Excessive Firm Turnover in the Shadow of Unemployment

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Abstract

This paper studies how pecuniary self-employment affects business cycle dynamics, macroeconomic efficiency, and the outcomes of structural reforms. I employ a two-sector dynamic general equilibrium model with endogenous producer entry. One sector (the "hiring sector") is populated by monopolistically competitive firms that employ workers subject to search-and-matching frictions in order to produce output. The other sector consists of self-employment firms that use the output of the first sector as input. Self-employment is introduced as a possible occupational choice for the unemployed, relating firm creation more directly to the state of the labor market and to workers' opportunity costs. Consistent with the U.S. data, the model shows that self-employment represents 7.4% of employment and is procyclical. The procyclicality of self-employment arises as positive productivity shocks in the hiring sector cause profits for the self-employed to rise strongly enough that additional unemployed workers are drawn into self-employment, despite tighter labor market conditions and a competing incentive to seek traditional employment. As a result, the number of firms is more volatile and welfare costs of business cycles are higher in the presence of self-employment. Novel sources of inefficiency exist since neither workers nor firms internalize the consequences of self-employment. This dispels the common misconception that all labor market rigidities increase self-employment; on the contrary, economies with almost no unemployment benefits or a very weak bargaining power could still show high self-employment rates. Furthermore, I show that reforms facilitating entry in one or the other sector are more effective when the self-employed are relatively less productive or have greater monopoly power.

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1 Introduction

Although the role of large firms as drivers of aggregate fluctuations and potential source of market distortions has been receiving increasing attention in academic and policy literature (Azar et al., 2017; di Giovanni and Levchenko, 2012; Gabaix, 2011), very small firms still represent a significant portion of the economy's labor market and employ a large total number of workers in many countries (Figure 1). While small in terms of output, these small businesses play an important role in labor market dynamics.[1] This is becoming more relevant thanks to the recent rise of a "gig economy" in which technology allows individuals to become "solopreneurs" quite easily. In the United States, "a mix of technology, economic necessity and adventure is leading more Americans to found companies that plan to stay very small" (Wall Street Journal, 2016).

Self-employment includes both startups (the successful ones that grow into large entities not being my focus) and small mom-and-pop businesses. The latter type of firms, which are more focused on monetary benefits and less on job creation or growth, exist in large numbers in both advanced and developing economies (Figure 2a). In the US, around a third of business owners report having no better choice of work[2] or maintaining income as their main motive, and more than half respond that they view entrepreneurship as a source of income (Table 1). These firms operate in industries with relatively low profits and high shutdown rates. They remain small and hire no other employees; hence they do not participate in the labor market. Moreover, their number fluctuates over the cycle as conflicting forces interact: Economic expansions create more incentive to start a business due to higher demand by consumers (entrepreneurial effect) but, at the same time, expansions dampen the need of self-employment since it is easier to find work (refugee effect; Thurik et al., 2008). In the US, the entrepreneurial effect is stronger, and self-employment rises in periods of expansion (Table 2).

Motivated by this evidence, the goal of this paper is to study the role of solopreneurship (or self-employment) for macroeconomic dynamics, efficiency, and the outcomes of structural reforms intended to facilitate producer entry in the economy. The central concept on which I rely to accomplish my goal is that of self-employment as an occupational choice. I explore why workers have an incentive to start small businesses—despite entry costs and the risk

[1] Nonemployer firms take up 81% of all firms and yet they contribute slightly over 3% of overall receipts and sales (US Census, 2016) A nonemployer business is defined as a firm that has no paid employees, has annual receipts of over $1,000 ($1 for construction), and is subject to federal income taxes. Most of nonemployer businesses are self-employed individuals running very small and unincorporated businesses (US Census Nonemployer Statistics, 2019).

[2] The Global Entrepreneurship Monitor Adult Population Survey (GEM APS, 2019) defines them as necessity-driven businesses.

of low profit and high chance of shutting down—and how these individual decisions can contribute to inefficient resource allocations.

I introduce self-employment as an occupational choice in a two-sector, dynamic general equilibrium model of the economy: One sector (the "hiring sector") is populated by monopolistically competitive firms that hire workers subject to search-and-matching frictions in the labor market to produce output as in Diamond (1982) and Mortensen and Pissarides (1994). The other sector (the solopreneurs sector) consists of self-employment (one-person) firms that use the output of the first sector as input to produce their own output (think of it as services). Different from the conventional search-and-matching setup where workers always look for a job until hired, an unemployed worker can either choose to stay in the labor market and keep searching for a job or pay an entry cost and become a new solopreneur firm.[3] Solopreneurs have lower monopoly power than firms in the hiring sector, they are characterized by a different (plausibly, lower) level of average productivity, and they fail at a higher rate. New firms can be created endogenously in both sectors subject to sunk costs of business creation. These costs are a combination of technological requirements for producer entry, which a planner would take as given, and regulatory barriers to entry.

I calibrate the model to match U.S. macroeconomic and labor market, and I show that the theoretical framework results in an empirically-consistent 7.4% of employment coming from self-employment. As in U.S. data, self-employment is procyclical: Even though an economic boom implies a higher job finding probability for the unemployed, the potential profit from entrepreneurship also rises. Consequently, we observe a shift in the composition of total employment toward self-employment. For hiring firms, it becomes harder to fill vacancies since much labor has exited the unemployment pool and joined the market as enterprises, while hired workers benefit from a further increase in wages. Total household income rises as wages are higher and more family members are employed in one or the other sector.[4] Consumption and output increase by more when the economy features self-employment than without, and unemployment falls by more as some household members escape unemployment by becoming business owners. However, this results in increased volatility of the economy as the size of the self-employment sector rises, and a larger welfare cost of business cycles.

By comparing the outcome of the decentralized economy to that chosen by a benevolent social planner, I show that additional inefficiency wedges emerge along the margins of job

[3]Only the unemployed's choice of self-employment is mentioned here because under reasonable calibration, the model endogenously shows that the employed would not want to give up their current job and switch to self-employment.

[4]As in Andolfatto (1996) and Merz (1995), I assume that there is a representative household with members employed by hiring firms, self-employed members, and unemployed members. Household members pool their incomes so they all have the same consumption.

creation and product creation in both sectors relative to a model without self-employment. Decentralized occupational choice introduces additional sources of inefficiency because the self-employed do not take into account the impact they have on labor market tightness when entering nor the effect they have on consumption when using hiring sector goods as input. Moreover, the hiring firms, when posting vacancies, do not consider the present discounted value of self-employment. In other words, self-employment as a decentralized occupational choice becomes an additional source of distortions and inefficiency.

Incorporating the concepts of regulatory barriers and solopreneurship as occupational choice in my model also allows me to study the role of self-employment for the outcomes of structural reforms intended to facilitate business creation. Among others, calls for such reforms to boost feeble economic growth especially after the 08-09 global financial crisis have been made in multiple occasions by former ECB President Mario Draghi or by the IMF—for instance, in its April 2016 and October 2019 World Economic Outlook. The standard argument is that lowering barriers to entry in product markets should improve economic performance by leading to more competition and lower prices, along with more demand for labor and a fall in structural unemployment. Abundant literature has studied the topic[5], but—to the best of my knowledge—no one yet has studied the dynamic consequences and welfare effects of facilitating entry in the "gig economy," or how the consequences of this reform would compare to those of reforms of the hiring sector. The final part of this paper shows that success of product market reforms depends on whether the targeted firms hire actively and produce differentiated enough goods.

