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The Beveridge Curve: an Analysis for the Italian Labor Market

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Abstract

Descriptive evidence of the unemployment-vacancy relationship for Italy over the period 2004-2019 reveals that the Italian Beveridge Curve has undergone a considerable outward shift as of 2011, essentially driven by the sizeable rise in unemployment and the slight reduction in the rate of job openings for years 2011-2013. Among the potential factors behind the shift, shocks to workers' transitions across the states of employment, unemployment and inactivity are considered as the contributing factors because of the significant fluctuations they have experienced between 2011-2013. A stylized matching model for the Italian economy is developed. The theoretical framework models a three-state labor market, allowing for the participation margin along with the employment and unemployment ones. The coexistence of fixed-term and open-ended jobs and institutional features, such as firing costs in the case of employee's lay-off and exogenous wage rigidity, are also included. By shocking the parameters of workers' flows across labor market states, the calibrated version of the model accounts for almost all the increase in unemployment and for part of the observed outward shift of the Italian Beveridge Curve.

Keywords: Beveridge Curve, Italy, outward shift, matching model, three-state labor market, participation, wage rigidity, firing costs

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1 Introduction

The Beveridge Curve has always occupied a pivotal position in the macro labor literature given its ability to assess the state and the functioning of labor markets. Furthermore, the analysis of the coexistence of unemployment and job vacancies, embedded in the negatively inclined Beveridge locus, evolved during the last decades thanks to the advancements in the measurement of vacancies and *"to the parallel development of theories of labor-market frictions, pioneered by Diamond 1982, Pissarides 1985, and Mortensen and Pissarides 1994"* (Elsby, Michaels, and Ratner 2015).

The *search and matching model* they have developed, considered as the canonical workhorse model of the aggregate labor market, formally models the existence of a "job-worker matching process," where unemployed workers are involved in a search process, and firms dispose of vacant positions to be filled.

Nevertheless, except for the contribution of Cardullo and Guerrazzi 2016, the literature lacks of both an empirical evaluation and a theoretical explanation of the Beveridge Curve pattern and dynamics for Italy for years after 2004.

In this regard, the purpose of this master thesis is twofold. First, to fill the gap of the existing literature by providing *descriptive evidence* of the curve for the period 2004-2019. This objective could be easily realized by means of the recent availability of new and reliable data about job openings for Italy since 2004. In this respect, the visual inspection of the curve in section 2.3 will reveal a considerable outward shift as of 2011, essentially driven by the rise in unemployment and by the decrease in the job vacancy index in the same year. The second objective is to evaluate if a *stylized matching model* for the Italian labor market, allowing for flows between employment, unemployment, and non-participation (instead of focusing solely on flows between employment and unemployment, as in a standard matching model), could account for the sizeable rise in unemployment and the observed rightward shift of the curve.

Indeed, the literature on search equilibrium models conveys that there could be two potential determinants of such a movement of the curve: a deterioration in the efficiency of the matching process, or an increase in the rate of job destruction, the latter interpreted as workers' flows from employment to unemployment.

The degree of matching efficiency has *"no obvious counterparts in reality"* (Cahuc, Carcillo, and Zylberberg 2014), no empirical evidence could be gathered, resulting in an omission of this estimation for Italy in order to check for significant fluctuations since 2011. On the other side, the second parameter can be directly inferred by looking at the empirical evidence on workers' transition probabilities. Since 2010, Eurostat has collected empirical evidence about quarter-on-quarter flows across the labor market states of employment, unemployment, and inactivity for European countries, including Italy.

As starting point, the theoretical model will be based on Mortensen and Pissarides 1994 model of equilibrium unemployment, including *endogenous job creation* and *endogenous job destruction*. Furthermore, reacting to the empirical evidence about fluctuations of significant magnitudes in workers' transition probabilities between employment, unemployment and non-participation observed for the period 2011-2013 (section 4.4), I will model a three-state labor market, where the participation margin is also included along with the employment and the unemployment margins, where *"flows in and out of unemployment now may be associated either with job loss/finding or with labor force entry/exit"* (Elsby, Michaels, and Ratner 2015). This is the

main difference in my framework with respect to the bulk of the existing literature that models workers' flows just across two states; i.e., employment and unemployment.
The model will also be consistent with the existing labor market institutions for Italy: binding national collective agreements for wages, and strict rules of job security provision in the case of worker's lay-off.

To conclude, a *numerical analysis exercise* will be conducted. First, I will calibrate the enriched matching model for the period from the second quarter of 2010 to the first quarter of 2011, the period *before* the shift. Then, I will check whether the calibrated version of the model, accounting for shocks to flows across the three states, is able to capture the rise in unemployment and the observed shift in the Beveridge Curve.

1.1 Related Literature

As for the literature review, I will start by presenting the literature related with the empirical evidence of the Beveridge Curve for Italy. This stream of the literature will be presented and differentiated according to two aspects: the rationale behind the investigation of the Beveridge Curve and the period for which the analysis is conducted. Then, the contribution of the literature on matching models will be reviewed. First, I will focus on matching models that have tried to reproduce a *stylized* Italian economy. Then, contributions that have extended the standard Diamond-Mortensen-Pissarides framework (DMP henceforth) with the inclusion of employment protection, assumptions *different* from Nash bargaining as wage-setting mechanism and non-participation will be assessed.

1.1 Empirical evidence of the Beveridge Curve for Italy

Empirical estimations of the Beveridge Curve and of its dynamics are generally carried out for different countries. However, the estimation of the Beveridge Curve for Italy collects a more narrow set of contributions which differ in two main respects: the reason for estimating the curve dynamics, and the period under analysis.
Regarding the first aspect, most of existing works (Destefanis and Fonseca 2007, Di Giorgio and Giannini 2012) has been concerned with the effects of primary reforms of the labor market implemented at the beginning of 2000s. Others (Mandrone 2012) have rather analyzed whether the matching process for Italy has been affected by different regional mechanisms due to the differentiation of the Italian labor market in the three main geographical areas of the North, Center and South. Some works (Destefanis and Fonseca 2007) replicated also at the regional level the analysis initially conducted at the national level. Finally, Cardullo and Guerrazzi 2016 addressed for Italy the concern raised by Shimer 2005 about the cyclical behavior of unemployment and vacancies[1].
Regarding the period of analysis, the literature focused either on the period before 2004 (Destefanis and Fonseca 2007, Mandrone 2012, Di Giorgio and Giannini 2012) or on its aftermath (Cardullo and Guerrazzi 2016). The gap of existing literature for the more recent period is evident.
This differentiation is related to data availability, because there exist just two available data sources on job

[1] The so-called "unemployment-volatility puzzle". According to Shimer 2005, the standard DMP matching model is not able to fully reproduce unemployment dynamics because any productivity shock is immediately absorbed into the wage and doe not generate enough volatility for the unemployment rate.

vacancies for Italy. The first is the Help Wanted Time Series (HWTS) provided by the Institute for Workers Professional Development (ISFOL), based on job openings published on newspapers advertisements and covering the period 1976-2003; the second is the official vacancy index worked out as of 2004 by the Italian Institute of Statistical Analysis (ISTAT).

The estimation of the Beveridge Curve for Italy in the period 1993-2003 by Destefanis and Fonseca 2007 aimed to assess the *causal effects* on the efficiency of the matching process of the *Treu Act* (1997), reform aimed at liberalizing the use of fixed-term and part-time jobs (table 3 for a description of the reform). They replicated their analysis at the regional level and their findings pointed out that the reform effectively enhanced an improvement in matching efficiency, only for the Northern region.

Similarly, Di Giorgio and Giannini 2012 estimated the Beveridge Curve for the period 1980-2006. Their objectives consisted in investigating the Beveridge curve dynamics in the United States and Italy and in analyzing the effects of the introduction of new forms of *atypical, fixed-term jobs* due to the implementation of the *Biagi Act* (2003) on the curve dynamics for the latter country. The choice of the US for the comparison was not casual, because, as underlined by the authors, *" the two countries represent almost polar cases because of different wage rigidities and search mechanisms"*. Their results showed that Beveridge Curves for both countries have undergone an inward movement (since 1980s for US, since 1990s for Italy). For the latter country, the reform determined a decrease in unemployment -even if most of new hires involved fixed-term jobs-, thus improving efficiency of the Italian labor market along this margin.

In his work, Mandrone 2012 first proposed a qualitative description of the "Help-Wanted Time Series" dataset and the main drawbacks this index had as a measure of vacancy openings for the period before 2004 (limitations of this measure are broadly discussed in section 2). Subsequently, he plotted the Beveridge Curve for Italy as a whole and for the three geographical areas by means of the above-mentioned dataset about job vacancies. He found out that typical downward sloping pattern of the Beveridge Curve could be observed just for the Northern and the Center regions of the country.

Finally, the work of Cardullo and Guerrazzi 2016 provided the *only* empirical estimation of the Beveridge Curve for years after 2006, thus relying on the new available official vacancy data furnished by Istat after 2004. The two authors presented two key findings: first, they estimated through an OLS regression the slope of the unemployment-vacancy relationship and they detected a significant negative coefficient over the period 2004-2014, in line with the theoretical prediction of a downward sloping Beveridge Curve. Furthermore, the *"unemployment-volatility puzzle"* advocated by Shimer 2005 may be inferred even for Italy.

1.2 Search Equilibrium Model Theoretical Literature

The building up of a matching model describing a *stylized version* of the Italian labor market is something already present in the literature on search equilibrium models.

Garibaldi and Violante 2005 built a model aimed at capturing the simultaneous existence in the Italian labor market of workers hired under fixed-term contracts and under open-ended contracts, the so-called *"dual"* or *"outsider-insider structure"*. The first type of contracts represents apprenticeship/training contracts or entry jobs for initial periods in an employment relationship, the second type of contracts is rather considered of unlimited duration. In their model, each new match starts as outsider, before transitioning towards the insider phase. Furthermore, outsider and insider workers differ in their productivity levels and wages paid by the firm, the latter being set *exogenously.* Any type of contract is subject to employment protection in the case of layoff, *"imposing to the firm firing costs, composed by a transfer component (severance payment) from the firm to the worker and taxes to be paid outside the job-worker pair"* (Garibaldi and Violante 2005). Gerali, Guglielminetti, and Liberati 2021 also adopt the outsider-insider structure and the fixed-wage assumptions for Italy. Their objective consists in analyzing the effects of the reforms broadly enhancing the use of fixed-term contracts, implemented in Italy since the mid-90s (i.e., *Treu Act (1997), Biagi Law (2003)).* As other papers (Cahuc and Postel-Vinay 2002, Bentolila et al. 2012, Sala, Silva, and Toledo 2012), they extend the "outsider-insider structure" by allowing contracts in the outsider phase to be converted with exogenous probability either into fixed-term jobs or into jobs of unlimited duration.

Garibaldi and Violante 2005 and Gerali, Guglielminetti, and Liberati 2021 just model a two-state, employment and unemployment, labor market, whereas the search equilibrium model of this thesis will include a third state, *inactivity.* In this regard, several authors have built a general equilibrium model with the three labor market states. Garibaldi and Wasmer 2005 built a general equilibrium model where agents could be in either one of the three states of full-time home production, unemployment and employment and where entry and exit decision in the labor force, job creation by the firm, and job destruction decision by the worker-firm pair are all endogenous. Haefke and Reiter 2011 proposed a general equilibrium search model where only the participation decision by workers is endogenous, but they introduce fluctuations in the cost of vacancy openings. Petrongolo and Pissarides 2008 amended the equation defining the dynamics of unemployment by including also participation flows, rather than "only" flows in and out of unemployment.

In contrast to the existing literature, the model developed in this thesis will differ in two respects:

1. it differs from previous general equilibrium matching models describing a stylized version of the Italian economy because of the inclusion of the *participation margin*;
2. it extends previous works modeling the third state of the labor market by including the role played by job security provision and a wage formation mechanism different from the baseline assumption in matching models. Employment protection will impose firing costs to the firm, including both the *transfer component (severance payment)* and the *tax component* (i.e., red-tape costs), in the case of lay-off for any type of contract. The wage will not anymore be negotiated between the employees and the employer through Nash bargaining as soon as a match is formed. Fully rigid real wages will be assumed, given that wages in Italy are set through collective agreements, binding at sectoral level.

The rest of the thesis is organized as follows. In section 2, unemployment dynamics, vacancy dynamics, and the descriptive evidence of the Beveridge Curve for Italy for the reference period 2004-2019 are presented. Section 3 and section 4 describe the performance of the Italian economy, its main Labor Market Institutions, and investigate which could be the underlying factors behind the rise in unemployment and the observed outward shift of the Beveridge Curve as of 2011. Section 5 is dedicated to the building up of the matching model. Section 6 presents the numerical analysis. Finally, section 7 concludes.

2 The Descriptive Evidence of the Italian Beveridge Curve

2.1 The dataset

Descriptive evidence of the equilibrium unemployment-vacancy relationship is provided for Italy for the period 2004-2019. For this sake, quarterly data for the main variables of interest for the Beveridge Curve representation, unemployment and job vacancy rates[2], are collected from the RTFL and the VELA surveys of Istat (Italian Institute for Statistical Analysis) for individuals aged between 15-74 years.

The first dataset represents the primary labor force survey for Italy, whereas the latter, just available as of 2004, provides information about vacancies and hours worked for firms[3] and substitutes the Help Wanted Time Series (HWTS henceforth) used as *the* measure of job openings during the period 1993-2003. Furthermore, given that the Italian labor market is structurally affected by long-term unemployment, it seems wise to include in the data at disposal the long-term unemployment rate, the unemployment rate of 12 months or more as percentage of the total unemployment rate, as defined by the International Labour Organization.

There are several reasons behind the choice of the period 2004-2019 for the analysis. As previously mentioned, official statistics for job openings are made available as of 2004, whereas before 2004, the only available statistics for vacancies was the HWTS furnished by ISFOL.

Based on help-wanted job advertisements collected by the Center for Business Statistics, the ISFOL HWTS dataset provided information about job advertisements on the leading 32 Italian newspapers over the period 1978-2003[4] Nevertheless, for reasons of attrition, homogeneous figures are available only for the years 1993-2003 (Mandrone 2012). However, the HWTS has been subject to three noteworthy critiques that may undermine its reliability for analyzing the overall vacancy dynamics before 2004 (Mandrone 2012). First, the job advertisement was just a minor matching channel, whose utilization during the decade 1993-2003 further decreased with the use of online job-search. Second, the HWTS included mainly skilled job vacancies, targeting very specific job profiles. Lastly, 12.6% was the use of this channel among the other job-matching channels, and roughly 6% were matches created by job advertisements.

In addition to these qualitative critiques, the two series for unfilled job openings do not overlap (as easily seen in fig. 5), resulting in the inability to implement consistent merging procedures (Cardullo and Guerrazzi 2016). This issue, jointly with the qualitative drawbacks highlighted before, leads to the decision of referring uniquely to the job vacancy index provided by the VELA survey.

However, the latter survey also presents certain drawbacks that determine potential limitations in the analysis to conduct (and in the stylized search and matching model to develop). The job vacancy rate is collected neither according to skill levels nor on a regional basis, thus excluding *a priori* the analysis of skills and regional mismatches phenomena for Italy; second, even if job openings are differentiated according to

[2]In the analysis that follows, variables follow Istat and Eurostat official definitions in LFS surveys. Thus, the unemployment rate is computed as the ratio of unemployed individuals as a percentage of the corresponding labor force, whereas the job vacancy rate (JVR) is the percentage of job vacancies over the sum of job vacancies and already occupied jobs.

[3]Firms considered by the survey have 10 or more employees. Sectors covered are NACE Rev, B to S, excluded O.

[4]Though the HWTS relies on job advertisements as a basic survey unit, an estimate of the number of job vacancies opened by firms has been furnished for each quarter.

full-time or part-time positions, there is no differentiation among vacant positions referring to fixed-term jobs and those instead referring to open-ended positions, whereas the Italian labor market has been deeply affected, in the last two decades of the 2000s, by the coexistence of fixed-term and open-ended jobs (the so-called *two-tier structure*).

Lastly, it seems cautious to conclude the analysis in 2019, given that the outburst of the Covid-19 crisis has profoundly affected and distorted the dynamics of the labor market[5].

2.2 Unemployment rate and vacancy rate dynamics

The analysis of the patterns for unemployment, long-term unemployment and vacancies over the reference period 2004-2019 and of which could be the determinants behind the dynamics for these variables[6] is the objective of this subsection.

