpha_0^2 + \alpha_1^2 \Delta b_{t-1} + \gamma_1^2 \Delta a_{t-1} + \tau_1^2 EC_{t-1}\epsilon_2, \end{aligned} \tag{6}$$

in which ϵ_1 and ϵ_2 are identically, mutually independent standard Gaussian variables and EC_{t-1} is the error correction mechanism.

Table 4 presents the results of the Granger procedure and Table 3 – the results of the estimation of the VECM(1) adjustment of the matching process.

Table 3. Results of VECM(1) model for the adjustment of the matching process

Variable	Coefficient	Std.Error	t-stat	p-value
Explanatory variable Δb_t				
α_0^2	0.0001	α_0^2	4.1900	0.0000
α_1^2	0.3193	0.1453	2.1970	0.0289
γ_1^2	0.01110	0.0063	1.7700	0.0779
τ_1^2	-0.1882	0.03889	-4.8420	0.0000
Explanatory variable Δa_t				
α_0^1	-0.0026	0.0008	-3.4290	0.0007
α_1^1	-4.4721	3.4194	-1.3080	0.1921
γ_1^1	-0.1591	0.1475	-1.0790	0.2818
τ_1^1	3.9550	0.9144	4.3250	0.0000

Source: own study with results presented with accuracy up to four significant digits.

Table 4. Results of Granger causality procedure F-tests of zero restrictions

Variables	Test statistic	p-value
All lags of Δa	$F(1.248) = 3.13393$	[0.0779]
All lags of Δb	$F(1.248) = 1.71051$	[0.1921]

Source: own study with results presented with accuracy up to four significant digits.

When looking at the estimates, gathered in Tables 3 and 4, we observe no Granger causality. This means that the adjustment of the matching process is fully flexible in the short run. The jumps in either vacancy rate or unemployment rate are instantaneously balanced by corresponding changes in the second variable without a feedback loop. The adjustment process in the short run is relatively weak when compared to the long-run changes.

Granger causality refers to a statistical concept wherein one variable is said to cause another variable if changes in the first variable can predict or influence changes in the second variable over time. The lack of Granger causality in our research suggests that the adjustment process of the matching mechanism is fully flexible in the short run, particularly when it comes to the interactions between job vacancies and the unemployment rate.

For entrepreneurs and start-ups, this finding has both advantages and challenges. On the positive side, the lack of Granger causality implies that any sudden changes in either the vacancy rate or the unemployment rate can be instantaneously balanced by corresponding adjustments in the other variable. This instantaneous balancing of supply and demand in the labour market can be beneficial for entrepreneurs seeking to quickly hire employees when opportunities arise or downsize their workforce when economic conditions require adaptation.

Furthermore, the flexibility in the short-term matching process can create a more conducive environment for entrepreneurship. Start-ups often operate in a fast-paced and unpredictable landscape, and the ability to find talent quickly in response to market demands can enhance their competitiveness and agility. Moreover, the instantaneous balancing observed in the short term allows entrepreneurs to seize immediate opportunities as they emerge, capitalizing on market trends and novel business prospects.

However, the relatively weak adjustment process in the short run compared to the long run can present challenges for entrepreneurs as well. While the labour market demonstrates flexibility, the gradual nature of changes in the matching process over the long term suggests that significant economic shifts may require more time to fully stabilize. This can lead to short-term imbalances between job vacancies and the unemployment rate, posing potential challenges for entrepreneurs in finding the right talent pool or adapting to sudden economic downturns.

Finally, to better understand the effect of government or public interventions during the COVID-19 outbreak, we analysed the adjustment mechanism under the presence of sudden shocks in the parameters of the Beveridge curve. The impulse response to sudden shocks in the job-matching mechanism can vary depending on various factors, including the nature and magnitude of the shock, the economy's resilience, and the effectiveness of policy interventions. Analysing and understanding these impulse responses can help policymakers and researchers develop strategies to mitigate the negative effects of shocks, enhance job-matching efficiency, and promote overall labour market stability. Figure 2 presents the results.