Specifically, I show that cutting red tape that interferes with entry by hiring firms is more effective than facilitating entry by soloprenuers, as creation of hiring firms has a larger impact on total job creation and employment. Deregulation of the solopreneur sector is more effective when its productivity is relatively lower, because the associated increase in demand of hiring sector output to produce a given amount of solopreneur output is larger. Deregulation of both sectors is more effective when solopreneurs are able to produce more distinctive outputs and therefore have sufficiently high monopoly power. Finally, labor market reforms that facilitate job creation in the hiring sector are more beneficial than solopreneurship deregulation.

The rest of the paper is organized as follows. Section 2 reviews related previous research. Section 3 presents the model. Section 4 analyzes the sources of inefficiency in the model by comparing its decentralized outcome to the solution of the social planner problem. Section 5 discusses the calibration. Section 6 studies the implied business cycle dynamics. Section 7 discusses the implications of various structural reforms. Section 8 concludes.

[5] See Section 2 for more details.

2 Related Literature

My paper relates to the recent literature on occupational choice with entrepreneurship as a selection. I expand on a dynamic stochastic general equilibrium model with endogenous entry and search and matching frictions to explore its impact on the business cycle dynamics. To my knowledge, incorporating firm creation as an occupational choice in a dynamic framework and focusing on its macroeconomic impact has been scarce, which is where my contribution lies in. This paper also adds to the discussion on structural reforms by accounting for the existence of self-employment and how it influences the effectiveness of the relevant policies.

One of the popular theoretical models for explaining entrepreneurship is that of occupational choice. The workforce becomes divided into two groups as some "choose" to become business owners, whether it is to make use of their entrepreneurial abilities (Lucas, 1978), exploit business opportunities (Holmes and Schmitz, 1990), or to trade off risk and returns (Kihlstrom and Laffont, 1979, following Knight, 1921). Instead of focusing on the business owner's personal characteristics as done by Schumpeter (1911), Knight (1921), and Oxenfeldt (1943), in my paper the choice is based on comparing wage earned as paid employee and the future expected profit as a business owner (Creedy and Johnson, 1983; Acs and Audretsch, 1989; Geroski, 1995). However, due to the existence of search and matching frictions, the choice is dependent on the endogenous probability of being matched as a paid worker in the labor market (Fonseca et al., 2001; Poschke, 2013, 2018). As a result, I focus more on what Lucas (1978) refers to as "marginal entrepreneur," who is indifferent between entrepreneurship and paid employment.

Switching to self-employment is costly in my model but not necessarily a binding constraint, as long as the expected future stream of profits are enough to cover the sunk entry cost. This approach differs from papers that explore the entrepreneurial choice under financial constraints, stemming from Fazzari et al. (1988) to Evans and Jovanovic (1989), Ghatak et al. (2001), Banerjee and Newman (1993), and Shapiro and Mandelman (2016), to name a few. However, this does not imply entrepreneurs inherently struggle to obtain credit, as shown by Levenson and Willard and Parker and van Praag (2004). I follow the latter stream of thought for two reasons. First, technology allows individuals to become business owners at a low cost, as mentioned in the introduction. Furthermore, the relationship between entrepreneurship and getting credit is modest as shown by Figure 2b. By allowing the possibility of being hired in the labor market, this paper explains how there still might be competing incentives for business creation, despite high costs for entry or difficulties of obtaining credit. It also helps explain the puzzle of empirically observing high entry barriers along with high entry rates, posed by Geroski (1995).

Many empirical papers have touched on the cyclicality of self-employment but with no set consensus. Positive changes in the returns and environment of entrepreneurship boosts firm entry (entrepreneurial effect; Rees and Shah, 1986; Rampini, 2004; Fonseca et al., 2001). At the same time, lower employment from an economic boom implies lower motivation for workers to start their own business (refugee effect; Koellinger and Thurik, 2011; Thurik et al., 2008). Thus, the cyclicality of self-employment depends on which effect dominates, also shown by the empirical evidence from Table 2. By introducing a DSGE framework, this paper shows both forces in effect, but that the entrepreneurship effect dominates when calibrated for the US economy, consistent with the data.

The theoretical model used here follows the recent thread of literature in macroeconomics and international economics that stem from microeconomic foundations to study short-run business cycle fluctuations (Bilbiie et al., 2012; Cacciatore and Fiori, 2016; Ghironi and Melitz, 2005). Search and matching frictions in the labor market are introduced following Diamond (1982) and Mortensen and Pissarides (1994) as real business cycle models do not focus on unemployment. The joint modeling of endogenous entry and labor market frictions is along the lines of Cacciatore (2014). Using this theoretical framework, my paper presents how a significant amount of employment coming from self-employment can induce a more volatile business cycle dynamics and inefficiency in the aggregate economy.

Lastly, this paper contributes to the ongoing discussion on structural reforms by considering different types of entrepreneurship when evaluating the effectiveness of deregulation in labor and product markets. The consequence of structural reforms depend on various factors such as type of reforms, timing, and relationship with other policies (Campos et al., 2017). Blanchard and Giavazzi (2003) shows that such deregulation leads to lower unemployment in the long run, although for labor market deregulation there can be a trade-off in the short run, which is also supported by Cacciatore et al. (2016) and Cacciatore and Fiori (2016). Everaert and Schule (2008) suggest that coordinating reforms across markets and countries can be beneficial. Fiori et al. (2007) looks at the relationship between product and labor market deregulations. I add to the literature by showing how reforms have a larger effect when they target actively hiring firms or those that produce more differentiated goods.

3 The Model

To focus on the unemployed's choice between continuing to look for a hired job and starting one's own business, I construct a closed economy model where two sectors exist. The hiring sector consists of firms that hire workers from the labor market to produce. Thus these firms are subject to search and matching frictions. The other sector has self-employed firms that do not hire any other employees and produce using the basket of standard sector goods as intermediate goods. Variables related to the standard sector are denoted by subscript h (for *hiring*) and variables from the self-employment sector are denoted by subscript s (for *self-employment*). All contracts and prices are written in nominal terms and prices are flexible. Thus I solve for real variables and money is only a unit-of-account as in the cashless economy of Woodford (2003).

3.1 Households

There exists a unit mass of atomistic, identical households. Each household is considered as a large extended family with a continuum of members along a unit interval. Whether how many family members work in equilibrium depends on the labor matching process and the free entry condition in self-employment. Once each family member earns some type of income, they pool all their earnings and there is full consumption sharing between employed and unemployed members (Andolfatto, 1996).

The representative household maximizes the expected intertemporal utility function:

$$\mathbb{E}_t \sum_{j=t}^{\infty} \beta^{j-t} \left[\frac{C_j^{1-\gamma}}{1-\gamma} \right] \tag{1}$$

where $\beta \in (0, 1)$ is the discount factor and $1/\gamma$ is the intertemporal elasticity of substitution. The representative household's composite consumption basket C_t is an Armington aggregator of goods produced in two sectors – hiring sector ($C_{H,t}$) and self-employed sector ($C_{S,t}$):

$$C_t = \left[(1-\alpha)^{\frac{1}{\phi}} C_{H,t}^{\frac{\phi-1}{\phi}} + \alpha^{\frac{1}{\phi}} C_{S,t}^{\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{\phi-1}} \tag{2}$$

where $(1-\alpha) \in (0, 1)$ is the degree of bias towards goods from hiring sector and $\phi > 0$ refers to the elasticity of substitution between $C_{H,t}$ and $C_{S,t}$.