From the first quarter of 2004, the unemployment rate felt constantly until the 2008 crisis, reaching its minimum value of 5.9% in the third quarter of 2007. However, since the striking of the global financial crisis in 2007-2008 the rate has increased significantly, following an even faster pace for observations of 2011-2013[7]. At the beginning of 2014, the unemployment rate reached its peak of 12.8%, before beginning to reduce at the end of that year, but still with values largely above pre-crisis levels.

As shown in fig. 1, the unemployment rate dynamics mimic substantially those of the long-term unemployment rate, proving that the observed increase in unemployment is almost entirely driven by the increase of unemployment of more than 12 months.

Indeed, long-term unemployment has always been a persistent phenomenon for the Italian labor market dynamics and its magnitude has been strongly increasing over the period 2004-2019.

It reached its lowest value at the onset of the Great Recession, but the years of the crisis have been characterized by values of huge magnitude for this variable, and, as for the unemployment rate, a more rapid pace has been observed for the period 2011- 2013. In 2014, more than 70% of the total unemployment rate was composed of its long-term component. For years ahead 2014, the long-term rate began to show a decreasing trajectory, still its values have been considerably higher in comparison with the pre-Recession ones. In 2019, the share of long-term unemployment over total unemployment has been equal to 58%.

The job vacancy rate has shown a rather unstable path over the reference period. The value of 1.2%, observed at the beginning of the collection period, was almost halved in 2005[8], but then, the index has recovered before the occurrence of the crisis. As suspected, years of the Great Recession have seen a significant decrease in the rate of job openings, whereas a temporary slight increase of the index has been observed for years 2010-2011. Since 2013, the index has followed a slightly increasing trajectory.

[5]The implementation of the Decree "Cura Italia" (D.L. n.18/2020) and of the layoffs block is an example of how the unemployment rate values could be distorted starting from the second quarter of 2020.

[6]Seasonally adjusted variables are considered after testing for the statistical properties of the raw time series for all the three variables at stake.

[7]The unemployment time series has not been subject to any structural break over the reference period. Thus, we exclude the case where this substantial increase of the unemployment rate may depend on the occurrence of such break (i.e., as observed for Belgium in 2011).

[8]It is possible that the volatility of the vacancy series for 2004 and 2005 could be due to difficulties in the implementation of this new survey. However, there is no confirmation of such hypothesis in the literature.

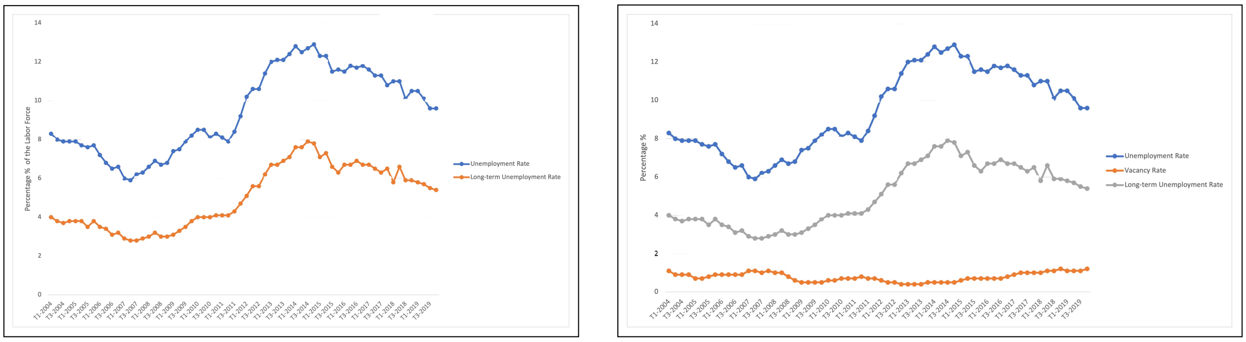

Figure 1: Patterns of unemployment, long-term unemployment and job vacancy rate, 2004–2019.

The works of Boeri and Garibaldi 2007 and Boeri and Garibaldi 2019 have tried to understand what is behind unemployment and vacancies dynamics over the reference period and they found out that a significant role has been played by the reforms implemented in the last two decades (table 3 proposes an overview of the main reforms). Boeri and Garibaldi 2007 proposed that the decrease in unemployment observed before the 2007-2008 crisis represented a temporary *"honeymoon"* effect of the *Treu Act* (1997) and of *Biagi Law* (2003), the two reforms enhancing the process of liberalization of fixed-term forms of employment. Furthermore, the same authors (Boeri and Garibaldi 2019) sustained that the unemployment and vacancies patterns after 2013 have likely been affected by the implementation of the *Jobs Act* (2014-2015), essentially aimed at reducing the strictness of employment protection legislation for open-ended contracts and at providing incentives for new hires under this typology of contracts.

2.3 The Beveridge Curve

The Beveridge Curve for Italy is plotted in fig. 2: the typical downward sloping pattern for the unemployment-vacancy relationship, conveyed by the literature since the seminal work of Beveridge 1942, is confirmed for my period of interest, 2004-2019. Interestingly, the plot reveals also that there are some major movements of the curve that deserve particular attention.
Notably, a **rightward shift** of the curve is detected as of 2011, and this phenomenon is still ongoing in 2019, the last year for which observations of the relevant variables are collected.
The latter represents the most relevant phenomenon to explain, and it will be the purpose of the second part of this master thesis to investigate and formalize, through a *stylized random search and matching model*, which could be the factors behind this shift.

More details of the overall dynamics of the Curve are provided. The reduction of the unemployment rate and the increase in the rate of job openings occurred before the 2007-2008 global financial crisis allowed the curve to slightly shift inward in the pre-crisis period: the coordinates of the curve at the onset of Recession were closer to the origin rather than those of 2004. However, the first years of the economic and financial crisis experienced a consistent decrease in the vacancy rate, particularly during 2008, and greater unemployment rate values.

While the vacancy index partially recovered the dramatic reduction observed during the crisis, the rate of unemployment has continued to increase, driving the outward shift of the curve observed since 2011. As

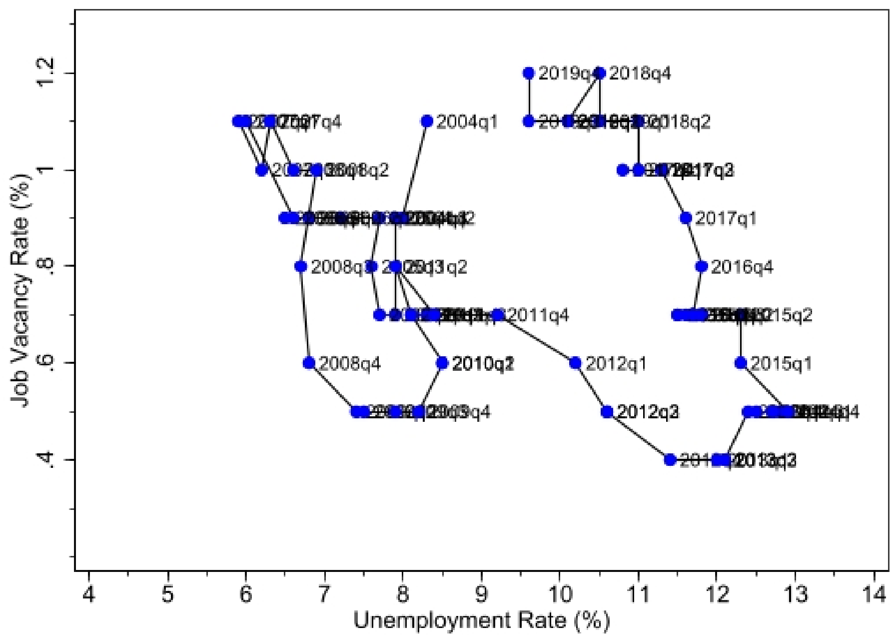

Figure 2: **Job Vacancy Rate and Unemployment Rate**

mentioned above, this has been the most striking fact in the aftermath of the Recession and for the interval of time under analysis. Furthermore, it appears that, as of 2011, there has been a strengthening in the magnitude of the rightward shift because the unemployment rate kept raising, accompanied by the slight decrease of the vacancy rate until 2013.

The job vacancy index has recovered after 2013, reaching its pre-crisis values in 2018. However, the same cannot be stated for the unemployment rate that kept being persistently high. Consequently, the coexistence of both high vacancy rate and high unemployment rate has led the coordinates of the curve to move upward. Lastly, despite that the job vacancy index has experienced in 2019 greater values than those of 2004, the persistence of the high unemployment rate for the Italian labor market has not made possible for the curve to return to its original position. This empirical finding sharply contrasts with the bulk of the economic literature investigating US Beveridge Curve dynamics during and in the aftermath of the Great Recession (Kroft, Lange, and Notowidigdo 2013, Krueger, Cramer, and Cho 2014): it is well documented that an outward shift has characterized even the US Beveridge locus during the crisis, however the path of unemployment and vacancies looped back to the original Beveridge Curve position for the United States.

We may refer to the the matching literature about the analysis of the US Beveridge Curve for another reason. Both the work of Kroft, Lange, and Notowidigdo 2013 and of Krueger, Cramer, and Cho 2014 pointed out that the increase in the incidence of long-term unemployment observed during the crisis could explain the rightward shift of the US Beveridge Curve.

Therefore, it seems valuable to plot the curve differing with respect to the usual one because of the unemployment rate decomposed by its long-term component and thus, by referring just to the short-term unemployment rate. In fig. 3, the Beveridge Curve for Italy considering the **short-term unemployment**

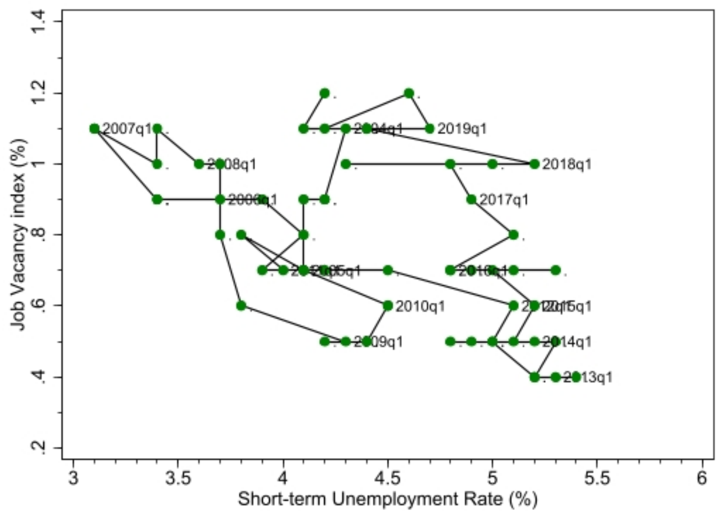

Figure 3: **Job Vacancy Rate and Short-term Unemployment Rate**

rate appears more stable, with little evidence of a shift (i.e., the magnitude of the shift is, indeed, less critical than in the previous figure).

Finally, it could be observed that Italy has experienced the rightward shift of its Beveridge Curve as of 2011, simultaneously with the outburst of the sovereign debt crisis. Thus, it is possible to rely on Eurostat LFS surveys[9] for checking whether other European countries significantly affected by this crisis -Ireland, Spain, Portugal- have also observed an outward shift of their curves. As shown in fig. 6, all these economies have experienced such phenomenon. However, for Ireland and Spain, the shift has been caused by an increase in both the vacancy and the unemployment rates, whereas the evidence for Portugal has been closer to the Italian case. For Portugal and Italy, the shift has been rather caused by a decrease in the rate of vacancy openings but an increase in the unemployment rate. While Italy has just experienced a minor inward shift in the most recent period, Beveridge Curves for all three economies have gradually returned to their original position.

[9]Eurostat LFS surveys allow, in this case, to have homogeneous figures among EU countries. However, the choice of countries to include in the analysis depend on data availability (i.e., despite Greece has been one of the countries most hit by the sovereign debt crisis, it is not meaningful for the purpose of this thesis to provide evidence of its Beveridge Curve because job vacancies data for this country are available just as of 2013). With respect to Italy, annual rather than quarterly observations are collected for other countries always for reasons related to data availability.

3 The performance of the Italian Economy

The rationale behind the inclusion of this section and section 4 about *Labor market institutions* is to describe the state and the performance of the Italian economy and of the labor market during the reference period 2004-2019, with particular concern for the years of the rightward shift of the Beveridge locus. Therefore, the objective is to identify key facts seen as the factors contributing to the outward shift of the Beveridge curve observed in 2011, which could occupy a relevant position in the search and matching framework.
Indeed, awareness has been raised in the previous section that the unemployment-vacancy relationship has undergone the shift almost simultaneously with the strike of the sovereign debt crisis. Not claiming any causal relationship, it could be argued that the observed shift could have been driven either by modified conditions for the Italian economy or that the phenomenon had rather its origin in the labor market.
Exploiting data availability, the first hypothesis is investigated by looking at the dynamics of the principal macroeconomic indicators, productivity measures, and of financial statistics for the universe of Small and Medium-sized Enterprises (SMEs) and large firms.
The perspective adopted in this section allows to consider the case where our primary phenomenon of interest, observed in the labor market, does not necessarily originate in this market or does not depend on the way the labor market is organized[10]. This latter hypothesis is exploited in section 4.

3.1 Macroeconomics Indicators and Productivity Measures

Among the wide range of national accounts statistics, the focus is on standard measures: general government debt and deficits as % of GDP, private sector debt-to-GDP, real GDP growth, and productivity measures, such as labor productivity per person employed and per hour worked, and total factor productivity.

As shown in fig. 7, even if it is acknowledged that Italy is among the countries with the highest public sector over GDP ratio, yet after the 2000s, this measure has experienced significant increments with respect to its values before the 2008 crisis. From 2009 until 2014, the ratio has been growing consistently (i.e., the value of 106.2% of 2008:Q4 reached 137.9% in 2014:Q2). Indeed, also the outburst of the Covid-19 pandemic has made the ratio worsening and reaching peaking values never observed before for this country.
The private sector debt over GDP, intended as the stock of liabilities held by the households, non-financial corporations, and non-profit institutions serving households, has been steadily increasing until 2011, before starting a decreasing trajectory for the years that follow. Primary balances, in deficit since 2000, have shown an unstable dynamics over the reference period, likely determined by the different economic measures and priorities of the several governments in charge and the great political instability of the country. From fig. 7, one can notice that, before the Covid-19 crisis, the lowest possible value of the primary deficit was reached in 2009, whereas during the years of the sovereign debt, the measure has not been worsening. It also appears that a path of reduction of these primary deficits has been conducted since 2014.
Finally, real GDP growth (variation with respect to the previous quarter)[11] has been sluggish in Italy since

[10] We are aware that the topic under analysis in this section is quite broad. The discussion in this section does not intend to be fully exhaustive, but to highlight the most relevant facts occurred during the period of interest.

[11] Since 1970s, several authors (Nordhaus and Tobin 1973, Sen 1980, Stiglitz, Fitoussi, and Duran 2018) have argued that the GDP is not the most comprehensive and complete indicator of the performance of an economy and of its well-being. Other

the 2000s. Phenomena of severe contractions have characterized the years of the Recession, whereas, as for other European economies, a huge contraction, followed by a suggestive spike, has supervened with the strike of the pandemic.
Labor productivity per person employed and per hour worked (fig. 10) have also been sluggish until the Great Recession, then decreasing considerably until 2014. Just a modest recovery for the years 2015 and 2016 followed. Whereas labor productivity per person employed has kept worsening until the last collected observation in 2020, labor productivity per hour worked has experienced a slight improvement during the pandemic period. We also include Total Factor Productivity (TFP), the proportion of output not explained by the amount of labor and physical capital as inputs of production. This measure captures improvements in the efficiency of the productive process due to organizational factors, new technologies, innovative processes and quality of human capital. As discussed by Visco 2020, causes behind the productivity slowdown for Italy since mid-90s essentially rely on the slow development of human capital and on scarce resources allocated by firms to R&D and innovation of the productive process. As shown in fig. 10, this measure has not recovered for years after the global financial crisis and the sovereign debt crisis.

