Inclusion of propensity to self-employment
in the labor market matching process

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Abstract

The literature on the labor matching process tends to focus on developed countries while ignoring less-developed countries, which are characterized by the absence of unemployment insurance and a high number of self-employed workers. This article incorporates the occupational choice of self-employment into a labor market matching function (MF) through a choice process using agent-based models and an "entrepreneurial propensity" indicator based on market wages. Findings show that the possibility of self-employment improves the average earnings of those who choose to be employed, while reducing labor market rigidities.

Keywords: labor market; propensity to self-employment; matching function (MF); agent-based model.

1. INTRODUCTION

The literature on wages and employment shows that economic shocks affect the behavior of labor markets, making it difficult for businesses to acquire the labor force they need and for the economically active population to find job opportunities in line with their expectations. Matching theory studies exactly this macroeconomic outcome of interactions between various agents in markets where frictions prevent instantaneous adjustments to the level of economic activity (Álvarez de Toledo *et al*., 2008). According to Mortensen and Pissarides (1994), the volatility inherent in these difficulties is actually what drives loss and creation of employment.

For Mendes *et al*. (2010), the level of matching in the labor market is a function of productive affinity; that is, the productivity of businesses partly determines the affinity of the workers they seek, although information asymmetries may hinder the process. Similarly, Pissarides (2000) finds that, when random shocks are present in the economy, a matching function (MF) of the labor market is a good alternative for estimating the expected income of both businesses and workers.

These studies give indications that the MF, understood as a mathematical relation describing the formation of mutually beneficial relationships between agents, is a valuable tool for analyzing the flows into and out of unemployment resulting from these agents' decisions. The analysis of flows derived from MFs is facilitated by the development of agent-based models (ABM), which, supported by simulations, expose the dynamics, interactions, and behavioral patterns of these flows.

ABMs are composed of agents with characteristics that make them unique, autonomous, and capable of interacting with each other and with their environment, with the aim of explicitly representing social or natural phenomena without having to rely on mathematical tractability (Railsback and Grimm, 2012). This type of model makes it possible to reproduce patterns observed in reality. For example, Lewkovicz *et al*. (2009) observed that in France there was a high rate of unemployment in workers over 50 years of age, and, using an ABM, found that this pattern was caused by the imposition of a new model of labor contract.

On the other hand, complex systems are composed of heterogeneous and rationally constrained individuals who decide on their actions and strategies in response to the very outcome of their interaction with each other (Arthur, 2013). Since the 2008 crisis financial crisis, when the dominant models had few positive contributions to policy design, there was a growing interest in incorporating elements of complexity theory (Battiston *et al*., 2016). Complexity theory allows the innovation and social transformation processes to be studied, through agent-based computational models sufficiently flexible to articulate the micro- and macro-levels of the economy (Richiardi, 2017).

Working within this approach, Hamill and Gilbert (2016) propose an ABM that presents the performance of a labor market where workers are differentiated according to age and skills, and have to choose between continuing in their job or quitting to look for a new one. The model also adopts some socioeconomic indicators that characterized the town of Guildford, capital of the county of Surrey in the UK, during the period from 2009 to 2013 (this reference model will be referred to as ABM-REF). The authors find that heterogeneity in wages complicates the matching process, potentially leading the economy into severe unemployment.

The research so far presented, including that of Hamill and Gilbert (2016), share a peculiarity: workers may remain indefinitely unemployed if they are not matched to any vacancy. The above scenario could be plausible in economies that ensure compensatory supports to the lack of labor income, but it

does not seem feasible in developing economies where there are no social security or unemployment insurance provision mechanisms in place. This could be the case for 58.8% of the world's economies (International Labor Organization [ILO], 2018).

This reality increases the probability that the population will venture into entrepreneurial activities (depending on economic need and business management capacity), with self-employment predominating, predictably. The ILO (2018) points out that self-employment is a popular source of occupation in countries that do not have unemployment benefits, where it reaches 37.4% of the labor force, while in countries with some form of social security it barely represents 15.5%.

Given the difficulty of generalizing matching results such as those presented above to the context of developing countries, the present article reviews the implications of relaxing the Hamill and Gilbert (2016) ABM assumption that the worker can choose to remain indefinitely unemployed. This is achieved by including the option of self-employment as an occupational activity. It is predicted that incorporating this option will result in lower permanence in unemployment for workers and, under certain conditions, in lower long-term unemployment.

This result would be consistent with the findings of Glocker and Steiner (2007) who, using a pseudo-panel data analysis for Germany, find a positive relationship between the time that workers are unemployed and the rate of entry into self-employment. The authors point out that this effect is significant compared to that of other possible determinants such as age or professional qualifications, and that it offsets the negative effect that prolonged unemployment can have on credit constraints and individual expectations.

Likewise, the results would be consistent with those obtained by Thurik *et al*. (2008), who through a vector autoregressive model estimate the dynamic interrelation between unemployment and self-employment for a panel of countries belonging to the Organization for Economic Cooperation and Development (OECD) for the period 1974-2002, finding that high unemployment rates induce more people to become entrepreneurs (refuge effect); however, the decision to become an entrepreneur reduces unemployment at the macroeconomic level. The results suggest that the refuge effect is relatively small, meaning that a policy to encourage innovative and high-growth entrepreneurship could have more favorable results than one aimed at inducing the unemployed to enter self-employment.

Studies such as Fonseca *et al*. (2001) seek to integrate self-employment into MFs, focusing on the effect of entry costs to self-employment on employment levels. The authors introduce a factor of innate entrepreneurship in individuals. Meanwhile, Narita (2020) studies the effects of public policies on informality on the composition of the labor market, using an MF whereby a choice is made between working and entrepreneurship in both the formal and informal sectors.