By defining output as sum of price times quantity from both sectors, the corresponding price index is given as:

$$P_t = \left[(1-\alpha) P_{H,t}^{1-\phi} + \alpha P_{S,t}^{1-\phi} \right]^{\frac{1}{1-\phi}} \tag{3}$$

where $P_{H,t}$ and $P_{S,t}$ refer to price of sectoral output.

The sectoral output bundle consists of a continuum of goods – H and S – from each sector respectively in a Dixit-Stiglitz fashion, where $\theta_S > \theta_H > 1$ is the elasticity of substitution across different varieties:

$$C_{H,t} = \left[\int_{h\in H} y_t(h)^{\frac{\theta-1}{\theta}} dh\right]^{\frac{\theta}{\theta-1}}, \quad C_{S,t} = \left[\int_{s\in S} y_t(s)^{\frac{\theta-1}{\theta}} ds\right]^{\frac{\theta}{\theta-1}} \tag{4}$$

Note that θ_S is set greater than θ_H to incorporate the relatively weaker monopoly power in the self-employment sector.

At any period, while the household wants to consume goods in H and S, only a subset of goods $H_t \in H$ and $S_t \in S$ is available in each sector. Therefore, the price of each sectoral output bundle, or the price sub-index, is given as:

$$P_{H,t} = \left[\int_{h\in H_t} p_t(h)^{1-\theta_H} dh\right]^{\frac{1}{1-\theta_H}}, \quad P_{S,t} = \left[\int_{s\in S_t} p_t(s)^{1-\theta_S} ds\right]^{\frac{1}{1-\theta_S}} \tag{5}$$

where $p_t(h)$ and $p_t(s)$ are the prices of each variety in hiring and self-employment sector respectively.

The household's demand for the hiring sector's good h and the self-employed sector's good s is given by:

$$y_t(h) = (1-\alpha)\left(\frac{p_t(h)}{P_{H,t}}\right)^{-\theta_H}\left(\frac{P_{H,t}}{P_t}\right)^{-\phi} Y_t \tag{6}$$

$$y_t(s) = \alpha\left(\frac{p_t(s)}{P_{S,t}}\right)^{-\theta_S}\left(\frac{P_{S,t}}{P_t}\right)^{-\phi} Y_t \tag{7}$$

Real prices can be defined at both the firm level and the sectoral level as:

$$\rho_{h,t} \equiv p_t(h)/P_{H,t} \qquad \rho_{s,t} \equiv p_t(s)/P_{S,t} \tag{8}$$

$$\mathcal{P}_{H,t} \equiv P_{H,t}/P_t \qquad \mathcal{P}_{S,t} \equiv P_{S,t}/P_t \tag{9}$$

which then can be used to simplify the expressions for the demand functions as $y_t(h) = (1-\alpha)\rho_{h,t}^{-\theta_H}\mathcal{P}_{H,t}^{-\phi}Y_t$ and $y_t(s) = \alpha\rho_{s,t}^{-\theta_S}\mathcal{P}_{S,t}^{-\phi}Y_t$. This also allows me to write the model equations in real variables only.

3.2 Hiring Sector Firms

There is a continuum of monopolistically competitive firms in the standard hiring sector. Each produces a different variety h and are all subject to idiosyncratic sectoral productivity shock $Z_{H,t}$ respectively. For simplicity I assume there is no heterogeneity in firms' productivity. This implies that all firms are identical to each other and I can drop the index h.

Hiring firms follow a linear production function that requires only labor, hired from the labor market: $y_t(h) = Z_{H,t} l_{h,t}$, where $Z_{H,t}$ is the aggregate productivity of the hiring sector. A firm produces goods that are sold at a real price $\rho_{h,t}$. To produce, the firm requires workers, coming from either the pool of incumbent workers or from new matches it obtains from posting vacancies.

Labor Market

Job creation is subject to searching frictions in the labor market. The matching function is given as $M(U_t, V_t) = \chi U_t^{\xi} V_t^{1-\xi}$, where χ shows the efficiency of the matching process and $0 < \xi < 1$ is the matching elasticity. This constant-returns-to-scale function converts aggregate vacancies and aggregate unemployed workers into aggregate matches. The probability of a firm filling a vacancy is defined as $q(\theta_t) \equiv M_t/V_t$. The probability of an unemployed worker being matched to a firm is given as $\iota(\theta_t) \equiv M_t/U_t$. This implies that I can rewrite them as a function of labor market tightness, $\theta_t \equiv V_t/U_t$. If the labor market is tighter (higher θ_t), it implies that workers have an easier time finding a job.

The amount of workers that produces each period depends on the exogenous firing rate $\lambda \in (0, 1)$ and the number of vacancies that are filled. In every period, a fixed fraction λ of workers is fired. To hire new workers, a firm posts vacancies of v_t, out of which only $q_t v_t$ are actually filled. Following Krause and Lubik (2007), the newly hired matches become productive immediately. This gives the law of motion for employment in each firm:

$$l_{h,t} = (1 - \lambda) l_{h,t-1} + q_t v_t \tag{10}$$

In sum, in each period, a firm chooses real price of the good ($\rho_{h,t}$), labor ($l_{h,t}$), and number of vacancies to post (v_t) to maximize its intertemporal stream of profits subject to equations (6), (10), and the production function:

$$\mathbb{E}_t \sum_{j=t}^{\infty} \beta_{t,j} \left\{ \rho_{h,j} \boldsymbol{\mathcal{P}}_{H,t}\, y_j(h) - w_j l_{h,j} - \kappa v_j \right\} \tag{11}$$

Out of the revenue that the firm obtains, $\rho_{h,j} y_j(j)$, it pays the workers the wage and the real cost of posting a vacancy, κ, for each vacancy posted. $\beta_{t,j}$ is the stochastic discount factor, defined as $\beta_{t,j} \equiv \beta^{j-t} (u_{C,j}/u_{C,t})$.

Solving for the first-order conditions with respect to $l_{h,t}$ and v_t yields the following equation:

$$\frac{\kappa}{q_t} = \varphi_{h,t} Z_{H,t} - w_t + (1 - \delta_H)(1 - \lambda)\, \mathbb{E}_t\, \beta_{t,t+1} \frac{\kappa}{q_{t+1}} \tag{12}$$

where $\varphi_{h,t}$ is the real marginal cost of production. This is the job creation equation of a firm. Each firm posts vacancies and hires workers until the marginal cost of posting a vacancy equals its marginal benefit. By hiring one extra worker, the firm enjoys marginal revenue product ($\varphi_{h,t} Z_{H,t}$) net of the wage it pays. It also saves the vacancy cost next period if the match survives the exogenous firing rate, shown by the last term on the right- hand side of the equation.

Furthermore, the first-order condition gives the optimal pricing equation of the hiring firms, $\rho_{h,t} = \left(\frac{\theta_H}{\theta_H - 1}\right) \frac{\varphi_{h,t}}{\mathcal{P}_{H,t}}$, which shows firms putting constant markup over the real marginal cost. Consequently, the real profit of the hiring firm can be written as:

$$\begin{aligned} d_{h,t} &= \left(\rho_{h,t} \mathcal{P}_{H,t} - \varphi_{h,t}\right) y_t(h) \\ &= \frac{1}{\theta_H} \left[(1-\alpha)\rho_{h,t}^{1-\theta_H} \mathcal{P}_{H,t}^{1-\phi} Y_t + \rho_{h,t}^{1-\theta_H} \mathcal{P}_{H,t} M_{s,t} N_{S,t}\right] \end{aligned} \tag{13}$$

Endogenous Firm Entry

The number of products available is endogenously determined every period. To create a new variety, the entrant has to pay a sunk entry cost of $f_{EH,t}$. The entry cost has three components – regulation cost (f_{rh}), technological cost for business creation (f_{Th}), and cost of posting vacancies to hire enough workers to start producing. The latter cost is due to the entrants needing to build up initial stock of workers to produce. Thus the entry cost for a hiring firm is $f_{EH,t} \equiv f_{rh} + f_{Th} + \kappa v_{E,t}$, where $v_{E,t}$ is the number of vacancies posted by new entrants. Since the new entrants are identical to the incumbent firms, the stock of labor needed is also $l_{h,t}$. Combined with the timeline of firms, the vacancies posted by new entrants, $v_{E,t}$, is equal to $l_{h,t}/q_t - v_t$. Due to labor market tightness being time dependent, the entry cost for new entrants in the hiring sector changes over time. There is no time-to-build lag and new entrants start producing in the same period.