3.2 Financial Statistics

As of the strike of the 2007-2008 financial crisis and the subsequent increase in the unemployment rate, both the empirical and the theoretical macro labor literature have known interest in understanding the relationship between financial imperfections and the dynamics of the labor market. Indeed, it is now widely accepted that *"firms' leverage and access to finance are important for hiring and firing decisions: it is now empirically established that bank lending is correlated with employment losses when credit conditions deteriorate"* (Boeri, Garibaldi, and Moen 2018). For SMEs and large firms, availability in external financing, changes in conditions for accessing funds and in the cost of financing will be described (fig. 8, fig. 9).
The *leverage ratio*, debt-to-assets ratio, is a measure of financial leverage, and reliable indicator of firms' solvency, indicating the amount of assets financed with debt held by a company. As shown in fig. 9, this indicator started increasing as of 2006, and both during the Great Recession and the sovereign debt crisis, firms' solvency capacity as measured by this index has been worsening.
Furthermore, I exploit the OECD *Financing SMEs* dataset, providing a set of statistics assessing lending conditions exclusively for the universe of SMEs. The concern for this typology of firms is due to the entrepreneurial setting for Italy: according to the latest Istat 2019 census, of a sample of 280.000 firms with three or more employees, 79.5% counted between 3-9 employees, whereas a share 18.2% employed between 10-49 employees. Indeed, fig. 8 and fig. 9 show that both SMEs and large firms have experienced a severe worsening in their financing cost between 2011-2013 (with interest rates generally greater for SMEs), immediately improving in the following years. For the same years, whereas the *rejection rate* of loans authorized to SMEs has been increasing, the *collateral* required to them for benefiting from bank lending decreased with respect to the previous period, giving ambiguous signals about the evolution of the conditions for credit access for these firms as diagnosed by these two indicators.

indicators (i.e., Human Development Index), including *qualitative factors* affecting well-being, have been proposed. For the purpose of this master thesis, it seems appropriate to refer to the usual GDP indicator.

4 Italian Labor Market Institutions

This section aims to encompass the main Italian labor market institutions (LMIs henceforth), thus focusing on Employment Protection Legislation (EPL), the extent of active and passive labor market policies (respectively, ALMPs and PLMPs), the wage bargaining system, the key facts that could have affected the performance of the labor market, and the fact that the institutional framework has been subject to major reforms during the first two decades of 2000s (table 3 briefly reviews the reforms occurred).

The purpose of the analysis presented in this section is two-fold: first, continuing with the analysis conducted in section 3, but now deserving attention to the labor market; then, defining the *"playground field"* of the theoretical model that will be developed later in section 5, whose aim is to include the main institutional features present in Italy when the outward shift of the Beveridge locus has been observed and to extend the canonical DMP framework to include the factors seen as contributing to the shift.

4.1 Employment Protection Legislation

In the last two decades, Employment Protection Legislation (EPL) for Italy has known important modifications. The first years have seen the implementation of asymmetric labor market reforms such that the creation of a *two-tier, dual, system* has been advocated, whereas the most recent reform, the Jobs Act (JA), *"aimed at reducing this dual structure of the labor market"* (Boeri and Garibaldi 2019).

The two-tier reform strategy, consisting in liberalizing the use of fixed-term contracts but leaving unmodified the legislation for open-ended contracts, has been enhanced in Italy through the implementation of the Treu Bill (1997) and of the Biagi Law (2003), the subsequent introduction of new forms of "atypical" fixed-term jobs, but the persistence of existing strict employment protection rules for open-ended contracts. About the principal effects of these two reforms, the literature conveys with the analysis provided by Boeri and Garibaldi 2007, who sustained that the development of this two-tier system has led to an increase in employment (at least until 2008), a decrease in the unemployment rate (falling at the record low rate of 6.2% in 2007), but a significant labor productivity slowdown. Effects of these reforms have thus been defined as a "transitory honeymoon effect"[12].

Forward looking with respect to the inclusion of EPL in the theoretical model, we briefly review the rules of job security provision in case of any *individual* firm-employee layoff during the critical period of the Beveridge Curve shift. According to the Italian legislation, individual dismissals in firms with more than 15 employees were, in 2011, legal only in the following two scenarios: justified subjective motive (i.e., misconduct from the side of the worker ascertained by the court); justified objective, or economic, motive (i.e., justified reasons related with the production activity or events outside the worker's control). In both cases, the employee kept the right to appeal the firm's decision to the court, the latter being in charge of the final decision of judging the dismissal legitimate. The case when the separation is judged unfair is of interest for the theoretical model. In that case, the employee could decide among reinstatement in the firm or the receipt of a severance payment. Legal costs, social insurance contributions and the foregone wage during the trial period would also be paid by the firm. For firms with less than 15 employees, employee's dismissal implied

[12]The literature about the effects of the two reforms on the matching process for Italy has been discussed in section 1.1.

a maximum severance payment of 6 months. Thus, as for other studies for Italy (Garibaldi and Violante 2005, Gerali, Guglielminetti, and Liberati 2021), firing costs could be disentangled in a transfer and in a tax components in the case of terminating a worker under any type of contract.

On the other side, the Jobs Act (2014-2015) has tried to achieve the reduction of this dual structure, operated through the reduction of the use of atypical contracts, the revision for the use of fixed-term and apprenticeship contracts, and of employment protection for open-ended jobs. For the latter, exit flexibility of all new open-ended jobs of the private sector has been enhanced by eliminating the possibility of reinstatement in the case of most collective dismissals and individual dismissals for justified economic reasons, replacing reinstatement with a monetary compensation increasing with the worker's job tenure[13]. In order to reduce separations settled in court, out-of-Court procedures between the worker and the employer have also been introduced. The reform also included the provision of hiring incentives (temporary measure for the period 2015-2017) for open-ended contracts plus additional incentives for this type of contracts signature (i.e., as of 2015, reduction of the tax burden on open-ended jobs).

The restrictiveness of employment protection legislation can be acknowledged quantitatively and compared across countries through the widely used EPL indicators developed by OECD, allowing to assess whether the above-mentioned reforms of the labor market have led to the creation of a two-tier asymmetric system between fixed-term and open-ended positions and if the implementation of the JA has effectively enhanced a relaxation of the strictness of EPL for open-ended contracts. The index, which can take values from 0 to 6 (the latter value for stricter regulation), is composed of 21 items grouped in the following sub-indexes: a) EPR: individual dismissal for workers with regular contracts; b) EPC: additional regulations for collective dismissal; c) EPCR: weighted average of sub-indexed (a) and (b), computing an overall index for the protection of open-ended jobs (weights of 5/7 and 2/7 respectively); d) EPT: regulation of fixed-term forms of employment. The focus is on the evolution of sub-indexes (c) and (d) (fig. 11, fig. 12).
The EPCR index for Italy has not experienced significant changes since the first year it was computed in 1990. It slightly decreased just with the implementation of the Fornero Reform in 2012[14] and it has greatly decayed concurrently with the JA in 2014-2015 (i.e., implying the relaxation of the regulation of dismissals for open-ended jobs that, as shown above, was particularly restrictive before the reform). A modest increase has been observed in 2019. For the EPT, the reforms implemented at the beginning of the 2000s were indeed the principal responsible for the significant decrease of the index during the first decade of the new century. A decrease has been also observed as of the implementation of the JA, despite the reduction of the use of atypical contracts operated by the reform should have determined the increase of sub-index (d).

To sum up, the fact that the main variations of the EPCR and EPT indexes have not occurred during the critical period of the outward shift of the Beveridge Curve suggests that other factors underlying the shift should be investigated. Nevertheless, it appears evident that the theoretical model should account, to the best of the analytical tractability, for the differentiation among fixed-term and open-ended contracts and the strict rules (i.e., firing costs) applied in case of firm-employee separation.

[13]See Boeri and Garibaldi 2019 for an exhaustive overview of the main institutional changes operated by the reform and for an empirical evaluation of its effects along the labour market mobility and the unemployment margins.

[14]Law. 92/2012, implemented during the Monti government.

4.2 Active and Passive Labour Market Policies

Active labor market policies for Italy encompass three broad categories: a) employment subsidies for supporting jobs either in the public or in the private sector; b) provision of training schemes to improve the skills and the employability of the job-seeker; c) support to the unemployed worker through Public Employment Schemes (PES) in terms of job-matching, support in job-search, search for training (Pinelli et al. 2017)[15]. Table 4 provides evidence, sourced from the OECD *Labor Market Programs* database, of the total share of public expenditure as percentage of GDP for Active Labor Market Policies in Italy since 2004 and of how the total share of resources has been allocated among the three above mentioned categories[16].
It appears evident as the largest amount of spending has been devoted to employment subsidies, followed by training schemes and that employment services have always been receiving limited financial resources. Finally, the public expenditure for ALMP over the total expenditure for Labor Market Policies has decayed steadily over time, being substituted by an increasing share devoted to Passive Labor Market Policies.
Whereas the Fornero Reform has been silent about ALMPs institutional modifications (its main focus has been the reform of passive policies), the JA has put great emphasis towards the improvement of the existing system, mostly towards the reinforcement of the service provided by PES (i.e., introduction of a personalised individualised support for job seekers through a contract, "patto di servizio personalizzato", between the job seeker and the employment agency, with mutual sanctions for the two parties in case not respected).

Passive policies under analysis are those classified as "out-of-work income maintenance and support", including *full unemployment benefits* (i.e., unemployment insurance) and *partial unemployment benefits*, referring to benefits compensating for the loss of wage or salary due to short-time working arrangements (STW henceforth), intermittent work schedules, where the employer/employee relationship continues. Benefits provision in case of early retirement are also included[17]. As shown in table 4, the analysis of Passive Labour Market Policies for Italy sees how the total expenditure for this category has been increasing over the period for which evidence is available, mostly in the aftermath of the 2007-2008 crisis (resources for this category have been almost doubled from 2009 with respect to previous years). Whereas spending in case of early retirement has remained constant, both the expenditure for unemployment insurance and the one related with partial UBs increased after the Great Recession (to notice, the provision of partial unemployment benefits in 2009, essentially STW schemes, triplicated the previous value in 2008).

The unemployment insurance system before the 2012 Fornero Reform and the 2014-2015 JA has been characterized by "ad-hoc" unemployment benefits, targeting specific jobs or sectors and depending on the worker's previous job tenure and by extremely low replacement rate. On the other side, STW schemes have been consisting of multiple instruments according to the reasons of the worker's suspension or reduced time schedule[18]. Moreover, before the 2012 Reform, all forms of STW schemes used to provide an allowance at

[15] Despite active labor market policies could be interesting for what concerns matching mechanisms, because of the reduction of skill mismatches and of structural unemployment, their analysis is outside the scope of this work.

[16] ALMPs include also start-up incentives and funds directed towards job creation, but data for these two categories are not available for Italy.

[17] Even in this case, other passive policy categories are part-time unemployment benefits, redundancy and bankruptcy compensation, but data are missing for Italy.

[18] The STW compensation schemes consisted of: CIGO, in case of unforeseen events or temporary market crisis; CIGS, in

80% of the foregone wage, thus determining a replacement rate higher than the one enlarged by UBs at that time.

Thus, the rationale behind the 2012 Fornero Reform has been to revise and correct PLMPs, mostly for what concerned the broad fragmentation in coverage. STW arrangements have been reformed (i.e., elimination of CIGD as of 2017), whereas the unemployment insurance system improved both in its generosity and in its duration. Following the same line, the JA has further revised Short-Time Work schemes (extension of categories covered i.e., apprenticeship), the unemployment insurance mechanism and it has created a closer link between PLMPs, in terms of fruition of the benefits for the unemployed, and ALMPs, for what concern the unemployed participation in training activities (i.e., adhesion to professional re-qualification activities and mandatory employment programmes represents an eligibility requirement for UBs). In terms of passive policies, the most relevant changes have concerned the extension of the UBs duration, the increase in the level of benefits granted and the introduction of a further assistance instrument, assigned in case of benefits expiration of the principal insurance scheme, for those individuals still unemployed, with more than 55 years or in condition of economic need (also in this case, receipt of the benefit conditional on the acceptance of a personalized proactive job search project).

4.3 The wage-setting mechanism

Most of the works in the search and matching theoretical literature set wages as the outcome of *Nash bargaining* between the firm and the worker. Rather than following this assumption, the aim for the theoretical model in this thesis is to be consistent with the mechanism adopted in Italy.
In Italy, wages are set according to National Collective Bargaining Agreements (NCBAs) between employers and unions, *"legally binding for those employers and employees members of the bargaining social partners that have signed them, or that choose to adopt them"* (Eurofond, 2019 [19]). Furthermore, the collective bargaining mechanism is organized into two different levels: sectoral NCBAs and decentralized-level NCBAs (i.e., decentralization at the company or at the territorial, provincial or regional, levels). The former, valid for all employees of the same sector in the Italian territory and renewed every three years, establishes main items of the employment contract, such as working time, working conditions, job classification and minimum wage. The latter type of agreements has variable duration and rather regulates specific aspects of work, such as productivity standards, performance bonuses, incentive remuneration schemes, and special types of indemnities, still in accordance with mandatory provisions issued at the sectoral level.
Practical consequence of the above distinction is that *"the firm cannot pay a wage below the level set through the sectoral national agreements, despite significant geographic differences across regions in terms of productivity, firms' product demand conditions and profitability"* (Boeri, Ichino, et al. 2019).
Given the absence of a national minimum wage in the Italian legislation, sectoral NCBAs represent the minimum wage for each specific sector for workers and firms belonging to the bargaining social partners.

case of restructuring or bankruptcy procedures; CIGD, extension in coverage and duration of CIGO and CIGS introduced as of the Great Recession.

[19] https://www.eurofound.europa.eu/country/italycollective-bargaining

4.4 Observed Transition Probabilities between Labor Market States

Investigating the causes behind the observed outward shift of the Italian Beveridge Curve could find an appropriate answer through the analysis of variations in the *job separation* and *job finding probabilities* during the critical period 2011-2013, where the former refers to those agents entering the jobless pool after losing their job (i.e., unemployment inflow) and the latter to those workers rather exiting the unemployment pool (i.e., unemployment outflow). Indeed, the literature conveys that fluctuations in both outflow and inflow rates contribute substantially to the dynamics of the unemployment rate[20]. It becomes important then to analyze their dynamics and if there are interesting variations in these rates.

Eurostat LFS surveys provide, among the usual indicators, evidence of labor market quarter-on-quarter transition rates, intended as the movements of individuals aged 15-74 across the labor market states of unemployment, employment and economic inactivity through quarterly observations collected since the second quarter of 2010 for European countries. These transition rates compare the current position of the population with the position one quarter before. They are expressed in levels as % of the initial status, and each outflow is computed as the ratio of the relevant outflow and the sum of all outflows from the same labor market state. The survey has the advantage of identifying transitions to unemployment against transition to non-participation (not all surveys allow for this distinction), but attrition between periods is their major limitation.
The analysis of these hazard rates for Italy are as in fig. 13[21].

- The rise of flows from *employment to unemployment* observed as of 2011:Q2 until 2013:Q1 -of order of magnitude of 0.5% relative to a starting value of 1.30% in the second quarter of 2011- is the most striking phenomenon affecting this hazard rate over the decade 2010-2020. A decline is rather observed in the second quarter of 2013 and an unclear pattern for this flow characterizes years ahead 2013.
- The hazard rate from *employment to inactivity* does not experience huge variations for the period 2010-2020, except for the significant spike in the first quarter of 2020, likely depending on the outburst of the Covid-19 crisis.
- Also the transition rate from *unemployment to employment* suffers a suggestive contraction of almost 8% for the period 2011-2013 from the initial value of 16.4% in the second quarter of 2011. After 2013, it recovers the dramatic reductions (still not following a clear pattern for the remaining horizon). The other significant variation (magnitude of 5%) is observed with the outbreak of the pandemic crisis.
- The observations of flows from *unemployment to inactivity* generally undergo important fluctuations between 2011-2013, however they do not highlight a clear pattern. Thus, contrarily to the other hazard rates mentioned, clear conclusions cannot be drawn for this period. Still significant and interesting

[20] There is a sizeable literature (Elsby, Michaels, and Solon 2009, Fujita and Ramey 2009, Shimer 2012) that investigates this question.

[21] It is outside the purpose of this section to provide empirical evidence of the relative contributions of outflows from and inflows into unemployment to unemployment rate fluctuations. See Sulis 2012, Fugazza 2019 for an estimate of job finding and job separating probabilities by demographics and their contribution to unemployment movements in Italy. Fiaschi and Tealdi 2021 extend the analysis by considering five labor market states (i.e., inactive, unemployed, self-employed, temporary and permanent workers) rather than two.

are the dynamics of this flow during the recent pandemic.