Unlike the aforementioned studies in which the choice of entrepreneurship is associated with probabilities exogenous to the worker, the present article introduces the option of self-employment governed by a matching process between vacancies and workers, where the selection of the worker depends on an analysis of the opportunity cost of entrepreneurship in relation to forgoing the possibility of earning a wage. In this sense, the choice is underpinned by the worker's perception of the labor market and is therefore endogenous (Berkhout *et al*., 2016).

This paper consists of five sections, including this introduction. The second section provides an overview of the ABM-REF. In the third section, the self-employment component is integrated into the aforementioned model to subsequently analyze its effect on the inflows and outflows of unemployment in the labor market. In the fourth section, the simulation exercise is developed with the self-employment extension. The fifth section presents the results of the extended model and its comparison with the reference model, as well as some implications for developing economies. Finally, the sixth section offers some conclusions and recommendations for future research.

2. HAMILL AND GILBERT'S (2016) AGENT-BASED MODEL (ABM-REF)

This section presents an overview of the ABM-REF, which illustrates the basic dynamics of the flows between unemployment, employment, and inactivity in the Guildford labor market. It should be noted that the ABM-REF is based on an MF, whereby the amount of work actually performed in the economy depends on the arrangements linking job-seeking workers to available jobs in the labor market. In this function, the incentive for businesses to match is the generation of output through the labor force, while, workers, on the other hand, are motivated to match by the incentive of a wage (Pissarides, 2000).

Design and assumptions

Analysis assumes a situation of full employment (zero vacancies) in the labor market of a closed economy. Businesses are classified according to the number of workers they require to operate and their wages are set through a log-normal distribution. Following Hamill and Gilbert (2016), our analysis assumes that 2% of businesses with up to two employees close every quarter and those with three or more employees remain indefinitely in operation.

A further assumption is that the worker has the means (own or social benefits) to remain indefinitely unemployed, or that they have no costs to cover while they remain in that status. Another assumption is that, while in operation, businesses do not evaluate the performance of workers, meaning that once they fill a vacancy they remain in it until they retire, decide to resign, or the business closes. The probability of a worker resigning and becoming unemployed is constant and equal to 1.5% regardless of their age, salary level, or the size of the business where they work. Automatic retirement is triggered when a worker reaches 60 years of age;[1] if this happens, the worker becomes inactive and is replaced by another worker of 20 years of age (the minimum age for workers in the ABM). An additional assumption is that there are always a thousand employment options (employed or vacant) and a thousand heterogeneous workers (employed or unemployed).

The agents and their variables

To represent the dynamics of the participants in the labor market, the ABM-REF uses a set of 62 global variables (to which six are added in the extended model, referred to as ABM-AMP) that make up the interaction between workers and businesses, described below.

Workers

These are the agents, differentiated by age and skills, who offer their labor to businesses in exchange for a wage that covers their consumption needs. Skills in turn determine the wage demanded and, therefore, the affinity with vacancies (Chéron and Rouland, 2011). On the other hand, this wage is represented by a set of quantities,[2] whose median is equal to the wage received in the previous job, or to the one assigned based on the log-normal distribution in the case of the first job. The maximum and minimum wage of this set results from applying an adjustment factor to the median (based on the statistics of the reference labor market). In particular, the smallest value represents the minimum wage that one is willing to receive to accept employment (reservation wage). Increases in skills due to increases in experience have an impact on the median value over time.

Businesses

These are the agents that represent the productive units of the economy. They are differentiated by their size, represented by the number of workers they need, and follow a power law distribution[3] (consequently, these businesses' vacancies also follow this distribution). This implies that the larger businesses will have few counterpart vacancies in the economy, while smaller businesses will. Likewise, jobs are differentiated according to the wage it pays, which, in turn, is representative of the skills required of the worker.[4] In a matching situation, the wage associated with a vacancy, inflexible in this case, can be defined as the surplus that corresponds to the worker for participating in the productive process (generation of output). Given that the worker has knowledge of remunerations, the effective matching wage represents the highest income that they could obtain from the labor market during that quarter. It should be noted that businesses can identify interested parties whose salary range contains the value paid by the vacancy, and make the "final offer" only to the most desirable candidate. If the business does not find anyone who meets the aforementioned requirement, it must wait until the following period to repeat the search process and try to fill the vacancy.

The overall design of ABM-ref: overview of the stages and processes

This section describes the various stages of the ABM-REF design process. The model assumes that workers can only be in one of the following states: employed, unemployed, or inactive. An employed worker occupies a vacancy and is not looking for another job; an unemployed worker does not occupy a vacancy but is looking for one. An inactive worker ceases to be employed and decides not to work or stops looking for a job while unemployed. In this case, the worker transitions to inactivity and is replaced by another worker who transitions from inactivity to unemployment.

The ABM-REF consists of two stages in which the labor market dynamics take place derived from the interaction between agents. The first corresponds to the start-up routine of the ABM-REF, while the second refers to the functioning of the labor market from which the inflows and outflows of unemployment are obtained and labor market statistics are generated and collected (which in this case are repeated for 200 quarters). The start-up routine includes the processes of "creation" of initial workers and allocation of their wages according to the log-normal probabilistic distribution, as well as the generation of businesses and jobs. The percentage of businesses that close and are replaced by others is determined according to structural unemployment levels, as is the percentage of workers who leave the labor market and become inactive.