Prospective entrants are forward-looking and calculate their expected post-entry value of becoming an entrepreneur based on future stream of profits and exogenous exit rate, $\delta_H \in (0, 1)$. Then the value of a hiring firm is:

$$e_{h,t} = d_{h,t} + \mathbb{E}_t \left[\sum_{j=t+1}^{\infty} (1-\delta_H)^{j-t} \beta_{t,j} d_{h,j}\right] \tag{14}$$

Entrants enter only when this value of firm is enough to cover the sunk entry costs, leading to the free entry condition $f_{EH,t} = e_{h,t}$. Once they enter, they continue to produce until they are hit by the death shock, δ_H, and exit. This gives rise to the law of motion for hiring firms:

$$N_{H,t} = (1-\delta_H)N_{H,t-1} + N_{HE,t} \tag{15}$$

where the number of producing firms is determined by the number of incumbents that survive the death shock and new entrants in the period.

3.3 Self-Employment Sector Firms

Firms in the self-employment sector are assumed to stay small with no other employees. Therefore, they do not participate in the labor market. Instead, they use the basket of goods from the hiring sector as intermediate goods for production: $y_t(s) = Z_{S,t}M_{s,t}$. $Z_{S,t}$ is the aggregate productivity of self-employed sector and $M_{s,t}$ is the amount of of hiring sector goods basket used as intermediate goods.

The self-employed chooses $\rho_{s,t}$ to maximize profits each period:

$$\max \rho_{s,t}\, \mathcal{P}_{S,t}\, y_t(s) - \mathcal{P}_{H,t}\, M_{s,t} \tag{16}$$

The profit maximization problem for these firms is a static one since these businesses do not have a stock of labor as the hiring firms. From the first-order condition, the optimal pricing equation is obtained:

$$\rho_{s,t} = \left(\frac{\theta_S}{\theta_S - 1}\right)\frac{\mathcal{P}_{H,t}}{\mathcal{P}_{S,t}\, Z_{S,t}} \tag{17}$$

where $\mathcal{P}_{H,t}\,/Z_{s,t}$ is the real marginal cost of the self-employed, defined as $\varphi_{s,t}$. As a result, the real profit for the self-employed is given by:

$$\begin{aligned} d_{s,t} &= (\rho_{s,t}\,\mathcal{P}_{S,t} - \varphi_{s,t})\, y_t(s) \\ &= \frac{1}{\theta_S}\alpha\rho_{s,t}^{1-\theta_S}\,\mathcal{P}_{S,t}^{1-\phi}\, Y_t \end{aligned} \tag{18}$$

Endogenous Firm Entry

Like hiring firms, self-employed firms enter until one-time entry cost is equal to the future stream of benefits. The value of a self-employed firm is the current and future expected stream of profits:

$$e_{s,t} = d_{s,t} + \mathbb{E}_t\left[\sum_{j=t+1}^{\infty}(1-\delta_S)^{j-t}\beta_{t,j}d_{s,j}\right] \tag{19}$$

Only when this value of self-employment is enough to cover the entry costs will an unemployed worker enter the market. Thus the free entry condition for necessity-driven enterprises is $f_{rs} + f_{Ts} \equiv f_{ES} = e_{s,t}$. Notice that for the self-employed, the entry cost only consists of the regulation cost and technology cost since they do not participate in the labor market.

Similar to the hiring firms, the self-employed become productive in the same period they enter. Once the entrepreneurs start a business, they continue to produce until hit by the death shock $\delta_S \in (0, 1)$. Empirical evidence suggests that the necessity-driven businesses are more likely to choose industries prone to low entry barriers and high exit rates. To incorporate this characteristic, the exit rate for the self-employed sector is set higher than that of the hiring sector.

There is no endogenous choice by the incumbent self-employed to exit the market. Even if business owners are allowed to do so voluntarily and join the unemployment pool, under reasonable calibration the surplus from continuing as an entrepreneur is always larger that that of exiting and searching for hired work. Then the law of motion for self-employment is:

$$N_{S,t} = (1 - \delta_S)N_{S,t-1} + N_{SE,t} \tag{20}$$

Because of the assumption of one-man firm that I made earlier, the law of motion of employment for the self-employed is equivalent to the law of motion for firms in the self-employment sector.

The timing of events is as the following. In any given period t, at the start of the period matches are exogenously separated and are added to the existing unemployment pool. Aggregate shocks are realized in both sectors. The new entrants pay sunk entry cost and enter. Standard sector firms post vacancies and matching occurs. After the hiring round, all active firms in both sectors produce. Finally, a portion of the firms are hit by the relevant death shocks and ceases to exist.

3.4 Labor Market

The labor market in this paper has three states for the worker: employed, unemployed, and self-employed. The employment status for a family member in each period is determined endogenously. This process is described in Figure 3. If a worker is employed this period, he either continues to be employed next period or is fired. As an unemployed worker, one can choose between searching for a wage-paying job and self-employment. If already self-employed, he is exposed to the same death shock as any other firm.

It is possible to depict the same figure using Bellman equations. The value for a worker from employment can be written as:

$$W_t = w_t + \mathbb{E}_t\,\beta_{t,t+1}\Big[(1-\delta_H)(1-\lambda)W_{t+1} + \{1-(1-\delta_H)(1-\lambda)\}\max(U_{u,t+1}, -f_{ES}+S_{t+1})\Big] \tag{21}$$

If employed, the worker gains wage and the discounted continuation value of being employed next period only if he is not fired and the firm survives the death shock. What happens if the worker is fired? In the standard Diamond-Mortensen-Pissarides model, the worker is added to the pool of unemployed workers. However, here the unemployed can choose between staying in the labor market and keep searching for hired work or paying sunk entry cost to become an entrepreneur. Which option the worker chooses depends on the value of unemployment and starting self-employment. The value of unemployment is written as the following:

$$U_{u,t} = u_b + \mathbb{E}_t\,\beta_{t,t+1}\Big[(1-\delta_H)\iota_{t+1}W_{t+1} + \Big\{1-(1-\delta_H)\iota_{t+1}\Big\}\max(U_{u,t+1}, -f_{ES}+S_{t+1})\Big] \tag{22}$$

If a worker is unemployed, she receives unemployment benefits of u_b. With probability ι_{t+1} next period, the worker is matched to a firm and gains value from employment. If not matched, the worker again faces the possibility of switching to self-employment.