- Finally, flows from *inactivity to employment* and *to unemployment* also fluctuate for 2011-2013 -and as well with the 2020s events-, but it appears evident as the hazard rate *I-U* experiences fluctuations of greater magnitude with respect to the rate *I-E* (for the first, the increase during the critical period 2011-2013 is of 2.4% from an initial value of roughly 3.6%, while for the latter, the decrease is not greater than 1% from a starting value around 4%).

It is straightforward to see that fluctuations in the transition flows across the three labor market states of employment, unemployment and inactivity for the years of the shift cannot be neglected at all: except for the hazard rate from employment to inactivity, all others rates experience fluctuations of important magnitude.

Before moving on, two aspects should be noticed: first, these flows are characterized by great heterogeneity along dimensions such as demographics (i.e., age, gender), educational attainment, duration of the unemployment spell (Fugazza 2019) and job tenure. Second, during the period for which hazard rates fluctuations are described, Italy has undertaken major reforms of the labor market and of the pension system - *Fornero Reform* of the *pension system* (2012), *Fornero reform* of the *labor market* (2012)[22], JA (2014-2015) - that may have additionally affected their dynamics (Boeri and Garibaldi 2019, D'Amuri et al. 2021). These dimensions will not be exploited for the sake of this master thesis. Nevertheless, they could be interesting objects of discussion and analysis for future studies.

The objective of the analysis conducted in section 3 and in this section has been to evaluate and identify potential factors behind the shift of the curve, the key phenomenon to be explained. From the analysis provided, it seems that the most relevant facts to account for could be the worsening of productivity measures, the increase in the cost of financing for non-financial corporations (mostly, for SMEs) and the significant fluctuations in workers' hazard rates across the three states.

In this respect, it follows the decision to adhere, for the theoretical model, to a stream of the matching model literature entirely formulated in terms of *productivity shocks.*

Then, it must be observed that the standard Diamond-Mortensen-Pissarides search framework does assume perfect financial markets. Strictly speaking, the realization of a search equilibrium model that includes financial imperfections as those documented in section 3.2 could be an ambitious and complex project, because this type of theoretical frameworks usually models three markets (the good market, the labor market and the financial market) rather than just two as standard in the matching literature, and assume frictions affecting each of the three markets.

Therefore, shocks in transitions across employment, unemployment and inactivity during the critical period 2011-2013 would be reasonably considered as the underlying factors behind the sizeable rise of the unemployment rate and the outward shift of the Beveridge Curve observed for Italy. The latter will be the distinguishing feature of the theoretical model to be developed in section 5.

[22] It must be noticed that Italy undertook both a reform of the pension system (Law. 214/ 2012) and of the labor market (Law. 92/ 2012) during the Monti government. In the preceding sections, with the term *Fornero reform* we always refer to Law. 92/2012.

5 The Theoretical Model

This Section outlines the search equilibrium theoretical model based on Mortensen and Pissarides 1994 matching model with *endogenous job creation* and *endogenous job destruction*.

As stated in the Introduction, this theoretical framework is built to reproduce a stylized version of the Italian labor market. For this purpose, the coexistence of fixed-term and open-ended jobs and institutional features, such as job security provision in the case of lay-off and rigid wages, are assumed. Furthermore, the model has the objective to explain the rise in unemployment and the observed shift of the Beveridge Curve for Italy. In this regard, it models workers' transitions across the three states of employment, unemployment and inactivity such that unemployment dynamics depend also on participation flows, in addition to flows in and out of unemployment. This represents the principal difference of this theoretical model with respect to the existing literature.

The model is developed in *steady-state*. Formal derivations of analytical results are in Appendix B[23].

5.1 Model Set-up

Assuming an economy where there are only two goods: a good produced by the firms, consumed by all individuals (the *numeraire*), and labor, assumed to be homogeneous and the only factor of production.

Demographics and Preferences. The labor market is populated by infinitely lived and risk-neutral workers and a large supply of potential firms. As consequence of agents' preferences, utility is linear and all agents discount the future at the common exogenous rate r, strictly positive. A worker can be employed (either as outsider or insider), unemployed or non-participant and a firm either filled (with an outsider worker or with an insider worker) or vacant.

Three-State Labor Market. Consider a model where L represents the *constant* working-age population (assuming no entry and no exit from the working-age population). Along with flows between employment and unemployment, workers' flows from and to inactivity are included. Thus, in this framework, the states of the labor market are three: employment (E), unemployment (U) and non-participation (N), such that:

$$E + U + N = L \tag{1}$$

Let λ^{ij} denote the transition rates associated with worker flows from the labor market state i to state j, where $i, j \in \{E, U, N\}$. No *job-to-job transitions* are considered (i.e: direct worker mobility between two jobs without experiencing an unemployment spell). Following Mortensen and Pissarides 1994, exit out of unemployment and entry into employment by workers are endogenous and depend on the stochastic arrival of an idiosyncratic productivity shock. This methodology treats the hazard rates of employed and unemployed workers from the labor force, λ^{EN} and λ^{UN}, and from inactivity to employment and unemployment, λ^{NE}[24] and λ^{NU}, as exogenous. In principle, agents' decision to enter or leave out the labor force could have been endogenous, in practice, the framework would have been significantly more complex.

[23] Standard extensions to the theoretical model could be on-the-job search, search and recruitment intensity.

[24] This transition probability is included in the model, however the literature working on the participation margin usually assumes that after entering the labor force, the worker starts an unemployment spell or, if included, that the flow N-E represents, for example, *school-to-work* transitions.

Matching. Assuming that every employer with a vacancy recruits with equal intensity and that unemployed agents search, also at a given intensity, aggregate matching inputs are represented by the numbers of job vacancies V and of unemployed workers U. Vacant positions are assumed to be homogeneous.
Let the function *M(V,U)* be the constant return matching function, strictly increasing with each of its arguments. As in Cahuc, Carcillo, and Zylberberg 2014, the Cobb-Douglas specification is assumed:

$$M = A(U)^{\eta}(V)^{1-\eta} \tag{2}$$

where A indicates matching efficiency (i.e., it captures the degree of mismatch and a decrease of the value of A implies deterioration of the matching process) and η is the elasticity of the matching function.
The probability of filling a vacant job per unit of time is then expressed as follows:

$$\frac{M(V,U)}{V} = M(1, \frac{U}{V}) \equiv m(\theta) \rightarrow A\theta^{-\eta} \tag{3}$$

The exit rate from unemployment is defined by:

$$\frac{M(V,U)}{U} = \frac{V}{U}\frac{M(V,U)}{V} = \theta\mu(\theta) \rightarrow A\theta^{1-\eta} \tag{4}$$

The ratio of vacancies to unemployment, $\theta \equiv \frac{V}{U}$, known as labor market tightness, is an endogenous variable to be determined. Differentiating eq. (3) with respect to U and eq. (4) with respect to V defines the following properties:

$$\mu(\theta)' = -\frac{U^2}{V^2}M'_U(1, \frac{U}{V}) < 0 \tag{5}$$

$$[\theta\mu(\theta)]' \equiv \mu(\theta) + \theta\mu'(\theta) = M'_V(V,U) > 0 \tag{6}$$

Respectively, vacant jobs are filled at a rate that diminishes with the labor market tightness (eq. (5)), whereas the hazard rate of unemployed workers to employment is an increasing function of θ (eq. (6)).
Finally, *"Inada conditions"* are respected in order to ensure the existence of the equilibrium:

$$\lim_{\theta \to 0} \mu(\theta) = \infty \quad \text{and} \quad \lim_{\theta \to \infty} \mu(\theta) = 0 \tag{7}$$

As stated in the Introduction, hires of individuals who are out of the labor force are not mediated through the matching function[25] (the matching function allows contacts just between unemployed workers and firms), but hires from non-participation may happen at the exogenous rate λ^{NE} (i.e., school-to-work transitions).
Production. Workers' productivity is a random variable y, drawn over the support $[\underline{y},\ \bar{y}]$ and with cumulative distributive function $F(y)$. Let $k = \{o, i\}$ denotes, respectively, the match in the outsider and in the insider phase.
Each *new* match starts as an outsider. It has very high productivity level y_o drawn over the support $[\underline{y},\ \bar{y}]$ and pays real wage w_o. Values y_o and w_o are assumed to be high enough such to make the acceptance probability after the contact between the vacancy and the employee equal to 1[26]. Then, matches could either move or not move to the insider phase, according to conditions defined below. Each match with the insider worker has random productivity value y_i and pays out w_i.

[25] See Kroft, Lange, and Notowidigdo 2013, Krueger, Cramer, and Cho 2014 for alternative approaches.
[26] This assumption excludes the case of a reservation threshold set by the two parties to create the job relationship (see Garibaldi and Violante 2005 for this approach). However, the value y_o is not necessarily the maximum value of the support $\bar{y}$.

Over time, both kinds of matches are subject to two shocks: idiosyncratic productivity shocks with Poisson arrival rate $\lambda > 0$ and the not-productivity related shock that makes the filled job vacant, arriving at the exogenous Poisson arrival rate λ^{EN}. In details:

1. Idiosyncratic productivity shocks follow a Poisson process with incidence rate λ, affecting both the new match with the outsider and the match in the insider phase. For the first type of match, λ striking implies that the match moves towards the insider phase if the new productivity level drawn from the distribution $F(y)$ is above the *endogenous reservation threshold* y_R; otherwise, the job is destroyed. For the match with the insider, a new productivity value of the match is drawn from the same distribution after the arrival of the Poisson rate λ. Also in this case, if the new draw of y is below y_R, the job relationship is destroyed. Draws are i.i.d. over time and across production units.

2. The rate λ^{EN} is the *exogenous* probability for any match to become vacant, following the worker's decision to leave the labor force (i.e., the job position becomes vacant because the worker retires).

Thus, matches in the outsider phase differ from those in the insider phase because of the productivity value and the wage paid by the firm[27]. Both the outsider and the insider job relationship are subject to *job security provision* in case of destruction, to be described in more details below. Vacant jobs after the λ^{EN} shock arrives do not impose to the firm any fulfillment in terms of job security provision.

Wage Determination. This model differs from the bulk of the matching literature because it does not assume that match-specific wages and profits are the outcome of a generalised Nash bargaining between workers and firms. National collective bargaining for Italy (section 4.3) do not allow to hypothesize a fully flexible wage setting mechanism between the two parties. The implication is that wages **cannot** be renegotiated after a new productivity drawn. Thus, *exogenous wage rigidity*, with real wage w_o and w_i for, respectively, jobs in the outsider and insider phases and where $w_i \geq w_o$ are rather assumed. Furthermore, the source of wage rigidity and the mechanisms setting w_o and w_i are considered as exogenous to the model. Finally, the extent of taxation on the employee's wage and on the firm's net profits is excluded from the analysis.[28].

Employment Protection Legislation. The extent of job security provision is modeled such to account for two features: the coexistence of fixed-term and open-ended contract, the "dual structure" of the Italian labor market, and the fulfillments firms are subject to in case of any *individual* employee-worker layoff.

The "outsider-insider" structure models the presence of fixed-term contracts (with duration $\frac{1}{\lambda}$) covering the entry period of an initial employment relationship, as widespread in the Italian economy. With this approach (followed by Garibaldi and Violante 2005, Gerali, Guglielminetti, and Liberati 2021), temporary contracts turn automatically into permanent one as soon as λ strikes and the new productivity drawn is above the threshold y_R. A more realistic modeling may assume that, after the productivity shock, only a fraction π of the outsider workers acquire the insider status[29]. However, this alternative assumption raises

[27]This assumption is standard in the modeling of the *outsider-insider structure* (Garibaldi and Violante 2005, Gerali, Guglielminetti, and Liberati 2021). It seems very reasonable.

[28]This latter assumption derives from the fact that unemployed workers are entitled to unemployment benefits and that this raises the question of how the unemployment insurance system is financed. In this model, how the UB system is financed is excluded from the analysis.

[29]See Bentolila et al. 2012 for a dual "outsider-insider" structure with exogenous probability π of conversion of fixed-term

the analytical complexity of the model, since it entails to define a further reservation productivity threshold for the conversion of fixed-term contracts into open-ended ones. Thus, in this model is *as if* $\pi \to 1$.

In section 4.1, it has been underlined that, when the outward shift of the Beveridge Curve has been observed, EPL in case of any individual employee-firm layoff could have been disentangled in a transfer component (severance payment)[30] and "taxes" (legal costs and social insurance contributions to the worker) imposed to the firm in the case the court judged unfair the employee's layoff. Therefore, f_a parametrizes the tax component of firing costs, whereas f_b the transfer component. The two parameters summarize employment protection in this set-up in case of endogenous separation for both types of contracts.

5.2 Dynamics of individuals inflows and outflows between the three states

The *steady-state unemployment rate* in the framework of a three-state labor market model is here defined. Following Petrongolo and Pissarides 2008, the share of unemployed and employed evolve according to the following system of differential equations:

$$\dot{U} = 0 \to (\lambda^{UE} + \lambda^{UN})U - \lambda^{EU} E = \lambda^{NU} N \tag{8}$$

$$\dot{E} = 0 \to -\lambda^{UE} U + (\lambda^{EU} + \lambda^{EN})E = \lambda^{NE} N \tag{9}$$

The sum of the two above equalities leads to:

$$\lambda^{EN} E + \lambda^{UN} U = (\lambda^{NU} + \lambda^{NE})N \longrightarrow N = \frac{\lambda^{EN} E + \lambda^{UN} U}{(\lambda^{NU} + \lambda^{NE})} \tag{10}$$

Let u $\equiv \frac{U}{U+E}$ and let us substitute N of eq. (10) into eq. (8), the steady state unemployment rate u is such that (proof in section B.1):

$$\begin{aligned} u &= \frac{\lambda^{EU} + \epsilon}{\lambda^{EU} + \epsilon + \lambda^{UE} + \zeta}, \\ \epsilon &= \lambda^{EN}[\frac{\lambda^{NU}}{(\lambda^{NU} + \lambda^{NE})}] \\ \zeta &= \lambda^{UN}[\frac{\lambda^{NE}}{(\lambda^{NU} + \lambda^{NE})}] \end{aligned} \tag{11}$$

Contrarily to the two-state labor market, steady state unemployment does **not** depend anymore on just exit out of unemployment λ^{UE} and entry into unemployment λ^{EU}, but it does depend on:

- *composite inflow rate into unemployment*, $\lambda^{EU} + \epsilon$, interpreted as the sum of the entry rate into unemployment λ^{EU} and $\epsilon = \lambda^{EN}[\frac{\lambda^{NU}}{(\lambda^{NU}+\lambda^{NE})}]$, *"the rate at which workers enter unemployment by flowing from employment to nonparticipation (λ^{EN}) and, conditional on leaving non- participation, transition to unemployment ($\frac{\lambda^{NU}}{(\lambda^{NU}+\lambda^{NE})}$)"* (Elsby, Michaels, and Ratner 2015);
- *composite outflow rate from unemployment*, $\lambda^{UE} + \zeta$, interpreted as the sum of the exit rate out of unemployment and the indirect flow ζ.

contracts.

[30] Differentiation of EPL obligations according to firms' size is not explicitly modeled: it is *as if* all firms have more than 15 employees.

5.3 Value Functions

Both workers and employers maximize wealth, that, given the assumption of risk-neutrality of agents' preferences, is defined as the expected present value of future net income streams. The latter assumption is standard in the matching literature, however it has important implications in the presence of employment protection: it excludes the role of labor market institutionss as insurance devices against income shocks[31].
At every instant, a job can be either filled or vacant. When it is filled, it can yield discounted expected profits $\Pi_k(y)$ according to the belonging to the outsider phase or to the insider phase. When the job falls vacant, the firm expects to gain profits Π_v.
Similarly, the employee could be either an outsider, with expected utility $V_o(y)$ or an insider, with expected utility $V_i(y)$. In case she is unemployed, she has expected utility V_u, whereas the asset value in case the agent is out-of-the labor force, V_n, is normalized to 0.

The asset value to the firm of a filled job position in status k, $\Pi_k(y)$, solves:

$$r\Pi_k(y) = y_k - w_k + \lambda[\Pi_l - \Pi_k(y)] + \lambda^{EN}[\Pi_v - \Pi_k(y)], \quad k = \{o, i\}, \tag{12}$$

where

$$\Pi_l = [\int_{\underline{y}}^{y_R} (\Pi_v - f_a - f_b) dF(y) + \int_{y_R}^{\bar{y}} \Pi_i(y) dF(y)] \tag{13}$$

The value of a job for the firm consists of discounted net profits $(y_k - w_k)$, varying according to the employee's status, and of the continuation value, identical irrespective of job tenure. The continuation utility accounts for the two types of shocks that can supervene. First, as soon as λ strikes, the new individual productivity value is drawn. The term Π_l in eq. (13) represents the *option value* of the filled job. If the new productivity drawn is below the threshold y_R, the firm fires the employee and its discounted expected profits amount to the value of a vacant position, Π_v, minus the **total** firing costs $(f_a + f_b)$. Otherwise, if the new productivity drawn is above the threshold, the job relationship continues, yielding profits $\Pi_i(y)$. Finally, the second type of shock, arriving with a Poisson rate λ^{EN}, makes the job vacant.