The flows of workers in the labor market can be of five types: *(i)* from unemployment to employment, *(ii)* from unemployment to inactivity, *(iii)* from inactivity to unemployment, *(iv)* from employment to unemployment, and *(v)* from employment to inactivity. The evolution of these flows makes it possible to calculate four key indicators: *(i)* the unemployment-to-employment flow (UEF), which is the number of workers migrating from unemployment to employment as a proportion of the unemployed; *(ii)* the employment-to-unemployment flow (EUF), which refers to the number of workers moving from employment to unemployment as a proportion of employed workers; *iii)* the long-term unemployment ratio, understood as the ratio between the number of workers who have been unemployed for more than three quarters and the total number of unemployed; and *iv)* the unemployment rate, which is equal to the number of unemployed workers as a proportion of the total number of workers.[5]

The quitting rate also serves as a control variable, which is equal to the number of workers who voluntarily quit their jobs in a period with respect to the workers initially in employment. The present study conducts tests with quitting rate levels ranging from 1% to 6%, seeking consistency with the reference document in which the quitting rate was fixed at 5%.

The ABM was designed according to the assumption that it is the unemployed who begin the search process by making their salary ranges publicly known. Equipped with this information, businesses with vacancies start the matching process in which the business with the vacancy with the highest salary chooses its preferred candidates for the position. Then, the business offering the vacancy with the next highest salary does the same; so on and so forth until all vacancies go through the matching process. Even if complete information is available, this process may not be entirely successful in terms of emptying the market. This is due to the heterogeneity in the wages demanded by the workers, those offered by the businesses, the absence of wage bargaining, and the assumption that the worker cannot return to the job they quit, which generates frictional unemployment.

The collected statistics allow the flows of workers between employment and unemployment to be identified in each period, as well as the workers' behavior over time. This mechanism is equivalent to conducting a permanent survey on unemployment in the economy. It should be noted that Hamill and Gilbert (2016) do not collect statistics on flows involving inactivity, as these statistics are not relevant to their ABM. An employed worker will experience one of the following four situations each quarter: *i)* quit and move to unemployment, *ii)* retire to transition to inactivity, *iii)* move to unemployment as a result of the closure of the business where they work, *iv)* or continue in employment. It is important to mention that the spaces left by workers when they leave self-employment due to retirement become opportunities for potential entrepreneurs.

Each period, a random percentage of unemployed people move from the labor force to inactivity. And as already mentioned, a small percentage of businesses with up to two employees are selected to cease operations and exit the economy; as a result, the workers in these businesses become unemployed. Furthermore, in each period new businesses are created to replace those that exit; these maintain the same number of jobs, to which a new wage is assigned according to a log-normal probabilistic distribution. This constitutes the dynamics of creation and destruction of labor relations contemplated in this MF.

Begg *et al*. (2014), understand that unemployment can be classified as frictional, structural, classical, or resulting from a lack of aggregate demand. The present article assumes that labor mobility and that businesses require workers with certain skills, and can therefore be understood as belonging to the category of studies related to frictional and structural unemployment.

To ensure that findings are comparable, the data used to simulate the ABM-REF are the same as those used by Hamill and Gilbert in their 2016 study, and come from the Office for National Statistics England's Labor Force Survey, which studies unemployment in the population.

3. INCORPORATING THE OPTION OF SELF-EMPLOYMENT IN THE LABOR MARKET

Integrating the self-employment option for workers into the ABM-REF allows us to analyze the effect of this occupational opportunity on flows into and out of unemployment. Unlike Narita (2020), who simulates a labor market where the probability of entrepreneurship depends on experience, the extension proposed here is based on the availability of vacancies and the wage offered, in line with Berkhout *et al*. (2016),[6] where unemployed workers choose between seeking employment or entrepreneurship, relying on what is called the "propensity indicator for self-employment as an economic activity."[7] $G(\mu_w, \sigma_w, k_w)$ This indicator is understood as an approximation to the probability of starting up, as a function of the mean (μ), the standard deviation (σ), and the bias (k), of the wage set (w) offered by the businesses in which the worker could be employed. Thus, μ_w, σ_w and k_w represent, respectively, in terms of wages, the mean to which the worker can aspire, the volatility, and the asymmetry of the distribution.

On the other hand, maintaining equality between the number of workers and the number of jobs available in the economy (which for the ABM-AMP corresponds to salaried jobs and self-employment) requires monitoring the enterprises created. Otherwise, the AMB-REF's underlying assumption, the economy starts from an initial state where all workers and jobs are occupied, cannot be guaranteed, and, therefore, the ABM-AMP would not provide unemployment inflows and outflows based on observable statistics. To maintain the aforementioned equality and make the matching functions equivalent, we limit the number of self-employment opportunities to 130, setting wage jobs at 870 (consistent with the evidence presented by Hamill and Gilbert (2016) for Guildford, which indicates that 13% of the labor force engaged in self-employment activities, over the period 2009-2013).[8]

Earnings from self-employment are calculated using individual labor productivity obtained through an allocation process based on a log-normal distribution, similar to that used to allocate wages. These earnings can be equal to or greater than the wage sought from employment. On the other hand, self-employment ventures will close when the following occurs: the entrepreneur retires (upon reaching the age of 60),[9] or the earnings are less than their minimum acceptable wage, in which case they will become unemployed and may seek another job or try to start up again. If the enterprise closes, the individual becomes unemployed. Douglas and Shepherd (2000) understand that considering skill differences in employment options makes economic sense, although, unlike these authors, the AMB-AMP is oriented towards the pecuniary implications of the matching process and the choice of self-employment.[10]

Figure 1 presents the processes described above, both for the ABM-REF and the ABM-AMP, highlighting with a dotted rectangle the contribution of the proposed incorporation of the inflows and outflows of self-employment. These processes are described below.