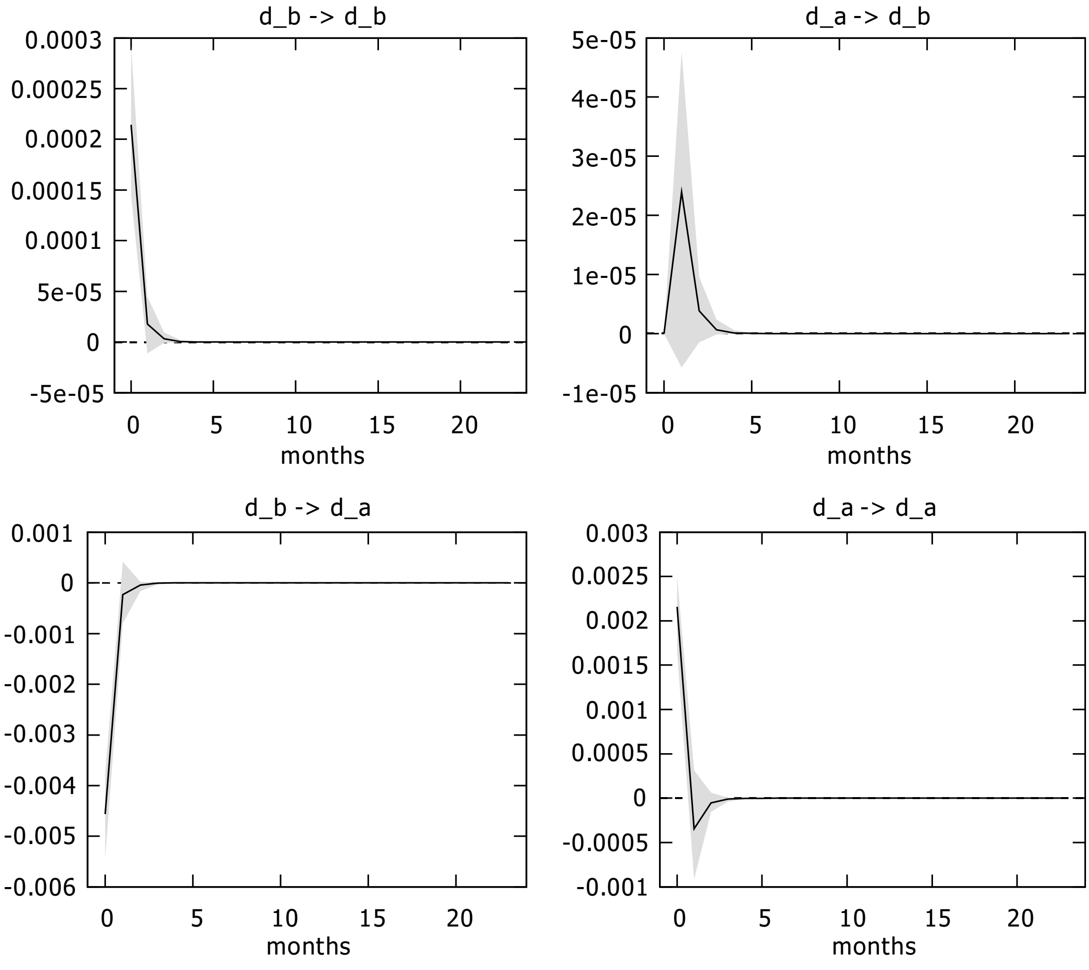

Figure 2. Impulse response functions

Source: own elaboration.