The discounted expected value for the firm from a vacant job, Π_v, reads as follows:

$$r\Pi_v = -h + [\mu(\theta) + \lambda^{NE}][\Pi_o(y) - \Pi_v] \tag{14}$$

Let h be the exogenous cost per vacant job and per unit of time and let $(\mu(\theta) + \lambda^{NE})$ be the rate at which vacant jobs change state and become filled. To be noticed that in the *three-state labor market*, the change of state for the vacancy happens at the rate $(\mu(\theta) + \lambda^{NE})$ rather than at the rate $\mu(\theta)$ as standard in the two-state literature, because also non-participants in the labor market could be *directly hired* and fill a vacant position at the rate λ^{NE}. Any match starts in the outsider phase.

On the worker's side, the Bellman equation for the job-seeker, V_u, solves:

$$rV_u = b + \theta\mu(\theta)[V_o(y) - V_u] + \lambda^{UN}[V_n - V_u] \tag{15}$$

Let b represents the *out-of-work benefits* for the unemployed worker. The endogenous rate $\theta\mu(\theta) = \lambda^{UE}$ represents the exit rate out of unemployment, yielding lifetime value $V_o(y)$ for the agent being hired as

[31] See Pissarides 2004, with EPL provision, risk-neutral firms and risk-adverse workers.

outsider. The rate λ^{UN} is the exogenous hazard rate at which the job-seeker moves out of the labor force, then having lifetime value V_n.

The value functions for the employee $V_k(y)$, varying according to her outsider or insider status, read:

$$rV_k(y) = w_k + \lambda[V_l - V_k(y)] + \lambda^{EN}[V_n - V_k(y)], \qquad k = \{o, i\} \tag{16}$$

$$V_l = \int_{\underline{y}}^{y_R} (f_b + V_u) dF(y) + \int_{y_R}^{\bar{y}} V_i(y) dF(y) \tag{17}$$

The employee earns w_k according to her outsider or insider status and, as for the firm, her continuation utility value is affected by two kinds of shocks. With incidence rate λ, the worker is subject to the productivity shock and V_l in eq. (17) represents her expected utility in this case: if the new draw of productivity is above the threshold y_R, the job-relationship will continue; otherwise, it is destroyed and the worker's expected utility amounts to the benefit in case of endogenous separation, f_b, plus the lifetime value of being unemployed. The decision to move to inactivity is exogenous and driven by the rate λ^{EN}.
Given our simplifying assumption of $V_n = 0$, eq. (15) and eq. (16) are rewritten as:

$$(r + \lambda^{UN})V_u = b + \theta\mu(\theta)[V_o(y) - V_u] \tag{18}$$

$$(r + \lambda^{EN})V_k(y) = w_k + \lambda[V_l - V_k(y)] \tag{19}$$

The Job Separation decision

The job separation decision refers to the decision of the agents to *eventually* terminate their existing job relationship. Indeed, after the productivity shock, the new value of productivity could either be below or above the preceding productivity value. Nevertheless, the firm and the worker fix a *cut-off value*, y_R, for guiding their decision to separate. Whereas in the case of Nash Bargaining the two parties agree on the same productivity threshold for operating separation (i.e., when the surplus to share becomes negative), the exogenous wages assumption will entail different productivity threshold values for the worker and the firm. The optimal reservation strategy for the two agents, after the idiosyncratic productivity shock, will apply independently of the nature of the job (i.e., both for outsider and insider) and it is defined as follows:

1. the employer prefers separation if the asset value of having a vacant position minus the firing costs levied after separation, $\Pi_v - (f_a + f_b)$, exceeds the value of continuing the job relationship, $\Pi_i(y)$;
2. the employee will opt for unemployment if the expected utility (s)he receives in this case, $(V_u + f_b)$, exceeds the value of being employed $V_i(y)$.

Relying on the fact that both $V_i(y)$ and $\Pi_i(y)$ are increasing in y, separation will occur when the value of the new shock, y, falls below the reservation threshold y_R, where the reservation value is such that:

$$y_R = max\{y_{Re}, y_{Rw}\} \tag{20}$$

where $V_i(y_{Rw}) = V_u + f_b$ and $\Pi_i(y_{Re}) = \Pi_v - f_a - f_b$.
However, as long as the insider worker is employed and keeps earning the same wage (independent of her productivity level), $w_i \geq w_o$, (s)he has no incentive to quit the job, whatever the value of y after the productivity shock. This is why, in the context of fully rigid wages, separations are decided **unilaterally** by the firm. The notation y_R is adopted for referring to the productivity threshold set by the firm.

5.4 Job Destruction and Job Creation Conditions

Defining the *job destruction* and the *job creation equations* will allow the characterization of the steady-state equilibrium of the model in section 5.5. The first equation will be derived from the optimal firing decision, whereas the second one from the optimal hiring decision, both decisions being taken by the firm.

Job Destruction. Let us first consider the job separation decision borne exclusively by the firm. According to the optimal reservation strategy set by the firm the value of y_R should satisfy $\Pi_i(y_R) = \Pi_v - f_a - f_b$. Assuming that the free-entry condition $\Pi_v = 0$[32] is satisfied such that $\Pi_i(y_R) = -(f_a + f_b)$, and using eq. (12), it is possible to find:

$$y_R = w_i - \lambda\Pi_l - (r + \lambda + \lambda^{EN})(f_a + f_b) \tag{21}$$

From eq. (12), it is possible to notice that $(r + \lambda + \lambda^{EN})[\Pi_i(y) - \Pi_i(y_R)] = y_i - y_R$.

Therefore, when the free-entry condition is satisfied, $\Pi_i(y_R) = -(f_a + f_b)$, the expression for the firm's expected profits from the job relationship with the insider worker takes the following form:

$$\Pi_i(y) = \frac{y - y_R}{r + \lambda + \lambda^{EN}} - (f_a + f_b) \tag{22}$$

Substituting the value found in eq. (22) in eq. (13) characterizing the endogenous value Π_l,

$$\Pi_l = \int_{\underline{y}}^{y_R} -(f_a + f_b)dF(y) + \int_{y_R}^{\bar{y}} \Pi_i(y)dF(y) = -(f_a + f_b) + \frac{1}{r + \lambda + \lambda^{EN}} \int_{y_R}^{\bar{y}} (y_i - y_R)dF(y) \tag{23}$$

Finally, replacing Π_l of eq. (23) in eq. (21) allows to obtain the reservation value of productivity y_R:

$$y_R = w_i - (r + \lambda^{EN})(f_a + f_b) - \frac{\lambda}{r + \lambda + \lambda^{EN}} \int_{y_R}^{\bar{y}} (y_i - y_R)dF(y) \tag{24}$$

The equation above defines the productivity threshold for the destruction rule of already existing jobs in the insider phase as function of the model parameters. It is an implicit equation in reservation productivity y_R, satisfying the following properties:

- reservation productivity is independent of labor market tightness. In the literature with endogenous job creation and job destruction, job destruction usually describes a positive relationship between reservation productivity and tightness because of the wage pressure that tightness exercises on wages. However, given our assumption of fixed wages, reservation productivity is independent of θ.
- It is inferior to the insider wage w_i. The inequality $y_R < w_i$ expresses the phenomenon of *labor hoarding*: firms sustain a loss in the current period when $y_R < w_i$, but they do not fire the worker because of firing costs and because, after the productivity shock, they expect potential future gains from higher productivity to compensate for this current loss.
- It is a decreasing function of the total firing costs $(f_a + f_b)$, consistent with the aim of firing costs to reduce the propensity to destroy jobs.

Job Creation. Equilibrium market tightness, θ, will satisfy the following job creation condition: the expected cost of hiring a worker must equate the expected present value of the future return to hiring,

[32] New firms will enter the market to create jobs, as long as the expected profits from a vacancy will be strictly positive. Thus, the inflow ends when $\Pi_v = 0$.

where the hiring decision is borne by the employer who opens a job vacancy. Clearly, the decision of the firm to open up a vacant position will be evaluated with respect to the expected profits from a newly filled job i.e., job in the outsider phase. We now turn to define the job creation equation (JC).

Consider the discounted expected profit for the firm from a vacant job in eq. (14):

$$\Pi_v = -h + (\mu(\theta) + \lambda^{NE})[\Pi_o(y) - \Pi_v]$$

Under the free-entry condition $\Pi_v = 0$, the following equality is obtained:

$$\frac{h}{(\mu(\theta) + \lambda^{NE})} = \Pi_o(y) \tag{25}$$

Now, let us consider the asset value of a newly filled job $\Pi_o(y)$ solved in eq. (12) under the free-entry condition:

$$(r + \lambda + \lambda^{EN})\Pi_o(y) = y_o - w_o + \lambda(\Pi_l), \tag{26}$$

$$\text{with } \Pi_l = \int_{\underline{y}}^{y_R} -(f_a + f_b)dF(y) + \int_{y_R}^{\bar{y}} \Pi_i(y)dF(y) \tag{27}$$

First, we substitute the value of $\Pi_i(y)$ found in eq. (22) into eq. (27).
The obtained value of Π_l can now be plugged into eq. (26), leading the follwing formula for the expected profit for the firm from a newly filled position, $\Pi_o(y)$:

$$\Pi_o(y) = \frac{1}{(r + \lambda + \lambda^{EN})}\{y_o - w_o + \lambda[\int_{y_R}^{\bar{y}} \Big(\frac{y_i - y_R}{(r + \lambda + \lambda^{EN})} - f_a - f_b\Big)dF(y)]\} \tag{28}$$

Considering together eq. (25) and eq. (28), the job creation condition is defined:

$$\frac{h}{\mu(\theta) + \lambda^{NE}} = \frac{1}{(r + \lambda + \lambda^{EN})}\{y_o - w_o + \frac{\lambda}{(r + \lambda + \lambda^{EN})}[\int_{y_R}^{\bar{y}} (y_i - y_R)dF(y)] - \lambda(f_a + f_b)\} \tag{29}$$

The equation above equates the average cost of opening a vacancy (LHS) and the expected profits from a newly filled vacancy in the outsider phase (RHS). In the left-hand side of eq. (29), h represents the vacancy opening cost per unit of time, whereas the denominator $\frac{1}{(\mu(\theta)+\lambda^{NE})}$ is the interval of time the vacancy stays unfilled. To be noticed that in our framework, on average, the vacancy remains unfilled for a shorter interval of time, contrarily to the *two-state labor market* where it stays unfilled for $\frac{1}{\mu(\theta)}$. The latter result depends on the fact that vacancy can be filled also through direct hiring (at the rate λ^{NE}) and not only through the matching technology. The right-hand side of eq. (29) is the stream of present discounted profits from the match for the firm, net of the worker's remuneration and of the total firing costs, fully levied on the firm.
In the job creation equation, a monotonic, negative, relationship between labor market tightness θ and the reservation productivity y_R is established. Indeed, a rise in y_R affects negatively labor market tightness : as y_R increases, the probability that the newly filled job moves to the insider phase decreases, expected profits from a new vacancy fall down, and firms decide to open up fewer vacancies.

5.5 The Steady-state Equilibrium

Let $\{r, h, b, f_a, f_b, w_o, w_i, \lambda^{NE}, \lambda^{EN}, \lambda^{NU}, \lambda^{UN}\}$ be the vector of *exogenous parameters*.
The *steady-state equilibrium allocation* for this model is the vector $\{\theta, y_R, \lambda^{EU}, \lambda^{UE}, V_u, V_k(y), \Pi_k(y), \Pi_l, V_l, u\}_{k=o,i}$ satisfying the following conditions:

1. The free-entry condition, as defined by eq. (29).

$$\frac{h}{\mu(\theta)+\lambda^{NE}}=\frac{1}{(r+\lambda+\lambda^{EN})}\{y_o-w_o+\frac{\lambda}{(r+\lambda+\lambda^{EN})}[\int_{y_R}^{\bar{y}}(y_i-y_R)dF(y)]-\lambda(f_a+f_b)\}$$

2. The reservation productivity level, y_R, as defined by eq. (24).

$$y_R=w_i-(r+\lambda^{EN})(f_a+f_b)-\frac{\lambda}{r+\lambda+\lambda^{EN}}\int_{y_R}^{\bar{y}}(y_i-y_R)dF(y)$$

3. The *endogenous parameters* $\lambda^{EU}=\lambda F(y_R)$ and $\lambda^{UE}=\theta\mu(\theta)$, defining, respectively, the job destruction and the job finding rates.

4. The Bellman Equations for employment eq. (18), eq. (19); the expected return of filled job positions eq. (12); the values Π_l, V_l defined by eq. (13) and eq. (17) in case of endogenous job destruction.

5. The equilibrium balanced flow condition in the labor market, defining equilibrium unemployment rate as in eq. (11).

$$u=\frac{\lambda^{EU}+\epsilon}{\lambda^{EU}+\epsilon+\lambda^{UE}+\zeta}=\frac{\lambda F(y_R)+\epsilon}{\lambda F(y_R)+\epsilon+\theta\mu(\theta)+\zeta}$$

The model is solved through a sequential process, similarly to the stochastic job matching model of Pissarides 2000. The process is decomposed into two steps. First, the pair (θ, y_R) in steady-state equilibrium is determined. Equations eq. (29) and eq. (24) represent the system of two equations that solve for the two unknowns of the model, (θ, y_R). Then, once y_R and θ are known, the endogenous rates λ^{EU} and λ^{UE} are obtained. With these two rates, the equilibrium unemployment rate u is finally defined.

To show that the unique equilibrium exists, we analyze the slopes of the job creation (JC) and job destruction (JD) equations. Indeed, whenever an equilibrium exists, it is characterized by the crossing of the JC-JD curves in the bi-dimensional (θ, y_R) space and it is unique (fig. 14).
In eq. (29), a negative relationship between y_R and θ is established. This is observed by application of the Leibniz Rule to the RHS of eq. (29) and by the well-know property that $\mu(\theta)'<0$ (i.e., the filled rate of vacant jobs decreases as soon as the number of vacancies, and therefore tightness, increases). As commented in section 5.4, as y_R increases, the probability that the newly filled job moves to the insider phase decreases, expected profits from a new vacancy fall down, and firms decide to open up fewer vacancies.
In eq. (24), reservation productivity is independent of labor market tightness. The latter is a special feature of our model - it differs sharply from the literature with endogenous job creation and endogenous job destruction where the job destruction equation establishes a positive relationship between the two variables - and depends on the assumption about the wage setting mechanism. When wages are the outcome of individual Nash bargaining, labor market tightness exercises an upward pressure on wages[33]. However, given our assumption of rigid wages, reservation productivity is independent of θ.

Finally, after obtaining the steady state values of (θ, y_R), we substitute the equilibrium values of tightness θ and of reservation productivity y_R into the endogenous values for the parameters $\lambda^{EU}=\lambda F(y_R)$, and $\lambda^{UE}=A\theta^{1-\eta}$. Once these endogenous rates are known, unemployment rate in equilibrium of eq. (11) is obtained. Comparative statistic analysis with respect to the model parameters are in section B.2.

[33] The result holds even with the outsider-insider structure, where both the hiring wage for the outsider and the renegotiated wage (as soon as the outsider becomes insider) depend positively on labor market tightness.

6 Numerical Analysis

In this section, the steady-state equilibrium of the model, derived in section 5.5, is solved *numerically* using Matlab. The model is calibrated in section 6.1. Then, section 6.2 presents the results of two simulation exercises whose objective is to ascertain the extent to which the most relevant shocks supervened during the *critical period* 2011-2013 could be deemed responsible for the rise in unemployment and the rightward shift of the Beveridge Curve for Italy in the same years.

6.1 Calibration

To calibrate the model, parameters are calibrated with the *quarter* as unit of time. The reference period for the calibration is the one preceding the outward shift of the Beveridge Curve for Italy, namely 2010:Q2-2011:Q1. Values of the parameters are presented in table 1. Some of these values can be directly imputed from the data, some parameter values are attributed by referring to the literature, whereas others are calibrated to fit a set of labor market magnitudes for the period before the shift of the curve.