Mechanics of exit from unemployment. In the ABM-REF, the unemployed can only exit this status through matching with a vacancy. However, incorporating self-employment provides an additional choice for the unemployed person, who must now choose between self-employment or continuing the job search. The worker's decision depends on the propensity to start up. The assumption behind this approach is that the worker can only engage in one productive activity each quarter as a result of an optimal choice process.

Figure 1. ABM-AMP Labor Market Model
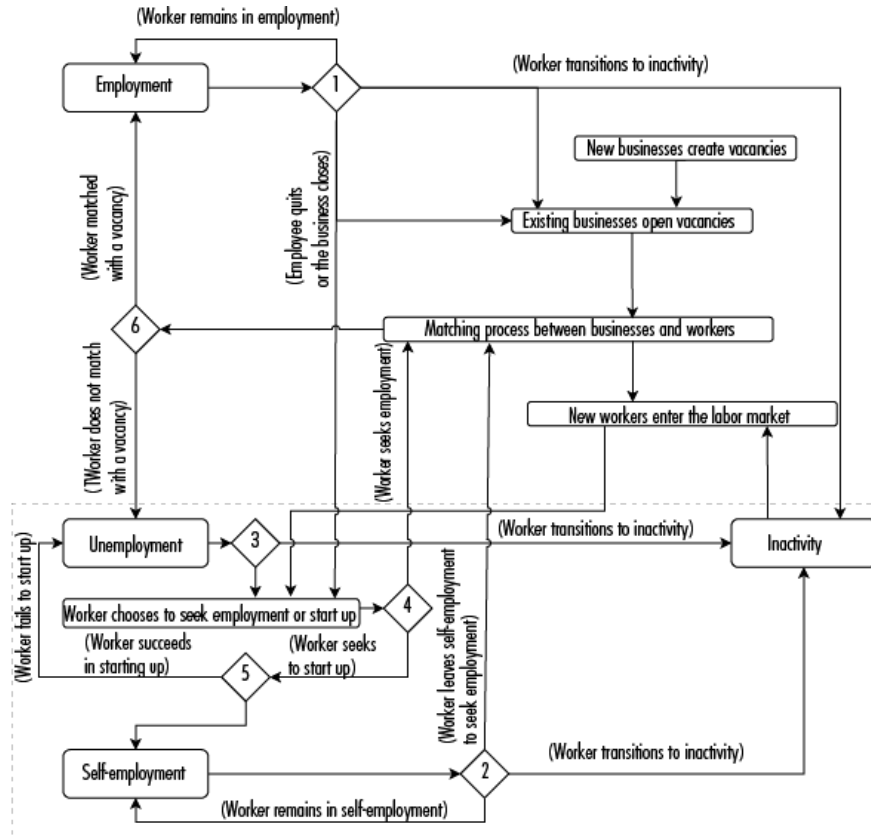
Source: Compiled by the authors based on Hamill and Gilbert (2016). The numbering inside the diamonds suggests the sequence of the model.
Unified Modeling Language (UML) was used. For further explanation of this language, see
http://openaccess.uoc.edu/webapps/o2/bitstream/10609/9121/1/Intro_UML.pd

Mechanics of entry and exit from self-employment. In the first instance, each unemployed person is shown to be familiar with their environment and characteristics, represented by the dispersion measures μ_w, σ_w, and K_w, based on the wages of the vacancies for which they are eligible.[11] Via these measures, the worker can gauge their propensity to start up a productive activity, $G(\mu_w, \sigma_w, k_w)$. This propensity consists of three components, one for each dispersion measure, resulting from logistic functions, such that the results can be equivalent to those of Berkhout *et al*. (2016). The propensity to choose self-employment as an economic activity has a negative relation with the average wage observed by a worker. The component associated with the mean (C_μ) is given by:

$$C_\mu = 2 \left[\frac{1}{1+e^{\mu_w}} \right] \tag{1}$$

Likewise, the propensity to start up has a positive relationship with the standard deviation, which represents the uncertainty that exists in the labor market about wages offered. Thus, the higher the standard deviation,[12] the less certain the worker is about the possibility of receiving a wage higher than or equal to the average. The standard deviation weighting is specified as

$$C_\sigma = 1 - 2 \left[\frac{1}{1+e^{\sigma_w}} \right] \tag{2}$$

Finally, the bias has a negative effect on the propensity to self-employment in the sense, given that it is caused by vacancies with high wages, then finding a job with above-average pay is more likely. But the opposite can also occur, lower-than-average wages skew the distribution and, therefore, entrepreneurship has a lower associated opportunity cost. This component (c_k) is defined as:

$$C_k = 2 \left[\frac{1}{1+e^{k_w}} \right] \tag{3}$$

Since we do not have information on the relative importance of each component of the propensity to start up (G), we decided to add them together and give them a uniform weight, represented as $G = \left(\frac{1}{3} \right) (C_\mu + C_\sigma + C_k)$ [13] The threshold of the indicator above which self-employment is chosen is based on the midpoint of its range. Thus, those unemployed who obtain $G < \left(\frac{1}{2} \right)$ are workers in search of work, while those who obtain $G \geq \left(\frac{1}{2} \right)$ are

workers seeking to start up.[14] However, as already mentioned, there are a limited number of self-employment opportunities in the market, and this number may be lower than the number of people seeking to become entrepreneurs.

In this sense, the workers who finally enter self-employment in each period are chosen randomly, which allows for the inclusion of workers of any salary range. In each period, the worker's minimum acceptable wage is compared with the wage from self-employment. If the latter is lower than the former, the worker moves from self-employment to unemployment. Those who are classified as workers seeking to become self-employed remain unemployed as long as they do not succeed, and may also opt to seek employment.