In the context of the job-matching mechanism, the impulse response refers to the reaction of the system to a sudden shock or perturbation. Over the business cycle, vacancy and unemployment rates move along the Beveridge curve (Michaillat & Saez, 2021; Lazaryan & Lubik, 2019). When an exogenous shock occurs in the job matching process, it disrupts the equilibrium and triggers a series of adjustments, which start immediately after the shock and end three months later. The whole job market returns to its initial state in the next quarter, which can be attributed to workers' bargaining power (Shimer, 2005). In the case of a positive shock, such as an increase in job vacancies or improved matching efficiency, the impulse response can manifest in several ways. Initially, there may be a surge in the number of job seekers finding employment, leading to a decrease in the unemployment rate. As more individuals are successfully matched with suitable jobs, the overall labour market conditions improve as previously reported by Michaillat (2012). This positive shock can generate a virtuous cycle, with reduced unemployment leading to increased consumer spending, economic growth, and further job creation (Ebrahimy & Shimer, 2010). Conversely, a negative shock, such as a sudden decline in job vacancies or a decrease in matching efficiency, can adversely impact the job-matching mechanism. This shock can result in increased unemployment as job seekers struggle to find suitable employment opportunities. The longer the shock persists, the more individuals may become discouraged and drop out of the labour force, exacerbating the unemployment situation. This is consistent with Herz and van Rens (2020) and Holmes and Otero (2020).

CONCLUSIONS

Generally, the slope of the Beveridge curve goes downward, which means that as the unemployment rate rises, the vacancy rate tends to decline. The curve's position describes the labour market's condition, where a low unemployment rate and a high vacancy rate signal a flourishing economy and a 'tight' labour market. As the economy shifts from recession to expansion or vice versa, it shows movements along the Beveridge curve. Conversely, alterations in the job-matching process's efficiency correspond to changes in the whole curve. Moreover, we find that both a_t and b_t vary proportionally. Furthermore, we observe that the matching mechanism in the USA has not been disturbed during the COVID-19 pandemic.

The matching process plays a crucial role in determining the position and shape of the Beveridge curve. The efficiency of the job-matching mechanism affects the rate at which job vacancies are filled and the speed at which individuals find employment. When the matching process is efficient, the curve tends to be steeper, indicating that a smaller increase in the unemployment rate corresponds to a larger decrease in the vacancy rate. Regarding the variables a_t and b_t, which represent the slope and intercept of the Beveridge curve, respectively, their proportional variation suggests that changes in the efficiency of the job matching process are associated with shifts in the entire curve. An increase in matching efficiency would lead to a steeper slope (a_t), indicating a more effective job matching mechanism. For entrepreneurs and start-up founders, understanding the labour market's short-term dynamics can help in making agile and responsive decisions when scaling or making hiring decisions based on immediate needs. However, recognizing the stronger impact of long-term changes can guide entrepreneurs in crafting sustainable business strategies that align with broader economic trends and ensure stable growth in the face of market fluctuations. Policies aimed at reducing structural unemployment should be designed with flexibility and be combined with training and education programs and other initiatives to stimulate job creation or enhance workforce skills. The long-term relationship between a_t and b_t might be also important to refine economic models and forecasting tools to improve the accuracy of prediction and help policymakers anticipate the effect of the reduction of structural unemployment on job creation adjustment mechanisms and ensure that monetary and fiscal policies like tax and interest rates are designed to stimulate job creation and labour market dynamics. Other recommendations include encouraging collaboration between public and private sectors to address structural issues in the labour market and factors influencing job creation and vacancies to enhance the effectiveness of policy interventions.

However, the statement claiming that the job matching process in the USA was not disturbed during the COVID-19 pandemic may require further examination and analysis. The pandemic had a significant impact on the global economy, leading to widespread disruptions in various sectors. The labour market was not immune to these effects, with millions of job losses and a surge in unemployment rates observed worldwide. While it is possible that specific aspects of the job-matching process in the USA remained intact, the overall labour market dynamics were undoubtedly influenced by the pandemic. Factors such as business closures, reduced hiring activities, and changes in demand for certain skills and occupations likely affected the efficiency and functioning of the job-matching process.

Therefore, a comprehensive assessment of the pandemic's impact on the job-matching process in the USA would involve examining specific data, trends, and policies implemented during that period. It would be necessary to consider the dynamic interplay between factors such as government interventions, economic recovery measures, and the evolving demands of the post-pandemic labour market.

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The contribution share of authors is equal and amounted to 50% for each of them.
MS – conceptualisation, literature writing, methodology, calculations, data analysis, discussion.
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Conflict of Interest

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