Interest rate (r). As standard in the literature, the interest rate r is set to 1% per quarter, implying an interest rate on yearly basis of almost 4%.

Incidence rate of productivity shocks (λ). The parameter λ is calibrated to mach actual data about the unemployment rate for the period before the outward shift. We set its value equal to 0.12.

Hazard Rates ($\lambda^{EN}, \lambda^{NE}, \lambda^{UN}, \lambda^{NU}$). Hazard rates $\lambda^{EN} = 0.0325, \lambda^{NE} = 0.0343, \lambda^{UN} = 0.3695, \lambda^{NU} = 0.038$ represent the *period average* and are set in line with the information drawn from Eurostat LFS Survey.

Matching function (A, η). The matching efficiency parameter $A = 1.358$ and the elasticity of the matching function $\eta = 0.538$ are set following Cardullo and Guerrazzi 2016, who have computed these values for Italy over the period 1993-2014 through the procedure implemented by Shimer 2005.

Cost of opening a vacancy (h). The cost of opening a vacant position $h = 0.015$ is recovered in order to match target values for the period before the shift occurred.

Productivity distribution boundaries ($\underline{y}, \bar{y}$). The productivity distribution for the employee in the outsider and insider status are defined over the range $y_k \in [\underline{y}, \bar{y}]$. We adopt the uniform distribution as productivity distribution and we set the values of the boundaries equal to $\underline{y} = 10$ and $\bar{y} = 22$. These values are experimental and study-specific and they are chosen to ensure that, net of their wages, it is still profitable for the firm to hire workers.

Out-of-work benefits (b). We follow Luksic 2020, who estimated the out-of-work benefits as share of labor income to be equal to $b = 0.04$ for Italy.

Firing costs (f_a, f_b). As for firing costs parameters, we follow Garibaldi and Violante 2005 who estimated both the tax component, f_a, and the transfer component, f_b, of the firing costs for Italy before the implementation of the Jobs Act (2014-2015). Their estimates suggest the tax component to be equal to 3.5 monthly wages (1.2 quarters), whereas the transfer component to be the double of this amount. Values are respectively set to $f_a = 1.2$ and $f_b = 2.4$.

Wages (w_o, w_i). Wages for the outsider and for the insider status are set in line with the information provided by Istat about the *average hourly* wages of workers hired under fixed-term and open-ended contracts.

Table 1: Calibration

	Parameter	Value
Interest rate	r	0.01
Incidence rate of productivity shocks	λ	0.12
Hazard Rate E-N	λ^{EN}	0.0325
Hazard Rate N-E	λ^{NE}	0.0343
Hazard Rate U-N	λ^{UN}	0.3695
Hazard Rate N-U	λ^{NU}	0.038
Matching efficiency	A	1.358
Elasticity of the matching function	η	0.587
Vacancy posting cost	h	0.015
Upper bound of the productivity distribution	$\bar{y}$	22
Lower bound of the productivity distribution	$\underline{y}$	10
Out-of-work benefits	b	0.04
Tax Component of firing costs	f_a	1.2
Transfer Component of firing costs	f_b	2.4
Wage in the outsider status	w_o	11.74
Wage in the insider status	w_i	14.64

With these parameters values, the model is then calibrated to reproduced stylized facts for the Italian labor market during the period 2010:Q2-2011:Q1. Table 2 presents target values, actual data for unemployment, exit out and entry into unemployment, and outcomes, simulated data for the same variables, for the period 2010:Q2-2011:Q1 (rows 1 and 2) and for the critical period 2011:Q2-2013:Q1 (from row 3 to 6). The endogenous equilibrium values for tightness θ and reservation productivity y_R are also presented.
It is possible to notice that the calibrated model is such that chosen target variables ($\lambda^{EU}, \lambda^{UE}, u$) for the period *before* the shift are matched fairly well.

6.2 Simulations Results

In this section, the main results of two alternative simulation exercises, carried out for the *critical period* 2011:Q2-2013:Q1, are summarized. The first numerical exercise allows for shocks to exogenous hazard rates ($\lambda^{NE}, \lambda^{EN}, \lambda^{NU}, \lambda^{UN}$), as documented in section 4.4. The second simulation considers jointly shocks to these transition rates and an adverse change in the degree of matching efficiency. Rationales for focusing on these two types of shocks rather than to shocks to other parameters of the model are essentially two:

1. as documented in section 4.4, the most striking phenomenon during the critical period has been the variations in transition flows across labor market states;
2. according to the *matching literature*, an outward shift of the Beveridge Curve could be attributed to the deterioration in the efficiency of the matching process.

Table 2: Simulations

	Equilibrium pair (θ, y_R)	u	λ^{EU}	λ^{UE}
Period *before* the shift 2010:Q2-2011:Q1				
1. Data	-	0.0825	0.0138	0.1775
2. Model	(0.0074, 11.4876)	0.0827	0.0149	0.1791
Critical Period 2011:Q2-2013:Q1				
3. Data	-	0.1037	0.016	0.1519
4. Model	(0.0074, 11.4925)	0.0943	0.0149	0.1780
Critical Period 2011:Q2-2013:Q1				
5. Data	-	0.1037	0.016	0.1519
6. Model	(0.0048, 11.4925)	0.1064	0.0149	0.1380

In both cases, all other parameters remain identical as in the preceding reference period. Rows 3 and 4 of table 2 compare target values and outcomes values for the critical period when the first simulation is performed, whereas rows 5 and 6 present the results of the second alternative numerical analysis. Effects on the equilibrium pair (y_R, θ) and capacity to replicate the target values λ^{EU}, λ^{UE}, u are thus analyzed. Shocks supervened to the exogenous hazard rates of the model during the critical period leave almost unaffected the value of tightness and reservation productivity in the equilibrium pair. Furthermore, the numerical analysis is able to capture that there is an increase in the rate of unemployment, but it does not completely match the target value for this variable. The simulated value of the hazard rate from unemployment to employment slightly decreases, however it does not capture the magnitude of this reduction observed in the data for the period 2011-2013. On the other side, by not affecting reservation productivity, this kind of shocks does not affect at all the hazard rate from employment to unemployment λ^{EU}.

In the second simulation exercise, a new value of matching efficiency $A = 1.25$ is proposed, slightly lower than in the baseline case, together with the parameter values for the exogenous transition rates used in the previous numerical analysis. Allowing for this hypothesis improves the match with the target value for unemployment, but it determines a decrease in the hazard rate λ^{UE} greater than in the first numerical exercise. Labor market tightness θ decreases, whereas reservation productivity and the flow out of employment are unaffected. However, the most pronounced increase in the unemployment rate is due to an even lower value of job finding rate, the latter being affected by a decrease in its multiplicative factor A.

Finally, we turn out to examine how well the calibrated model allowing for shocks to the exogenous hazard rates is able to capture the outward shift of the Beveridge Curve observed in Italy as of 2011. Figure 4 plots the Beveridge Curve as standard, using the unemployment and the job vacancy rates. Two curves are plotted in the figure. The solid blue curve, labeled *"Observed"*, plots the actual vacancy and unemployment rates. The red dotted curve, labeled *"Counterfactual"*, plots the observed vacancy rate starting with the second quarter of 2011 and the *predicted* unemployment rate. The latter uses the job finding rate and the job separation rate as predicted by the first simulation exercise.

It appears that the enriched matching model predicts that there is an outward shift of the Beveridge Curve

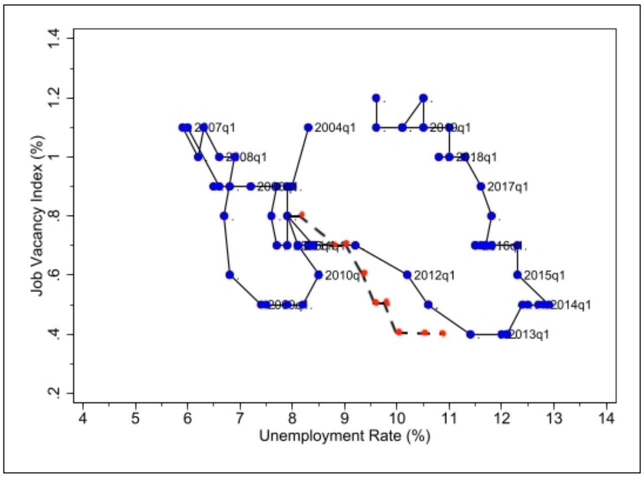

Figure 4: **Beveridge Curve**

Observed (blue solid line) - Counterfactual (red dotted line)

during the critical period, though by not as much as observed. This result likely arises because the model is able to predict the rise in unemployment observed between 2011-2013, but, without shocking also the parameter for matching efficiency, it underpredicts the magnitude of this rise.

7 Conclusion

This thesis filled the gap of the existing economic literature about the Beveridge Curve pattern and dynamics for Italy for years ahead 2004. Descriptive evidence about the unemployment-vacancy relationship reveals that a rightward shift of the curve has been observed as of 2011, determined by the considerable rise in the rate of unemployment and by the slight reduction in the rate of job openings.

In order to detect the potential causes behind this phenomenon, evidence about the state of the Italian economy and the functioning of the Italian labor market for the last two decades is gathered, with particular concern for the *critical period 2011-2013*. In this regard, in section 4.4, it has been shown that workers' transition flows across employment (E), unemployment (U) and inactivity (N) have experienced fluctuations of significant magnitude between 2011-2013. The hypothesis that shocks to these hazard rates could be the factors underlying the rise in unemployment and the observed outward shift of the curve is considered.

Thus, this thesis developed a stylized matching model for the Italian labor market. Reacting to the empirical evidence about workers' transitions, a three-state labor market is modeled, where agents can be employed, unemployed or out-of-the labor force and where exit out of unemployment and entry into employment by workers, and job separation decisions by firms are endogenous. It follows that unemployment dynamics do not depend anymore on just the exit out and entry into unemployment flows, but are also affected by participation flows. This is the principal difference of this model with respect to the bulk of the literature. The theoretical model also accounted for features characterizing the Italian labor market: the coexistence of fixed-term and open-ended contracts, the extent of job-security provision in the case of employee's layoff, and wage rigidity, due to the presence of binding agreements as the wage-setting mechanism.

In section 6.2, it has been shown that the enriched matching model, allowing for shocks to exogenous workers' transition flows, can account for the rise in the unemployment rate and for part of the observed outward shift in the Beveridge curve during the period 2011-2013. The results suggest that shocks to transition flows can play an important part in understanding our two key phenomena, but that other mechanisms should be considered in order to fully capture and match the observed shift.

For this purpose, our search equilibrium model could be extended in several ways.
A first extension could be to assume that agents out-of-the labor force may also be hired through the matching technology, as modeled in the search equilibrium models of Kroft, Lange, and Notowidigdo 2013 and Krueger, Cramer, and Cho 2014. So far, we have been considering that only hires for unemployed workers were mediated through the matching function and that agents out-of-the labor force were directly hired at an exogenous rate. Direct implication of this alternative approach consists in a new measure for the endogenous labor market tightness, θ, not anymore defined as the ratio of vacancies over unemployed agents, but as the ratio between vacancies and the working-age population.
Given the role played by *long-term unemployment* in the Italian labor market dynamics, it could be appropriate not only to incorporate nonparticipants in the matching technology, but also to assume a matching function with different withdrawal rates out of unemployment according to the length of the unemployment spell (i.e., short-term vs long-term unemployment) as done by Krueger, Cramer, and Cho 2014.
Another relevant extension could be to consider an extended general equilibrium matching model that allows for *financial frictions*. Despite the baseline Diamond-Mortensen-Pissarides search framework does assume perfect financial markets, several have been the theoretical contributions after the Great Recession trying to account for both financial and labor market imperfections (i.e., Petrosky-Nadeau and Wasmer 2013, Petrosky-Nadeau and Wasmer 2015, Boeri, Garibaldi, and Moen 2018). The realization of a theoretical framework of this type could be an ambitious project, however it can capture the considerable variations in financial conditions in firms' access and cost of credit occurred with the outburst of the sovereign debt crisis.

Finally, the analysis conducted in this thesis has not tried to understand and explain another key fact: the slight decrease in the rate of job openings. Therefore, it should not be excluded the case that accounting also for this feature in an enriched theoretical model could provide a promising explanation and a better accounting of the shift of the Italian Beveridge Curve.

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Appendix A Additional Tables and Figures

1. Overview of the main labor market reforms in Italy

	Reforms description
1992-1993	Trilateral Agreements: between the government and social partners entailed the abolition of the wage indexation scheme (”scala mobile”) and the reform of the collective bargaining system.
1997	Treu Bill: use of temporary worker agency; new fiscal treatment of part-time work. New atypical contracts such as job-sharing; new fiscal treatment of part-time work.
2003	Legge Biagi (Law n. 30/2003): extension of new atypical forms of jobs; use of ”contratti di collaborazione coordinata e continuativa”if under a well- defined “professional project” i.e. a task with predetermined objective and output.
2012	Fornero Reform (Law. 92/2012): easing EPL for open-ended jobs; technical requirement for the ”contratti di collaborazione coordinata e continuativa a progetto” more stringent; enlargement coverage unemployment insurance; reduction of STW schemes (transitional period extending to 2017).
2014-2015	Jobs Act (Law. 183/2014): modifications of EPL for open-ended contracts; introduction of hiring subsidy for new open-ended jobs created.
2018	Decree Dignità (Law. 96/2018): increasing the rigidity of EPL for fixed-term contract (i.e., reduction of the maximum length of temporary contracts from 36 to 24 months; reduction of the use of fixed-term contracts to three circumstances (absence of one of the three automatically transform the contract into a open-ended one); reduction of no. of extensions within 24 months for fixed-term contracts from 5 to 4.

Table 3: Labor Market Reforms in Italy

2. The Job Vacancy Series 1993-2020

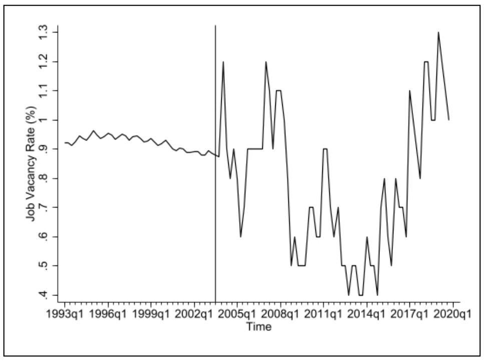


Figure 5: Job vacancy rate over the period 1993-2020.

Figures until 2003 uses the Help-Wanted Time Series of Isfol, figures since 2004 uses the VELA survey from Istat.

Source: ISFOL - Istat

3. Beveridge Curve for a set of European Countries

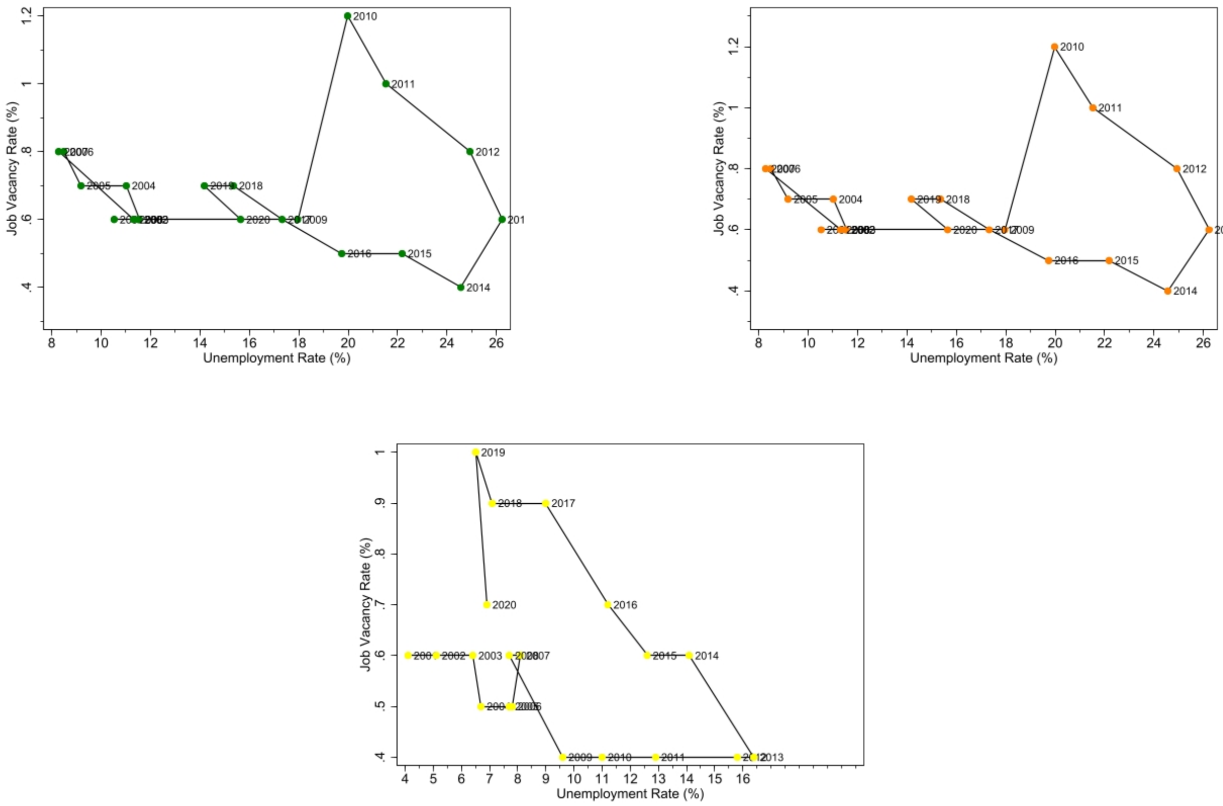


Figure 6: Beveridge Curves for a set of European countries

Top-left Ireland, **top-right** Spain, **center** Portugal.