4. THE SIMULATION EXERCISE

To allow comparison between models and thus validate the extension, it was necessary to run both in a controlled simulation environment under careful parameterization. The ABM-AMP comparison was simulated with NetLogo, which is the program used in the reference model. The parameters controlled in the simulations are wage flexibility and the percentage of workers moving to inactivity or quitting their jobs; this allowed for calibration of the extension, making the two models technically comparable. As for wage flexibility, the maximum increase is 5%, without considering the possibility of decreases. Additionally, the percentage of employed and unemployed that transits to inactivity each quarter is 2% and 15%, respectively.

The analysis is strengthened via the incorporation of the scenarios used by Hamill and Gilbert (2016) regarding the rate of workers quitting their jobs each quarter, ranging from 1% to 5%, are presented for both models. Table 1 presents the ABM-REF results for the mean (μ) and the standard deviation (σ) [15] of the simulated flows for each of the relevant indicators. It can be seen that, with a mean of 6.0%, the simulation that comes closest to the observed mean of 6.1% is the one that considers a resignation rate of 1%.

Table 1. Means and standard deviations [$\mu(\sigma)$] of the ABM-REF for different resignation rates

		Quitting rate (%)				
		1	2	3	4	5
Indicator (%)	UEF	18.14 (0.92)	19.91 (0.89)	21.9 (0.99)	23.04 (1.14)	24.63 (1.28)
	Unemployment rate	5.98 (0.35)	5.84 (0.29)	5.49 (0.38)	5.49 (0.21)	5.46 (0.32)
	Long-term unemployment	23.46 (1.17)	21.77 (1.19)	20.16 (1.08)	18.98 (1.32)	17.91 (1.30)

Source: Taken from Hamill and Gilbert (2016). Standard deviation is shown in parentheses.

Similarly, Table 2 presents the results of the ABM-AMP, where it can be seen that the 5% resignation rate generates an unemployment rate very similar to that observed in the reference period. This is the first element of validation that the extension is more representative of reality, in that it produces findings consistent with the empirical evidence.

Table 2. Means and standard deviations [$\mu(\sigma)$] of the ABM-AMP for different resignation rates

		Quitting rate (%)				
		1	2	3	4	5
Indicator (%)	UEF	15.92 (0.80)	17.39 (0.87)	18.32 (0.66)	19.45 (0.92)	20.92 (0.99)
	Unemployment rate	6.46 (0.32)	6.45 (0.36)	6.30 (0.35)	6.21 (0.30)	6.10 (0.41)
	Long-term unemployment	24.23 (0.97)	23.24 (1.14)	22.66 (0.85)	22.20 (1.36)	21.06 (0.98)

Source: Compiled by the authors. The standard deviation is shown in parentheses.

An inverse relationship can be observed between the average unemployment rates in Tables 1 and 2 as the resignation rate increases. This is because the higher the number of unemployed workers, the higher the outflow, as more jobs are freed up and there is more interest in filling them. When there is a low resignation rate, outflows are reduced and unemployment increases.

The second element of validation concerns the stability of the simulated unemployment rates, which were analyzed for 100 periods.[16] According to Hamill and Gilbert (2016), this rate ranged between 5.2% and 6.6% during their analysis. Figure 2 presents the evolution of this rate in the case of the ABM-AMP for different quitting rates (see Table 2). The criterion for choosing the most appropriate simulation to represent an economy such as

Guildford's is that the mean of the simulated unemployment rate should be close to the observed rate, while the variations should remain within its range. It is found that the scenario that best complies with the above is where 5% of workers quit their jobs.[17]

The variations observed in Figure 2 are due to the pressure generated by the mechanics of entry into self-employment on the efficiency of the matching between vacancies and unemployed. The average unemployment rate obtained in the ABM-AMP, with the aforementioned indicators, was 6.1%. This rate is similar to that observed in the South East of England between 2009 and 2013. Figure 2e shows that the quarterly unemployment rate obtained by the ABM-AMP oscillates in the range observed in the period (5.2%-6.6%), which means that incorporating self-employment mechanics to the ABM-REF, in line with Berkhout *et al*. (2016) is appropriate for the analysis.

5. RESULTS

First, the results and implications of the incorporation of the self-employment option in the flows between unemployment and employment are presented, comparing the results with those of the reference model. The findings related to the flows between unemployment and self-employment are described. Second, the effects of the self-employment option on economic indicators of the labor market are presented, such as the wage level and long-term unemployment.