Since I assume that the self-employed becomes productive right away, if the unemployed decides to start one's own business, she pays the entry cost and earns the value from self-employment beginning today ($-f_{ES}+S_t$). The value of being self-employed is determined by the expected future stream of profits and the probability of exiting the market, δ_S:

$$S_t = d_{s,t} + \mathbb{E}_t\,\beta_{t,t+1}\Big[(1-\delta_S)S_{t+1} + \delta_S(1-\delta_H)\iota_{t+1}W_{t+1} + \Big\{1-\delta_S(1-\delta_H)\iota_{t+1}\Big\}\max(U_{u,t+1}, -f_{ES}+S_{t+1})\Big] \tag{23}$$

After earning profit $d_{s,t}$ from the business, she continues as a business owner if she is not hit by the death shock. Once the self-employed is hit by the death shock, she joins the pool of unemployed workers right away. In this case, she can try to be matched to a hiring firm. If this is unsuccessful, it is again up to the worker's decision to either stay in the labor market as an unemployed worker or start one's own firm again.

Wage Setting

The worker's surplus for being matched is defined as $S_t^W \equiv W_t - \max(U_{u,t}, -f_{ES} + S_t)$, depending on the outside option of the worker. Because both the unemployed and self-employed exist in the economy, $U_{u,t} = -f_{ES} + S_t$ needs to be satisfied in equilibrium. This implies the surplus of a match for the worker can be simply written as $S_t^W \equiv W_t - U_{u,t}$. Then the expression for worker's surplus becomes:

$$S_t^W = w_t - \bar{\omega}_{h,t} + (1 - \delta_H)(1 - \lambda)\,\mathbb{E}_t\,\beta_{t,t+1} S_{t+1}^W \tag{24}$$

where the worker's outside option is the sum of unemployment benefits today and expected value coming from the possibility of being matched next period: $\bar{\omega}_{h,t} = u_b + (1 - \delta_H)\,\mathbb{E}_t\,\beta_{t,t+1} \iota_{t+1} S_{t+1}^W$.

If a hiring firm successfully fills a vacancy by being matched to a worker, the surplus it obtains can be written as the following:

$$S_t^F = \varphi_{h,t} Z_{H,t} - w_t + (1 - \delta_H)(1 - \lambda)\,\mathbb{E}_t\,\beta_{t,t+1} S_{t+1}^F \tag{25}$$

Once a worker is hired, the firm gains marginal revenue product and pays real wage. Surplus from the match continues next period only if the worker survives through the exogenous firing rate λ.

I assume Nash bargaining as the wage setting rule. Once a firm and a worker are matched, they split the joint surplus $(S_t^W)^\eta (S_t^F)^{1-\eta}$ according to their bargaining power. Put differently, the Nash bargaining maximizes the joint surplus with respect to w_t. Then the first order condition implies the bargaining solution is $\eta S_t^F = (1-\eta) S_t^W$, where $\eta \in (0, 1)$ is the worker's bargaining power. From this I obtain the bargained wage, which is a weighted average of the marginal revenue product and the worker's outside option:

$$w_t = \eta \varphi_{h,t} Z_{H,t} + (1 - \eta)\bar{\omega}_{h,t} \tag{26}$$

Note that a hired worker has no incentive to switch to self-employment, as long as the surplus from the match is positive. Since in equilibrium the value of unemployment is equal to that of self-employment, the surplus from being matched for an unemployed worker (S_t^W) is equal to the surplus from the match for the newly self-employed ($S_t^S \equiv W_t - \{-f_{ES} + S_t\}$). As long as $S_t^W > 0$, value of employment is always greater than that of becoming self-employed.

Budget Constraint of the Household

The extended family in the representative household have three types of family members: hired in the standard sector ($L_{h,t}$), self-employed ($N_{S,t}$), and unemployed. The employed members in the hiring sector earn real wage w_t. The self-employed earns profits $d_{s,t}$ as their income. Both the hired and self-employed are considered as employed: $L_t \equiv L_{H,t} + N_{S,t} = l_{h,t}N_{H,t} + N_{S,t} \in [0, 1]$. The rest, $1 - L_t$, earns unemployment benefits of u_b, financed by lump-sum taxes from the government ($T_t = (1 - L_t)u_b$). Note that because the family members are in the unit interval, L_t is equal to the employment rate.

The household starts the period with x_t shares of mutual funds of $(1 - \delta_H)N_{H,t-1}$ incumbent hiring firms. The share holdings can be sold for $e_{h,t}$. Thus $e_{h,t}x_t(1 - \delta_H)N_{H,t-1}$ enters the budget constraint as income. During the same period, the household purchases shares for the next period, x_{t+1}, by paying $e_{h,t}$ to finance entry and continued production in the hiring sector. Since new entrants become productive in the same period, all existing firms pay dividends, $d_{h,t}x_{t+1}N_{H,t}$. Note that there is no shareholdings for self-employed firms but the household still pays the entry costs.

Out of the total income that the household members earn through different channels, some are used to pay taxes and finance the entry cost of entrants in both sectors. The rest goes towards consumption. Then the budget constraint of the household can be written as the following:

$$\begin{aligned} &C_t + T_t + e_{h,t}N_{H,t}x_{t+1} + f_{ES}N_{SE,t} \\ &\quad = w_t l_{h,t}N_{H,t} + d_{s,t}N_{S,t} + u_b(1 - L_t) + e_{h,t}x_t(1 - \delta_H)N_{H,t-1} + d_{h,t}x_{t+1}N_{H,t} \end{aligned} \tag{27}$$

The first order condition with respect to x_t gives the Euler equations for the value of the hiring firm:

$$e_{h,t} = d_{h,t} + (1 - \delta_H)\, \mathbb{E}_t\, \beta_{t,t+1}e_{h,t+1} \tag{28}$$

The expressions for $e_{h,t}$ in (14) can be obtained through forward iteration of the Euler equation above if we do not allow any speculative bubbles.[6]

[6] There are no share holdings for the self-employed firms. However, one can assume there is a mutual fund of the self-employed and solve for the first order condition to find the Euler equation for the value of a self-employed firm.

3.5 Closing the Model

Once the sectoral basket of goods ($Y_{H,t}$ and $Y_{S,t}$) are produced, perfectly competitive retailers combine them to produce a final good Y_t. This final good is written as the following:

$$Y_t = \left[(1-\alpha)^{\frac{1}{\phi}} Y_{H,t}^{\frac{\phi-1}{\phi}} + \alpha^{\frac{1}{\phi}} Y_{S,t}^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}} \tag{29}$$

Aggregate output is used for consumption after financing entry costs in both sectors and vacancy posting costs:

$$Y_t = C_t + \kappa V_t + (f_{rs} + f_{Ts})N_{SE,t} + (f_{rh} + f_{Th})N_{HE,t} \tag{30}$$

where vacancies are posted by both incumbents and entrants in the hiring sector ($V_t = v_t N_{H,t} + v_{E,t} N_{HE,t}$). Unemployment in the economy is:

$$U_t \equiv 1 - (1-\lambda)L_{h,t} - N_{S,t} \tag{31}$$

In equilibrium, aggregate price index satisfies:

$$1 = (1-\alpha)\mathcal{P}_{H,t}^{1-\phi} + \alpha\mathcal{P}_{S,t}^{1-\phi} \tag{32}$$

where:

$$\mathcal{P}_{H,t} = \left(\frac{p_t(h)}{P_t}\right) N_{H,t}^{\frac{1}{1-\theta_H}}, \quad \mathcal{P}_{S,t} = \left(\frac{p_t(s)}{P_t}\right) N_{S,t}^{\frac{1}{1-\theta_S}} \tag{33}$$