Source: LFS survey, Eurostat

4. Evolution of Macroeconomic Indicators

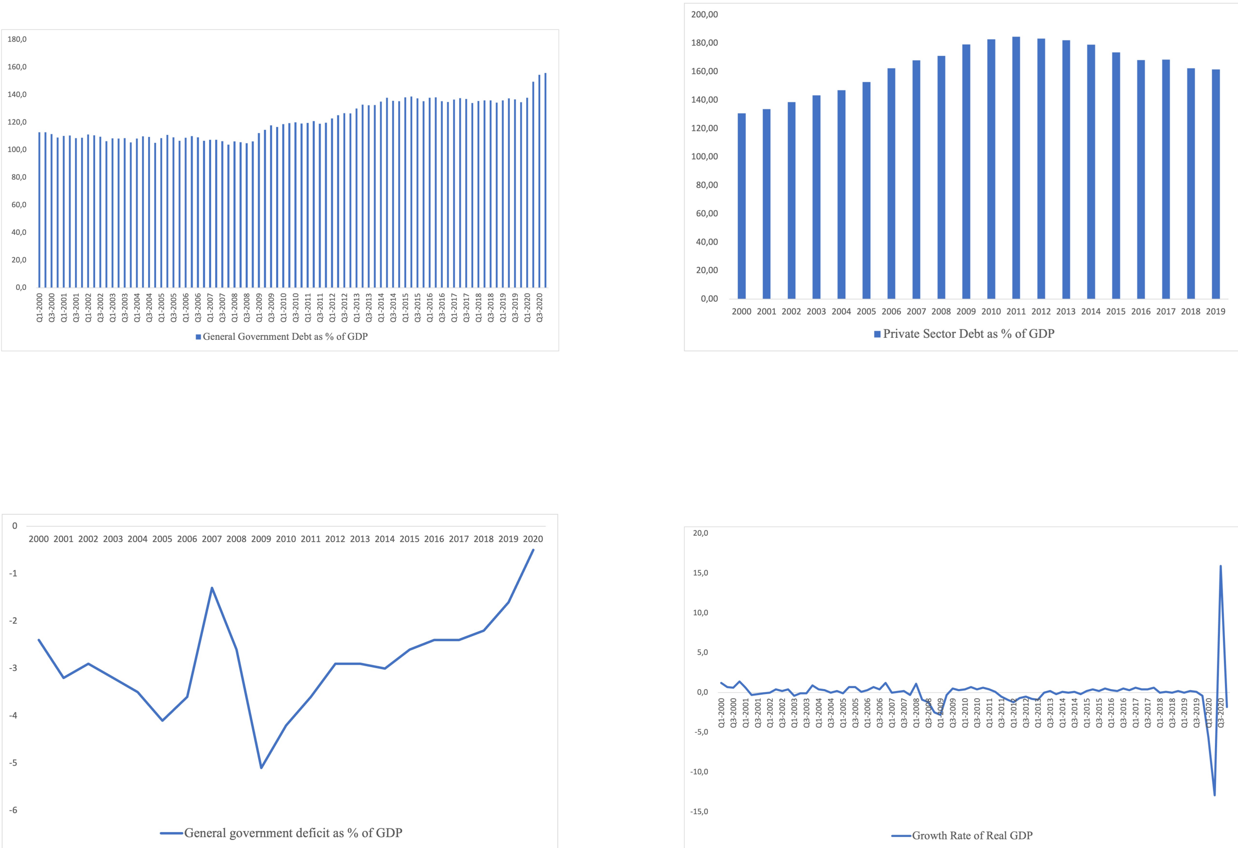


Figure 7: Macroeconomic Indicators.

Top-left panel. General Government Debt as % of GDP.

Top-right panel. Private sector debt as % of GDP.

Bottom-left panel. General government deficit as % of GDP.

Bottom-right panel. Growth rate of real GDP, % variation with respect to the previous quarter.

Source: ECB

5. Evolution of Financial Indicators

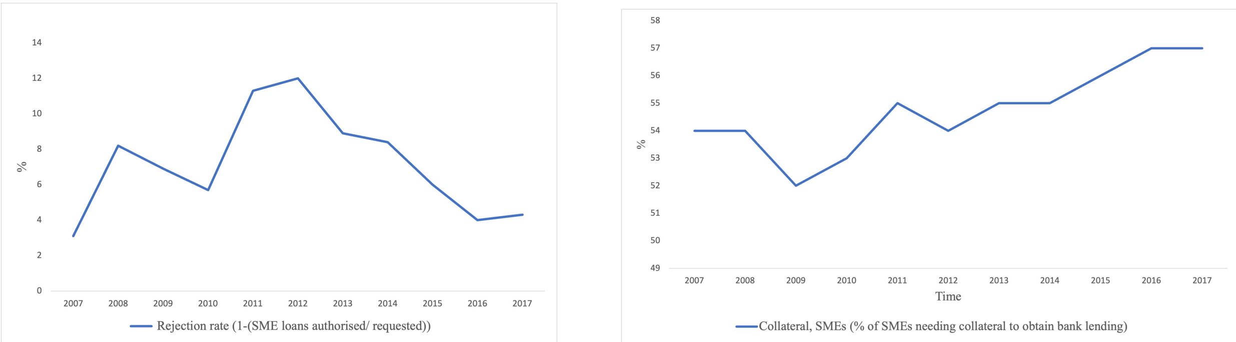


Figure 8: Financial Indicators for SMEs

Left. Rejection rate.

Right. Percentage of SMEs needing collateral to obtain bank lending.

Source: OECD, Financial Statistics

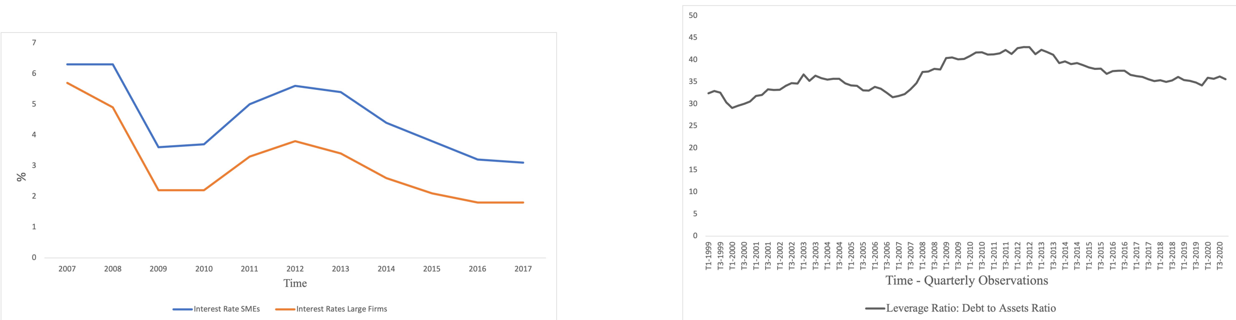


Figure 9: Financial Indicators.

Left. Interest rates for SMEs and large firms. Source: OECD, Financial Indicators

Right. Evolution of Leverage Ratio for non-financial corporations. Source: ECB

7. Productivity Measures

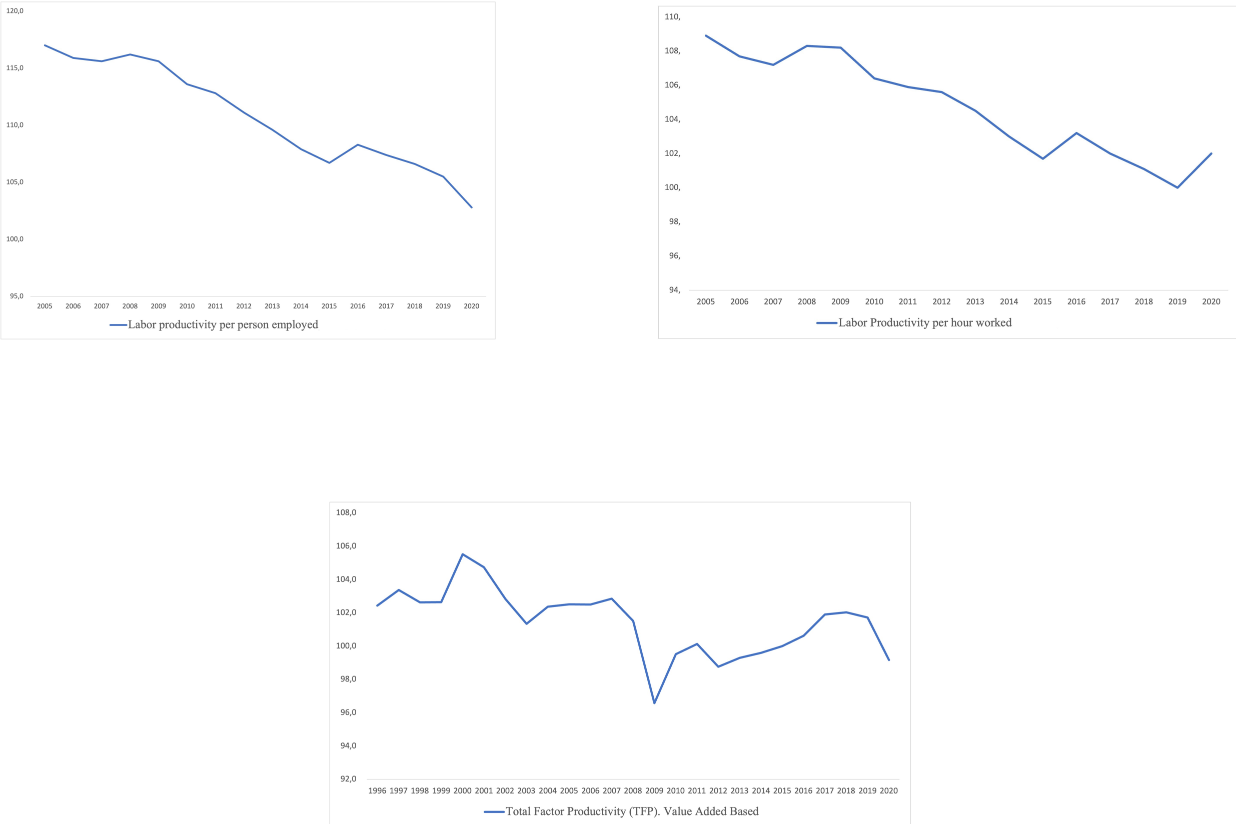


Figure 10: Productivity measures.

Top-left panel. Total volume of output (GDP) produced per unit of labor, measured in terms of the number of employed persons. Source: LFS Eurostat

Top-right panel. Total volume of output (GDP) produced per unit of labor, measured in terms of the number of hours worked. Source: LFS Eurostat

Figures expressed in PPS, provisional figures for 2019-2020.

Bottom panel. Total Factor Productivity. Value Added Based, Index 2015 = 100. Source: Istat

8. Quantifying the evolution of the OECD employment protection indicators for Italy

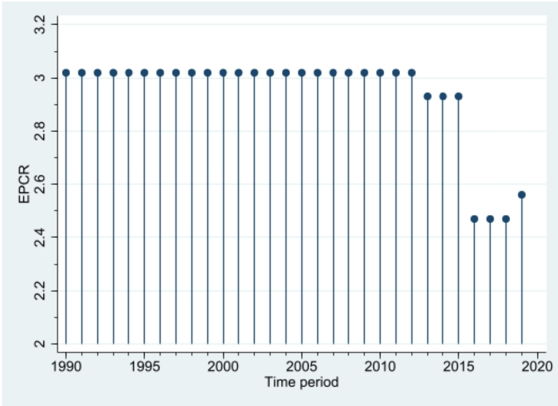


Figure 11: Evolution of the strictness of EPL for open-ended contracts 1990-2019 (OECD)

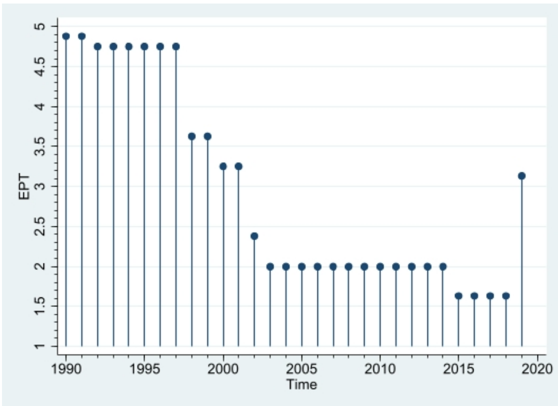
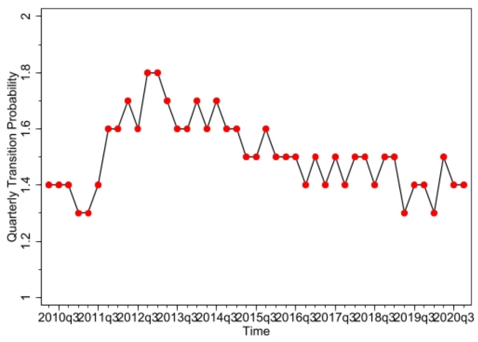


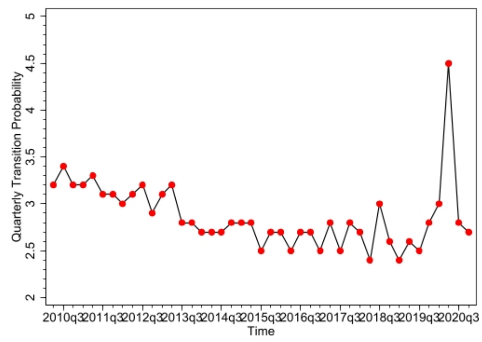
Figure 12: Evolution of strictness of EPL for fixed-term contracts 1990-2019 (OECD)

Year	ALMP - PES & Administration	ALMP - Training	ALMP - Employment Incentives	ALMP - Total	PLMP - Full UBs	PLMP - Partial UBs	PLMP - Early Retirement	PLMP - Total	Total LMP
2004	0,08	0,22	0,24	0,60	0,49	0,10	0,02	0,61	1,21
2005	0,08	0,20	0,20	0,53	0,55	0,10	0,02	0,67	1,21
2006	0,07	0,17	0,18	0,48	0,53	0,10	0,01	0,64	1,12
2007	0,07	0,18	0,14	0,43	0,50	0,08	0,01	0,59	1,02
2008	0,08	0,18	0,15	0,45	0,60	0,09	0,01	0,69	1,14
2009	0,10	0,17	0,15	0,45	0,92	0,31	0,01	1,24	1,69
2010	0,10	0,15	0,14	0,42	0,94	0,36	0,01	1,31	1,73
2011	0,10	0,13	0,14	0,40	0,93	0,30	0,01	1,23	1,64
2012	0,12	0,14	0,17	0,45	1,10	0,38	0,01	1,49	1,94
2013	0,09	0,15	0,16	0,42	1,08	0,42	0,01	1,52	1,90
2014	0,08	0,14	0,13	0,37	1,14	0,38	0,01	1,53	1,78
2015	0,09	0,16	0,22	0,49	0,99	0,28	0,01	1,28	-
2016	-	-	0,46	-	1,09	0,22	0,01	1,32	-
2017	-	-	0,43	-	1,07	0,13	0,01	1,21	1,56
2018	0,06	0,11	0,24	0,42	1,05	0,09	0,01	1,14	-