Figure 2: Quarterly unemployment rate for different quitting rates in the ABM-AMP.
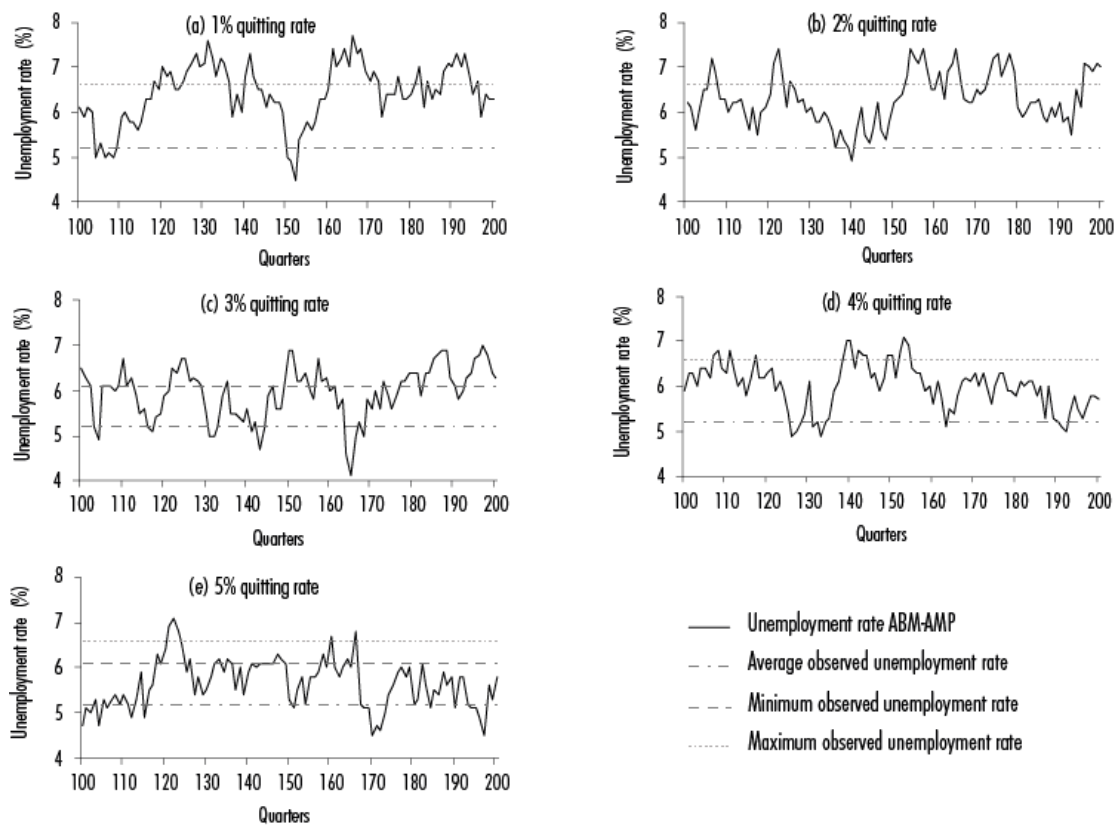
Source: Compiled by the authors using NetLogo.

Effects of incorporating self-employment on labor flows

Figure 3a shows the EUF in both models, which seem to oscillate around a medium value; however, the ABM-AMP shows higher volatility than the ABM-REF. These flows consist of people who quit their jobs and those who lose their jobs due to external shocks, in relation to the total number of workers in the economy.

Figure 3. Comparison of flows between unemployment and employment
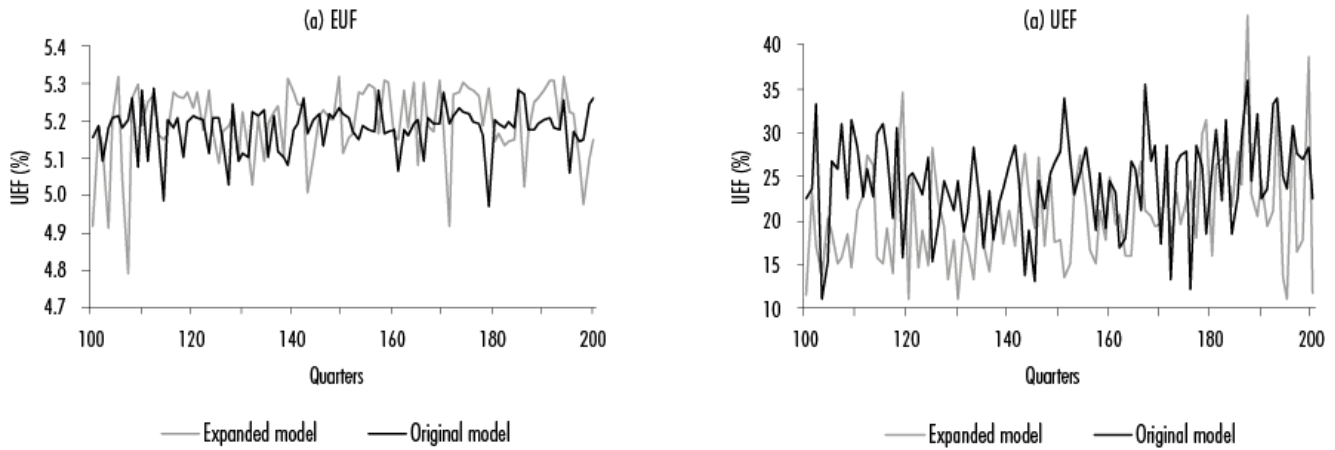
Source: Compiled by the authors using NetLogo.

This figure shows that the EDFs of the models do not show large differences. This is because the exit parameters are the same in both: 5% of workers quit their jobs and then look for a new one, and 2% of small businesses with up to two employees (including self-employment, when applicable) close each quarter. This could change if the possibility of job search while employed is added to the model, in which case we would expect a decrease in the inflow to unemployment, but also an increase in long-term unemployment, given the competition from unemployed workers.

Although the difference is not visually evident (see Figure 3b), the average EUF in the ABM-AMP is 2% lower than that presented in the ABM-REF. This is because, despite the fact that the matching mechanics were the same in both models (albeit with a distinct number of vacancies-to), the unemployed in the ABM-AMP had an alternative to matching, which reduced the outflow into wage employment.

Figure 4 shows that the number of workers seeking self-employment remains at around 87 per quarter due to the lack of trends in the main labor market indicators. This suggests that the stability of the ABM-AMP has an impact on the number of workers seeking to start up and, in addition, that for some unemployed people, the supply of vacancies does not meet the standards that make the opportunity cost of seeking self-employment lower than that of looking for a job, resulting in a propensity to seeking self-employment, resulting in a high propensity to entrepreneurship $G \geq \left(\frac{1}{2}\right)$. Following Berkhout *et al.* (2016), the above could represent situations of economic sectors with low vacancy supply or low wages, where seeking to start up becomes more prevalent than seeking employment.