In each sector, supply of goods should equal the demand for those goods. While the self-employment sector only serves the household, the hiring sector supplies to both the household (through consumption) and the self-employed (through intermediate goods). Thus output clearing in each sector is written as:

$$Z_{H,t} l_{h,t} = (1-\alpha)\rho_{h,t}^{-\theta_H} \mathcal{P}_{H,t}^{-\phi} Y_t + \rho_{h,t}^{-\theta_H} M_{s,t} N_{S,t} \tag{34}$$

$$Z_{S,t} M_{s,t} = \alpha \rho_{s,t}^{-\theta_S} \mathcal{P}_{S,t}^{-\phi} Y_t \tag{35}$$

Aggregate number of posted vacancies are $V_t = v_t$ – vacancies only come from the standard sector since entrepreneurs out of necessity do not hire any other workers. Productivity shocks in both sectors follow AR(1) processes in logs:

$$Z_{H,t} = \rho_H Z_{H,t-1} + \epsilon_{ZH,t}, \;\; \epsilon_{ZH,t} \sim N(0, \sigma_{ZH}^2) \tag{36}$$

$$Z_{S,t} = \rho_S Z_{S,t-1} + \epsilon_{ZS,t}, \;\; \epsilon_{ZS,t} \sim N(0, \sigma^2_{ZS}) \tag{37}$$

Table 3 summarizes the main equations of the model. The model is a system of 33 equations and 33 variables: C_t, $l_{h,t}$, U_t, V_t, $N_{S,t}$, $N_{SE,t}$, $N_{H,t}$, $N_{HE,t}$, $v_{E,t}$, v_t, $e_{h,t}$, $d_{h,t}$, $e_{s,t}$, $d_{s,t}$, w_t, $\bar{\omega}_{h,t}$, $\bar{\omega}_{s,t}$, $\varphi_{h,t}$, $\varphi_{s,t}$, $f_{eh,t}$, $\rho_{h,t}$, $\rho_{s,t}$, $\mathcal{P}_{H,t}$, $\mathcal{P}_{S,t}$, $y_{h,t}$, $y_{s,t}$, $Y_{H,t}$, $Y_{S,t}$, Y_t, $M_{s,t}$, M_t, ι_t, q_t.

Data-Consistent Variables

While in the model the household prefers consuming various goods, this variety effect is not included in the actual data. To correct for this, I follow a similar approach as Cacciatore et al. (2017) and set up a data-consistent price index $\tilde{P}_t$ using deflator Ω_t:

$$\tilde{P}_t \equiv \Omega_t^{\frac{1}{\phi-1}} P_t \tag{38}$$

$$\Omega_t \equiv (1-\alpha) N_{H,t}^{\frac{1-\phi}{1-\theta_H}} + \alpha N_{S,t}^{\frac{1-\phi}{1-\theta_S}} \tag{39}$$

Then for any real variable X_t in units of consumption, the equivalent data-consistent real variable can be constructed as $\tilde{X}_t \equiv P_t X_t / \tilde{P}_t = X_t \Omega_t^{\frac{1}{1-\phi}}$. The second moments of the model are found using the data-consistent variables.

4 The Planner's Solution and the Determinants of Inefficiency

To discuss efficiency of the decentralized economy, one needs to compare it to a first-best allocation. This is done by looking at the hypothetical centralized economy where a benevolent social planner chooses the allocation that maximizes social welfare.

As explained in detail in **??**, the social planner chooses $\{C_{H,j}, C_{S,j}, L_{H,j}, N_{S,j}, M_{S,j}, V_j\}_{j=t}^{\infty}$ to maximize the intertemporal utility function (eq. (1)) subject to the following constraints:

$$L_{H,t} = (1-\lambda) L_{H,t-1} + \chi (1 - (1-\lambda_t) L_{H,t} - N_{S,t})^{\xi} V_t^{1-\xi} \tag{40}$$

$$Y_t = C_t + \kappa V_t + (f_{rh} + f_{Th}) \{N_{H,t} - (1-\delta_H) N_{H,t-1}\} + (f_{rs} + f_{Ts}) \{N_{S,t} - (1-\delta_S) N_{S,t-1}\} \tag{41}$$

$$\rho(N_{H,t}) Z_{H,t} L_{H,t} = C_{H,t} + M_{s,t} N_{s,t} \tag{42}$$

$$\rho(N_{S,t}) Z_{S,t} M_{s,t} N_{S,t} = C_{S,t} \tag{43}$$

where expressions for C_t and Y_t are

$$C_t = \left[(1-\alpha)^{1/\phi} C_{H,t}^{\frac{\phi-1}{\phi}} + \alpha^{1/\phi} C_{S,t}^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}} \tag{44}$$

$$Y_t = \left[(1-\alpha)^{1/\phi} (Z_{H,t} L_{H,t})^{\frac{\phi-1}{\phi}} + \alpha^{1/\phi} (\rho_{s,t} N_{S,t} Z_{S,t} M_{s,t})^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}} \tag{45}$$

The efficient allocations are determined by the four equations below – each representing the marginal rate of substitution between two sector goods, job creation, and free entry condition for hiring and self-employed sector respectively – derived from the first-order conditions:

$$\frac{\xi_{H,t}}{\xi_{S,t}} = \left(\frac{\alpha C_{H,t}}{(1-\alpha) C_{S,t}}\right)^{-1/\phi} \tag{46}$$

$$\begin{aligned}\frac{\kappa}{q_t} &= (1-\xi)\rho(N_{H,t}) Z_{H,t} \left[A_t \left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{H,t}) Z_{H,t} L_{H,t}}{(1-\alpha) Y_t}\right)^{-1/\phi}\right] \\ &\quad - (1-\lambda)\xi \iota_t \frac{\kappa}{q_t} + (1-\lambda)(1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1} \left(\frac{1+A_t}{1+A_{t+1}}\right) \frac{\kappa}{q_{t+1}}\end{aligned} \tag{47}$$

$$\begin{aligned} f_{rh} + f_{Th} &= \frac{\theta_H}{\theta_H - 1} \rho(N_{H,t}) Z_{H,t} l_{h,t} \left[A_t \left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{H,t}) Z_{H,t} L_{H,t}}{(1-\alpha) Y_t}\right)^{-1/\phi}\right] \\ &\quad + (1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1} \left(\frac{1+A_t}{1+A_{t+1}}\right) (f_{rh} + f_{Th})\end{aligned} \tag{48}$$

$$\begin{aligned} f_{rs} + f_{Ts} &= \frac{\theta_S}{\theta_S - 1} \rho(N_{S,t}) Z_{S,t} M_{s,t} \left[A_t \left(\frac{C_{S,t}}{\alpha C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{S,t}) N_{S,t} Z_{S,t} M_{s,t}}{\alpha Y_t}\right)^{-1/\phi}\right] \\ &\quad - A_t \left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} M_{s,t} - \frac{\xi}{1-\xi} \iota_t \frac{\kappa}{q_t} + (1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1} \left(\frac{1+A_t}{1+A_{t+1}}\right) (f_{rs} + f_{Ts})\end{aligned} \tag{49}$$

where A_t is defined as:

$$A_t \equiv \left(\frac{C_{S,t}}{\alpha Y_t}\right)^{1/\phi} \left[\frac{1}{\rho(N_{S,t}) Z_{S,t}} \left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} - \left(\frac{C_{S,t}}{\alpha C_t}\right)^{-1/\phi}\right] \tag{50}$$

This A_t is zero when the marginal product from self-employed is equal to the marginal rate of substitution between hiring and self-employed sector goods ($\rho(N_{S,t}) Z_{S,t} = (\alpha C_{H,t}/(1-\alpha) C_{S,t})^{1/\phi}$). This result stems from the fact that one more unit of hiring sector good utilized as intermediate goods implies one less unit available for final goods consumption of the household.