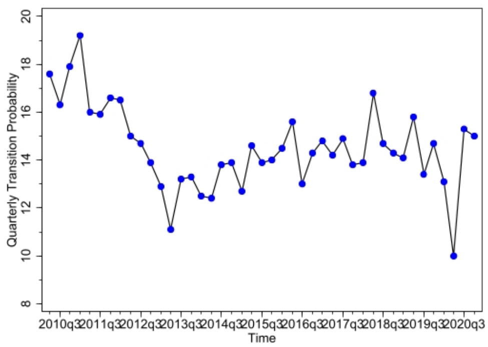
Table 4: Total share of public expenditure as % of GDP for categories of ALMPs and PLMPs (OECD)



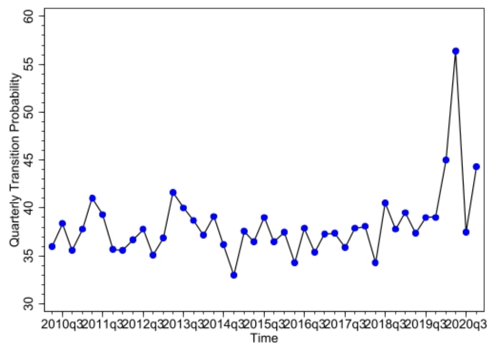
(a) Hazard Rate Employment-Unemployment



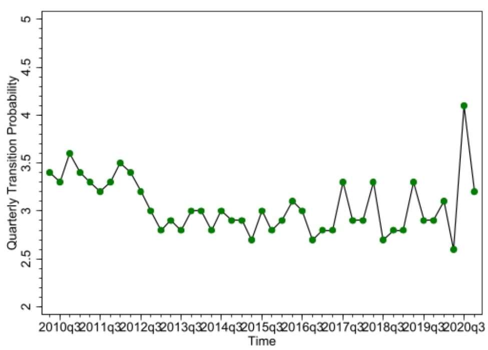
(b) Hazard Rate Employment-Inactivity



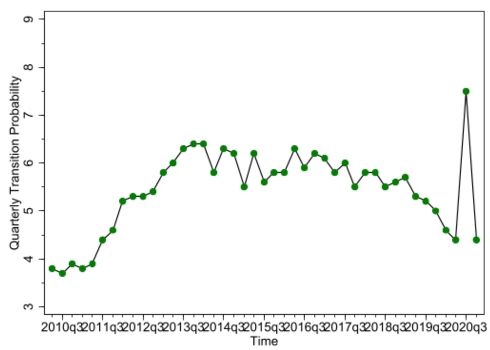
(c) Hazard Rate Unemployment-Employment



(d) Hazard Rate Unemployment-Inactivity



(e) Hazard Rate Inactivity-Employment



(f) Hazard Rate Inactivity-Unemployment

Figure 13: Quarterly Worker Flow Transition Probabilities across Employment, Unemployment, and Non-participation for Italy. Eurostat LFS survey

Appendix B Formal Derivations of Analytical Results

B.1 Steady-state unemployment rate

Let us recall the system of differential equations, eq. (8) and eq. (9), defining respectively the law of motion of unemployment and of employment:

$$\dot{U} = 0 \rightarrow (\lambda^{UE} + \lambda^{UN})U - \lambda^{EU}E = \lambda^{NU}N$$

$$\dot{E} = 0 \rightarrow -\lambda^{UE}U + (\lambda^{EU} + \lambda^{EN})E = \lambda^{NE}N$$

The sum of the two above equalities leads to eq. (10):

$$\lambda^{EN}E + \lambda^{UN}U = (\lambda^{NU} + \lambda^{NE})N \longrightarrow N = \frac{\lambda^{EN}E + \lambda^{UN}U}{(\lambda^{NU} + \lambda^{NE})}$$

Substituting the value of N into the law of motion of unemployment, eq. (8), we obtain:

$$(\lambda^{UE} + \lambda^{UN})U - \lambda^{EU}E = \lambda^{NU}\Big(\frac{\lambda^{EN}E + \lambda^{UN}U}{(\lambda^{NU} + \lambda^{NE})}\Big) \tag{30}$$

Simply rearranging the above equation:

$$\begin{aligned}
[\lambda^{UE} + \lambda^{UN} - \lambda^{NU}\frac{\lambda^{UN}}{(\lambda^{NU} + \lambda^{NE})}]U = [\lambda^{EU} + \lambda^{NU}\frac{\lambda^{EN}}{(\lambda^{NU} + \lambda^{NE})}]E \\
\frac{[(\lambda^{UE} + \lambda^{UN})(\lambda^{NU} + \lambda^{NE}) - \lambda^{NU}\lambda^{UN}]}{(\lambda^{NU} + \lambda^{NE})}U = \frac{[\lambda^{EU}(\lambda^{NU} + \lambda^{NE}) + \lambda^{NU}\lambda^{EN}]}{(\lambda^{NU} + \lambda^{NE})}E
\end{aligned} \tag{31}$$

Then, eq. (31) can be rewritten as:

$$\alpha U = \beta E \rightarrow U = \frac{\beta}{\alpha}E, \tag{32}$$

where

$$\begin{aligned}
\alpha &= \frac{[\lambda^{UE}(\lambda^{NU} + \lambda^{NE}) - \lambda^{NE}\lambda^{UN}]}{(\lambda^{NU} + \lambda^{NE})} \\
\beta &= \frac{[\lambda^{EU}(\lambda^{NU} + \lambda^{NE}) + \lambda^{NU}\lambda^{EN}]}{(\lambda^{NU} + \lambda^{NE})}
\end{aligned} \tag{33}$$

Recall the definition of unemployment $u = \frac{U}{U+E}$.
By means of eq. (32), it is possible to rewrite the unemployment rate as $u = \frac{\frac{\beta}{\alpha}}{\frac{\beta}{\alpha}+1}$.
After properly substituting the values of α and β, the steady state unemployment rate in eq. (11) is obtained:

$$u = \frac{[\lambda^{EU}(\lambda^{NE} + \lambda^{NU}) + \lambda^{NU}\lambda^{EN}]}{[\lambda^{EU}(\lambda^{NE} + \lambda^{NE}) + \lambda^{NU}\lambda^{NE} + \lambda^{NE}(\lambda^{NU} + \lambda^{NE}) + \lambda^{UN}\lambda^{NE}]}, \tag{34}$$

Easily rewritten as:

$$u = \frac{\lambda^{EU} + \epsilon}{\lambda^{EU} + \epsilon + \lambda^{UE} + \zeta}, \tag{35}$$

where $\epsilon = [\lambda^{EN}\frac{\lambda^{NU})}{(\lambda^{NU}+\lambda^{NE})}]$ and $\zeta = [\lambda^{UN}\frac{\lambda^{NE}}{(\lambda^{NU}+\lambda^{NE})}]$.

B.2 Comparative Statistics Analysis

In section 5.4, the *job destruction equation*, eq. (24), and the *job creation condition*, eq. (29), have been established.

$$y_R = w_i - (r + \lambda^{EN})(f_a + f_b) - \frac{\lambda}{r + \lambda + \lambda^{EN}} \int_{y_R}^{\bar{y}} (y_i - y_R)dF(y)$$

$$\frac{h}{\mu(\theta) + \lambda^{NE}} = \frac{1}{(r + \lambda + \lambda^{EN})}\{y_o - w_o + \frac{\lambda}{(r + \lambda + \lambda^{EN})}[\int_{y_R}^{\bar{y}} (y_i - y_R)dF(y)] - \lambda(f_a + f_b)\}$$

The first condition is an implicit equation in reservation productivity y_R, whereas the second equation defines the monotonic, negative, relationship between labor market tightness and reservation productivity. The analysis of how the various parameters of the model affect *job creation, job destruction equilibrium* conditions and the *steady-state unemployment rate* u is of interest here. For analytical simplicity, only **total** firing costs $f = f_a + f_b$ are considered. This simplification does not change the following analytical results. Let us define

$$F(y_R, w_i, r, \lambda, \lambda^{EN}, f) \equiv y_R - w_i + (r + \lambda^{EN})f + \frac{\lambda}{(r + \lambda + \lambda^{EN})} \int_{y_R}^{\bar{y}} (y_i - y_R)dF(y) = 0$$

$$G(y_R, \theta, w_o, r, h, \lambda, \lambda^{EN}, \lambda^{NE}, f) \equiv \frac{h}{\mu(\theta) + \lambda^{NE}} - \frac{1}{(r + \lambda + \lambda^{EN})}\{y_o - w_o + \frac{\lambda}{(r + \lambda + \lambda^{EN})}[\int_{y_R}^{\bar{y}} (y_i - y_R)dF(y)] - \lambda f\} = 0$$

Comparative statistics analysis with respect to the parameters of the model can be derived through total differentiation of $F(y_R)$, of $G(y_R, \theta)$, and application of the Leibniz Rule.

Total differentiation of the $F(y_R)$ with respect to parameters of the model:

$$\frac{dy_R}{dw_i} = -\frac{\partial F}{\partial w_i} / \frac{\partial F}{\partial y_R} > 0 \quad , \quad \frac{dy_R}{df} < 0 \quad , \quad \frac{dy_R}{d\lambda} < 0$$

1. Upward pressure on the wage to be paid to the insider worker, w_i, increases reservation productivity.

2. An increase in firing costs f lowers the reservation threshold because it is now more expensive for the firm to fire workers.

3. An increase in the arrival rate of idiosyncratic shocks λ also lowers the productivity threshold.

4. The effect of a marginal increase of parameters r and λ^{EN} on reservation productivity is ambiguous.

Total differentiation of the $G(y_R, \theta)$ with respect to parameters of the model:

$$\frac{d\theta}{d\lambda^{NE}} = -\frac{\partial G}{\partial \lambda^{NE}} / \frac{\partial G}{\partial \theta} > 0 \quad , \quad \frac{d\theta}{dh} < 0 \quad , \quad \frac{d\theta}{d\lambda^{EN}} < 0 \quad , \quad \frac{d\theta}{dw_o} < 0 \quad , \quad \frac{d\theta}{df} < 0 \quad , \quad \frac{d\theta}{dr} < 0$$

1. λ^{NE} increasing implies a decrease in the average time for a vacancy to be filled, thus a decrease of the average cost of opening up a vacancy. This increases the amount of vacancies opened by the firm (θ increases). The opposite reasoning holds if there is an increase in the cost of opening a vacant position, h.

2. An increase of the fixed wage to be paid to the outsider worker, w_o, reduces the expected profits from a new filled job for the firm, thus reducing the number of job vacancies opened.

3. An increase in the firing cost f to be paid by the firm in case of layoff decreases as well the expected profit from a new job, with the effect of decreasing θ.

4. An increase of the rate of incidence of the productivity shock, λ, has an ambiguous effect.
5. Finally, an increase in the rate of discount r and in the exogenous rate of job destruction, λ^{EN}, has the effect of decreasing expected profits $\Pi_o(y)$ and, subsequently, tightness θ.

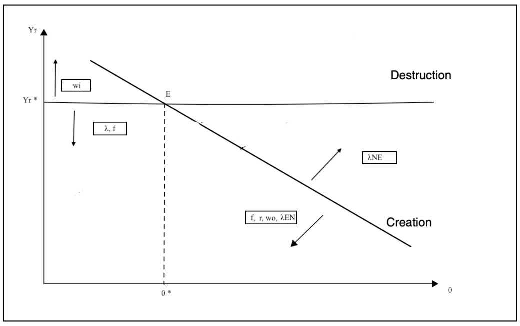


Figure 14: The unique equilibrium pair (θ, y_R) and Comparative Statistics analysis.

For graphical simplicity, the job creation equation is drawn with constant slope in the (θ, y_R) space, but it may not be necessarily the case that this equation has constant slope.

Effects on Equilibrium Unemployment. It is possible to observe how various parameters of the model affect steady-state unemployment u. Considering $\lambda^{EU} = \lambda F(y_R)$ and $\lambda^{UE} = \theta\mu(\theta)$, the *steady-state unemployment* reads:

$$u = \frac{\lambda^{EU} + \epsilon}{\lambda^{EU} + \epsilon + \lambda^{UE} + \zeta} = \frac{\lambda F(y_R) + \epsilon}{\lambda F(y_R) + \epsilon + \theta\mu(\theta) + \zeta} \tag{36}$$

From eq. (36), it is possible to observe that changes in equilibrium value of θ and y_R likely affect the unemployment rate. Increasing the productivity threshold y_R increases the job destruction rate: the stock of unemployment people increases as well. On the other side, labor market tightness θ increasing implies an higher job finding rate (i.e., $[\theta\mu(\theta)]' > 0$): equilibrium unemployment u decreases.

Results of comparative statistics analysis are summarized in table 5. It is possible to observe that some parameters of the model just affect the job creation equation (i.e., w_o, h, λ^{NE}); others just the job destruction condition (i.e., w_i). Other parameters $(r, \lambda, \lambda^{EN}, f)$ affect both conditions. For some parameters $(\lambda, \lambda^{EN}, r, f)$, it is possible to observe unambiguous results only for the reservation productivity threshold and/or for labor market tightness, but not for the stock of unemployment.

	w_i	w_o	h	λ^{NE}	λ	λ^{EN}	r	f
y_R	+	0	0	0	0	nd	nd	-
θ	0	-	-	+	nd	-	-	-
u	+	+	+	-	nd	nd	nd	nd

Table 5: Comparative Statistics Analysis

Appendix C Matlab Code

C.1 Running File

Baseline model 2010:Q2-2011:Q1

Defining the parameters

```
r         = 0.01;
l         = 0.12;
l_en      = 0.0325;
l_ne      = 0.0343;
l_un      = 0.3695;
l_nu      = 0.038;
a         = 1.358;
eta       = 0.587;
h         = 0.015;
y_lower   = 10;
y_upper   = 22;
y         = y_lower+2;
y_o       = y_upper-1;
b         = 0.04;
f_a       = 1.2;
f_b       = 2.4;
w_o       = 11.74;
w_i       = 14.64;
```

Solving for equilibrium values

```
% Initial guesses
theta0  = 7;
yr0     = y_lower+2;
Y0= [theta0; yr0];

fhandle = @matching_function;
options = optimoptions('fsolve','Display','iter');
[Y,fval] = fsolve(fhandle,Y0,options,r,l,l_en,l_ne,l_un,l_nu,eta,...
    a,h,y,y_o,y_lower,y_upper,b,f_a,f_b,w_o,w_i);
theta   = Y(1);
yr      = Y(2);

epsilon = l_en*(l_nu/(l_nu + l_ne));
zeta    = l_un*(l_ne/(l_nu + l_ne));
```

```
phi     = l/(r + l + l_en);
mu      = 1/(r + l + l_en);
pd_yr   = makedist('Uniform','lower',10,'upper',22);
x       = yr;
cdf_yr  = cdf(pd_yr,yr);

l_eu    = l* cdf_yr;
l_ue    = a*theta^(1-eta);
u       = (l_eu + epsilon)/(l_eu + epsilon + l_ue + zeta);

U      = [u];
L      = [l_eu l_ue];

disp(Y')
disp(U)
disp(L)
```

C.2 Matching Function File

```
function F = matching_function(Y,r,l,l_en,l_ne,l_un,l_nu,eta,...
    a,h,y,y_o,~,y_upper,b,f_a,f_b,w_o,w_i)

% Unpack unknowns
theta = Y(1);
yr    = Y(2);

% Grouping parameters
zeta    = l_un*(l_ne/(l_nu+l_ne));
mu      = l/(r+l+l_en);
phi     = 1/(r+l+l_en);
epsilon = l_en*(l_nu/(l_nu+l_ne));

% Cost of posting a vacancy
cov     = h/mu*(a*theta^(-eta)+l_ne) - y_o + w_o + l*(f_a + f_b);

% Defining CDF F(yr)
pd_yr  = makedist('Uniform','lower',10,'upper',22);
x      = yr;
cdf_yr = cdf(pd_yr,yr);
```

```
% System of equations: Free-entry conditions and reservation productivity
FE = cov - (y- yr)*unifcdf(y,yr,y_upper,'upper');
RP = yr - w_i + ((r+l_en)*(f_a + f_b)) + phi*((y - yr)*unifcdf(y,yr,y_upper, 'upper'));

F = [FE, RP];
```