Figure 4. Workers seeking to start up
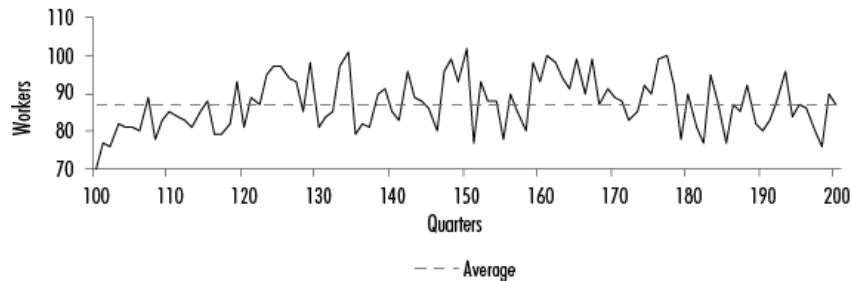
Source: Compiled by the authors.

On the other hand, Figure 5 shows that there is a temporal correspondence between workers who move between self-employment and unemployment. This is confirmed by the correlation index between both flows, which is 76%. This is due to the limit of 130 job opportunities, imposed with the objective of maintaining similarity with the number of enterprises observed in Guildford, and the high level of occupancy of these opportunities, which conditions the possibility of new income to the freeing up of spaces.

Figure 5b shows the evolution of the self-employment to unemployment flow (SUF) that occurs when the income associated with self-employment is less than the worker's minimum acceptable wage. This suggests that in the ABM-AMP there are always unemployed people seeking self-employment and taking advantage of entrepreneurship opportunities. Thus, if there were no restrictions on entry into self-employment, a significant part of the labor market might be willing to take up a place in this occupational field.

Figure 5. Self-employment inflows and outflows (ABM-AMP)
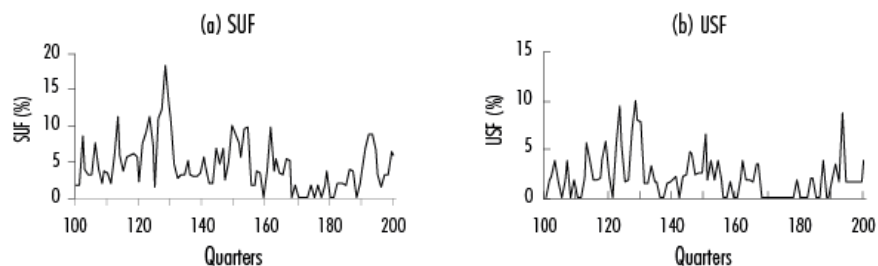
Note: USF refers to the number of workers moving from unemployment to self-employment,
while SUF refers to the workers moving from self-employment to unemployment
as a proportion of self-employed workers.
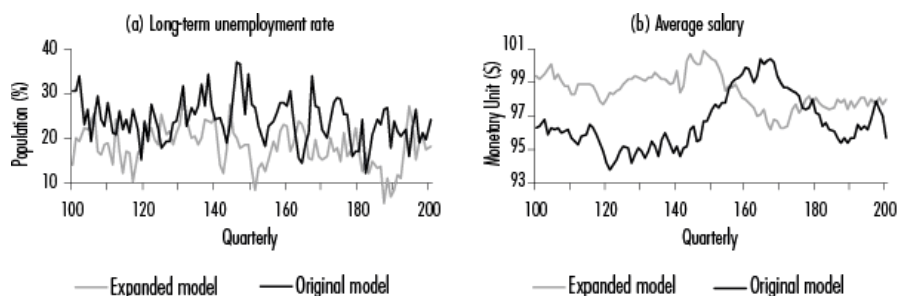Source: Compiled by the authors.

Effects of self-employment on wages and long-term unemployment

Figure 6 presents the evolution of long-term unemployment statistics and the wage level of employed workers for both ABM-REF and ABM-AMP. Figure 6a shows that the long-term unemployment ratio in both models oscillates around a mean value of 18.3% in the case of ABM-AMP and 24.1% for ABM-REF, so the average of ABM-AMP is lower (24%) than that of ABM-REF, as expected. This is because, in the long-term, unemployed workers have the possibility of transitioning to self-employment and developing an economic activity for at least one quarter.

Figure 6b shows the evolution of the average quarterly wage received by employed workers. It should be noted that the ABM-REF only shows the effect of wage flexibility on the labor market, while the extended model includes the effect of the opportunity for self-employment on the labor supply.

It can be seen that the average wage is higher in the expanded scenario for most quarters. Overall, ABM-REF wages are 1.9% lower than ABM-AMP wages. This is because self-employment attracts workers receiving low wages, while those who choose to participate in the labor market are generally workers with higher wages. Consequently, the incorporation of the option of entrepreneurship into the economy increases the average wage. However, between quarters 155 and 176, the ABM-REF average wage was higher, perhaps because of the entry of both businesses with high-wage vacancies in the reference model and low-wage businesses in the ABM-AMP.

Figure 6. Comparison of long-term unemployment and average wages

Source: Compiled by the authors.

Implications for developing economies

In the simulation exercise, using data from a developed country (the UK), we find that adding the option of self-employment maintains logical consistency between the ABM-AMP and the ABM-REF. However, the exercise presented here is sufficiently general to allow for extrapolations to be made on developing countries.[18] For example, incorporating the mechanics of Berkhout et al. (2016) does not particularize the contrast of wages observed in the economy versus those that could be earned in self-employment by the worker. These wages could include both those in the formal and informal economy. Therefore, the results would be consistent with those obtained in the ABM-REF.