There are three possible margins where inefficiency wedges can arise: job creation margin and product creation margin in hiring and self-employed sectors. Margins for both the decentralized and centralized economies are described in Table 6. The wedges can be analytically found by subtracting the right-hand side of allocation conditions of the social planner from that of the decentralized economy. As a result, the inefficiency wedge along the job creation margin is written as:

$$\Sigma_{JC,t} = \frac{q_t}{\kappa}\left[(\varphi_{h,t}Z_{H,t} - w_t) - (1-\xi)\rho(N_{H,t})Z_{H,t}\left\{A_t\left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{H,t})Z_{H,t}L_{H,t}}{(1-\alpha)Y_t}\right)^{-1/\phi}\right\}\right] + (1-\lambda)\xi\iota_t + (1-\delta_H)(1-\lambda)\,\mathbb{E}_t\,\beta_{t,t+1}\left(1 - \frac{1+A_t}{1+A_{t+1}}\right)\frac{q_t}{q_{t+1}} \tag{51}$$

Similarly, the inefficiency wedges along the product creation margins in hiring ($\Sigma_{PCH,t}$) and self-employed ($\Sigma_{PCS,t}$) sectors are:

$$\begin{aligned}\Sigma_{PCH,t} = \frac{1}{f_{rh}+f_{Th}}&\left\{\frac{1}{\theta_H}\rho(N_{H,t})\boldsymbol{\mathcal{P}}_{H,t}\,Z_{H,t}l_{h,t} - \kappa\left(\frac{l_{h,t}}{q_t} - \upsilon_t\right)\right.\\ &\left. - \frac{\theta_H}{\theta_H - 1}\rho(N_{H,t})Z_{H,t}l_{h,t}\left[A_t\left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{H,t})Z_{H,t}L_{H,t}}{(1-\alpha)Y_t}\right)^{-1/\phi}\right]\right\}\\ &+ (1-\delta_H)\,\mathbb{E}_t\,\beta_{t,t+1}\left(\frac{e_{h,t+1}}{f_{rh}+f_{Th}} - \frac{1+A_t}{1+A_{t+1}}\right)\end{aligned} \tag{52}$$

$$\begin{aligned}\Sigma_{PCS,t} = \frac{1}{f_{rs}+f_{Ts}}\frac{1}{\theta_S}&\rho(N_{S,t})\boldsymbol{\mathcal{P}}_{S,t}\,Z_{S,t}M_{s,t}\left\{1 - \frac{\theta_S^2}{\theta_S - 1}\frac{\rho_{S,t}Z_{S,t}M_{s,t}}{\boldsymbol{\mathcal{P}}_{S,t}}\right.\\ &\left.\times\left[A_t\left(\frac{C_{S,t}}{\alpha C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{S,t})Z_{S,t}M_{s,t}}{\alpha Y_t}\right)^{-1/\phi}\right]\right\} + \frac{1}{f_{rs}+f_{Ts}}\frac{\xi}{1-\xi}\iota_t\frac{\kappa}{q_t}\\ &+ (1-\delta_S)\,\mathbb{E}_t\,\beta_{t,t+1}\left(1 - \frac{1+A_t}{1+A_{t+1}}\right)\end{aligned} \tag{53}$$

What is noticeable here is that even if we assume that the Hosios condition holds ($\eta = \xi$), there exists no monopoly power in both sectors ($\rho_{k,t} = \varphi_{k,t}$ for $k \in \{h, s\}$), and no unemployment benefits ($u_b = 0$), the decentralized economy is not equal to that of the social planner. For the job creation margin wedge, only when A_t is equal to zero and $1-\alpha$ fraction of output is from the hiring sector is real wage determined as:

$$w_t = \xi\rho_{h,t}Z_{H,t} + (1-\delta_H)\,\mathbb{E}_t\,\beta_{t,t+1}\iota_{t+1}\frac{\xi}{1-\xi}\frac{\kappa}{q_{t+1}} + \xi\kappa\theta_t \tag{54}$$

and the inefficiency wedge is zero.

This is due to three additional factors stemming from self-employment that exist in the wedges. First, the self-employed do not take into account the impact they have on the labor market tightness when entering. If an unemployed worker starts one's own business, there is going to be a shrink in the unemployment pool, raising job finding rate and lowering vacancy filling rate. They also do not consider the impact on the final goods consumption when using hiring sector goods as intermediates to produce goods in the self-employment sector. Furthermore, when hiring firms post vacancies, they do not consider the present discounted value of self-employment that could have been created if the worker had not been matched to the firm.

5 Calibration

I use quarters as periods and set certain parameters according to the standard literature. Discount factor β is set at 0.99, which is interpreted as an annual real interest rate of 4%. Following Ghironi and Melitz (2005), elasticity of substitution across varieties for the hiring sector, θ_H, is equal to 3.8. For the self-employed sector, θ_S is set to 6.38. This reflects the relatively low markup in industries (53-68% of manufacturing sector's markup) the self-employed often select into, which are transportation, retail trade, and services such as accommodation and restaurants (Christopoulou and Vermeulen (2012)). The risk aversion coefficient γ is set at 2. Measuring elasticity of substitution between goods from hiring sector and self-employed sector is difficult. However, empirical evidence suggests that the majority of the self-employed produce nontradable service goods and serve only the domestic market. Thus I use the elasticity of substitution between tradables and nontradables for ϕ. This parameter is set at 0.5, following Mendoza (1992). The share of hiring sector goods, $1-\alpha$, is given as 0.3 to reflect the relatively smaller output generated by the self-employed.

To capture the characteristics of the product and labor market, I calibrate parameters according to the US economy for 1977:Q1 - 2007:Q4. Elasticity of the matching function ξ is set at 0.5 to match the midpoint of the estimates in Blanchard and Diamond (1989). Bargaining power of the worker η is equal to 0.5 to satisfy the Hosios condition. This ensures that the competitive equilibrium in this economy is efficient. Exogenous separation rate λ and exit rate for the hiring sector δ_H are calculated to match the total separation rate. λ^{tot} is set at 0.077, which is slightly higher than the estimates by Hall (2005), to capture the fact that separation rates are higher for smaller firms (Hobijn and Sahin (2009)).

The exit rates of industries that the self-employed select into most (transportation and services for the US) are higher compared to the manufacturing sector[7]. The probability of

[7] In 2016, the exit rates of transportation, communications, electric, gas, and sanitary services sector and services sector were 10.3% and 8.9% respectively, compared to 6.8% for the manufacturing sector.

exiting is also much higher for smaller firms, around 16% for firms with less than 5 employees compared to 3-4% for larger sized firms (US Census Business Dynamics Statistics (2016)). To reflect this, exogenous exit rate δ_S for the self-employed is set at 0.1, which is twice as high compared to the hiring sector. Value from unemployment is equal to 90% of steady-state wage, which includes the average replacement rate of 0.54 of the US reported by OECD (2019) and the constant disutility from labor. Following Ebell and Haefke (2009), the fixed portion of the entry cost (regulation and technological cost) for the hiring sector is calculated as 5.2 months of lost output. To incorporate the empirical evidence that the self-employed largely select into industries with lower entry to barrier and produce goods already available in the economy (Hurst and Pugsley (2012)), the entry cost for the self-employed is lower at 2 months of lost output.

Following the literature, I calibrate the values of matching efficiency χ and cost of posting vacancies κ to match the unemployment rate and probability of filling a vacancy. The job finding probability (ι) is set at 0.75 since the median unemployment duration is 6 weeks, consistent with the findings in Hobijn and Sahin (2009). Probability of filling a vacancy (q) is set at 0.9, which is in line with Andolfatto (1996). This yields the steady-state level of self-employed at 7.4% of total employment and the unemployment rate of 9.6%.