Also, the ABM-AMP does not impose barriers to entry to self-employment that can be equated with an operating cost. Consequently, as in the result obtained in the ABM-REF, for a developing economy, one would expect to find that the level of self-employment is linked to labor demand conditions and the wages offered by businesses.

Thus, extending the ABM-REF to consider data on informality does not contribute to a better understanding of a developing economy, unless specific rules are included; for example, on minimum earnings or incentives for businesses to hire workers with certain characteristics.

6. CONCLUSIONS

Self-employment is a genuine alternative for workers with entrepreneurial ambitions or who find themselves in saturated labor markets. In recent years, governments and international organizations have allocated significant resources to promoting entrepreneurship as a labor option for the population. This policy is informed, in part by a desire to reduce the rigidity of the labor market and guarantee macroeconomic stability. This article has studied the effect of considering the occupational alternative of self-employment on the inflows and outflows of unemployment via the ABM model proposed by Hamill and Gilbert (2016). The self-employment option was incorporated via the Berkhout *et al*. (2016) model, which proposes a choice problem between job search and entrepreneurship that considers the opportunity cost of the alternatives through the calculation of the probability of entrepreneurship.

It was seen that the incorporation of the self-employment option reduces the rate of workers who participated in the matching process. This trend was reflected in the reduced unemployment-to-employment flows. Likewise, the calculation of an individual indicator of propensity to self-employment was incorporated, based on the dispersion of wages offered to workers. The indicator modified the inflows and outflows of unemployment (in relation to the reference model) in a manner consistent with economic theories on the labor market. This finding demonstrates that this indicator can be considered an effective instrument for measuring the preference for a labor option that can be supported by dispersion measures, such as self-employment.

In light of the above, this paper concludes that entrepreneurship is less attractive the greater the ratio between the number of vacancies and unemployed workers, and to the extent that there is a greater supply of vacancies with above-average salaries. The propensity to start up allows us to infer that those who seek to start up in the labor market will prefer to do so in ventures that provide an income higher than the average wage of available vacancies. Conversely, in a highly-volatile labor market with few vacancies per worker and below-average wages (regardless of level), more workers will opt for self-employment. Due to the wage bias, we would expect an increase in the number of low value-added ventures, which would make the search for an income close to the average wage part of a rational decision, given that wages above this level would be unlikely and therefore more difficult to obtain.

For a developing economy facing circumstances such as a low wage level in available jobs and a limited number of vacancies in relation to the number of workers, the population will be more likely to seek self-employment as an option. In public policy terms, this suggests that simply promoting entrepreneurship may be inadequate, as the precarious conditions of the labor market are already a sufficient incentive. Understood in this way, support should be given to existing businesses (including the self-employed) to consolidate and attempt to transition to more robust forms of enterprise and thus increase the number of vacancies available in the market. This could involve, for example, increased support in the form of social security, access to financing, or tax advice.

It is important to emphasize that the extension developed can be used as a basis for integrating other mechanisms considered essential for the practical functioning of an effective labor market, such as wage negotiation, the job search process, learning over time, the effect of job skills, the benefits of self-employment, or the role of entrepreneurship in decision-making. This will allow us to obtain a more comprehensive view of the labor market that includes the different processes that affect the inflows and outflows of unemployment. Likewise, when seeking to understand developing economies, it is crucial to continue to incorporate elements related to labor informality and underemployment into the context of entrepreneurial propensity.

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[1] Minimum age to be eligible for retirement in England.

[2] Without this flexibility, matching would be more difficult and the analysis could generate higher unemployment rates than actually exist.

[3] In analytical terms, a power law is a functional relationship between two quantities A and B, whereby A is proportional to B raised to a power n. One of these quantities can even be the frequency of the other, resulting in a random variable reaching high values with a low probability and low values with a high probability. Power laws reflect a pattern of organization that is characteristic of complex systems (Buchanan, 2004). Pareto's income distribution law, according to which 20% of the population concentrates 80% of the wealth, is a basic example of a power law (Aljure and Gallego, 2010).

[4] Thus, if two vacancies pay the same, they are considered equal regardless of whether they are offered by different companies.

[5] The flows are relative; that is, they express the number of people who change their labor status from one period to another in percentage terms. In all cases the base refers to the initial period.

[6] This study contributes to the ABM-AMP, as it considers the processes of entry and exit to unemployment in a labor market in which self-employment is an option.

[7] This will be simplified to "propensity to start up."

[8] To maintain the possibility of matching, Hamill and Gilbert (2016) propose that these workers are employed by companies with two jobs. In the present study, these are transformed into effective self-employed.

[9] Although an entrepreneur could continue working after reaching this age, this assumption is made to ensure consistency with the ABM-REF.

[10] In any event the comparison of results is not appropriate given the differences between the respective methodologies used in each study.

[11] Matching is only possible if the worker's salary range includes that of the vacancy in question.

[12] A worker's uncertainty results from their lack of information about other workers.

[13] Both the propensity to start up and its components take values between 0 and 1.

[14] When there are less than three vacancies, the indicator is set at 2/3, which is consistent with what is observed in labor markets with limited labor supply.

[15] These terms should not be confused with w and w, which refer exclusively to the propensity to start up.

[16] Similar to Hamill and Gilbert (2016), 200 periods were simulated, although, for obtaining valid indicators only the last 100 were taken into account; the rest were considered part of the experimentation necessary to stabilize the simulation.

[17] The effect on unemployment of resignation rates of 6% and above was also analyzed. The test yielded unemployment levels higher than the peaks observed in Guildford, so these rates were discarded from the analysis.

[18] Given that the model does not distinguish between formal and informal markets, nor does it consider the formalities (legal or illegal) associated with self-employment or the costs of contracting companies.

[19] These costs could range from paying a tax to paying a criminal organization to continue operating.