Finally, the exogenous aggregate productivity shock for the hiring sector (Z_H) and the self-employed sector (Z_S) follow an AR(1) process in logs with persistence of 0.95 and standard deviation of 0.0072, following the common RBC literature. The benchmark calibration is summarized in Table 4.

6 Business Cycle Properties

6.1 Impulse Responses

Figure 4 depicts the response of the economy after a positive temporary productivity shock in the hiring sector of size one standard deviation (blue solid line). For comparison purposes, I construct an alternative economy with same parameter values except for the dynamics of self-employment. Put differently, the number of self-employed stays at the steady-state level with no entry and exit, similar to the traditional Diamond-Pissarides-Mortensen (DMP) model. Having such two setups allows me to explicitly observe the change that arises after including subsistence business as an occupational choice. The responses of this economy without fluctuations in self-employment is denoted with orange dashed lines. All variables are in percentage deviations from the steady state except unemployment, which is in deviations from the steady state.

It is possible to observe the opposite forces on self-employment at work from the impulse responses. As expected, after an increase in hiring sector's productivity, output rises. This gives more incentive to the firms in the standard sector to hire more workers by posting more vacancies. Because the labor market is tighter, workers have an easier time finding jobs, as shown by the higher job finding rate. This dampens the refugee effect of self-employment. However, after the positive productivity shock, more self-employed enterprises are created due to the environment being more favorable to business creation in general. Put differently, expected future stream of profits is higher for the self-employed, making it easier for them to enter. In sum, the entrepreneurial effect is stronger, leading to a procyclical self-employment.

Compared to the case where self-employment channel is shut down, in my benchmark model, relatively more workers choosing into business creation decreases the unemployment pool available to the hiring firms. This additional source of firm entry contributes to the overall volatility of active firms in the economy. It also increases vacancy posting costs and hiring firms post vacancies relatively less. At the same time, entry into self-employment sector pushes demand for hiring sector goods further through the entrepreneurs' demand for intermediate goods.

As a result, employment in the standard sector increases by less and wages for the hired workers end up being higher. Nonetheless unemployment rate falls relatively more since more workers are employed in the economy – but in the self-employment sector. In other words, a shift of employment between sectors is observed. As a result, consumption increases by more under the economy with self-employment.

Figure 5 shows the impulse responses after the same positive productivity shock of size one standard deviation but in the self-employed sector. Overall the magnitudes are smaller since the self-employed sector is smaller. The effect on the labor market variables are also more modest due to the self-employed firms being solopreneurs with no other employees. This will have an effect on the structural reforms (more details in Section 7).

6.2 Steady State Analysis

For a better understanding of self-employment, it is beneficial to investigate the link between self-employment and unemployment (more details can be found in **??**). In steady state, the total separation rate is $\lambda^{tot} = [\delta_H + \lambda(1-\delta_H)]\,(1 - N_S/L)$, where N_S/L is the self-employment rate as a fraction of total employment. While lower exit rate in the hiring sector and exogenous separation rate contribute to a lower separation rate in total, a higher self-employment rate also leads to a lower λ^{tot} $(\partial\lambda^{tot}/\partial(N_S/L) < 0)$.

Since in steady state the number of new matches equals the number of separations in the labor market, using the relationship $\lambda^{tot} L = \iota U$, I can solve for the steady-state expression of unemployment rate as the following:

$$U = \frac{\lambda^{tot} \left\{ \delta_H + \lambda(1 - \delta_H) \right\}}{(\iota + \lambda^{tot}) \left\{ \delta_H + \lambda(1 - \delta_H) \right\} - \iota \lambda \lambda^{tot}} \tag{55}$$

Since $\partial U / \partial \lambda^{tot} > 0$, combined with the result on total separation rate, I can show that higher self-employment rate brings a lower unemployment rate ($\partial U / \partial (N_S / L) < 0$). This relationship is due to the unemployed being able to start producing as self-employed in the same period, unlike workers in the labor market who need to be matched with probability ι.

The free entry condition for the self-employed states that firms will enter when the value of the firm is enough to cover the sunk entry cost, where the value of a self-employed firm is:

$$e = \frac{d_s}{1 - \beta(1 - \delta_S)} \tag{56}$$

Here, only the profit and exit rate matter because free entry depends on accounting profits, not economic profits. Specifically, higher profits with less probability to go out of business give more incentive to become entrants in the self-employment sector. Nonetheless, exploring economic profits is beneficial since it displays how labor market tightness is closely related to worker's surplus from self-employment. Defined as the difference between the value as self-employment and that of unemployment, surplus from self-employment ($S_t^S \equiv S_t - U_{u,t}$) in steady state is:

$$S^S = \frac{1}{1 - \beta(1 - \delta_S)} \left\{ d_s - \left(u_b + \frac{\beta(1 - \delta_S)(1 - \delta_H)\eta\kappa\theta}{1 - \eta} \right) \right\} \tag{57}$$

where the expression in the square brackets is the outside option of the self-employed. Since the unemployed have an easier time finding hired work under a tighter labor market, the surplus from switching to having one's own business depends negatively on the labor market tightness. Unemployment benefits also affect the unemployed's choice to stay in the labor market since a worker is no longer considered unemployed once he starts out as a business owner (this is explored in more detail in the policy exercises done in Section 7).

6.3 Comparison with Data

Under the calibration described above, Table 5 compares the second moments for the main macroeconomic aggregate variables to those from the US data for the period 1977:Q1

- 2007:Q4[8], omitting the global financial crisis. Data for vacancy filling rate is shorter than other variables since the Job Openings and Labor Turnover Survey (JOLTS) is only available from 2001. All the data used here are logged, then HP-filtered with smoothing parameter 1600 for quarterly data. In the table, Model I refers to the benchmark model where workers are allowed to select into self-employment. Model II is the scenario where entry and exit in the self-employed sector are shut down. As described in Equation 3.5, data-consistent variables are used to find the model-generated second moments (denoted with tildes).

Overall, the second moments generated by the model match those of the main macroeconomic variables fairly closely, with output, consumption, employment, and job finding rate correctly being procyclical and countercyclical vacancy filling rate. The job finding rate and vacancy filling rate are not as volatile as what data suggests. Compared to the model without self-employment, the benchmark model does better in matching the data more closely.

6.4 Welfare Cost of Business Cycles

Table 7 calculates the welfare cost of business cycles under different economies. I compute the percentage of steady-state consumption that the household would be willing to give up to move to a deterministic economy, denoted as Δ_{BC}. Higher Δ_{BC} implies higher welfare cost from business cycle dynamics. As documented by Schmitt-Grohé and Uribe (2004), second-order approximation to the policy functions is used to correctly evaluate welfare under different economies. This is due to the expected value of each variable being equal to its non-stochastic steady state values. Therefore, to assess the effects of business cycles, higher order is required. Welfare is calculated as the following:

$$\mathbb{E}_t \sum_{j=t}^{\infty} \beta^{j-t} U(C_j) = \frac{1}{1-\beta} U\left[\left(1 - \frac{\Delta_{BC}}{100}\right) C\right] \tag{58}$$

As shown in Table 7, the welfare cost from business cycles is always higher under the existence of self-employment dynamics (entry and exit) under both sectoral and aggregate shocks. Put differently, in the presence of productivity shocks in the hiring sector, the household in the benchmark model is willing to give up 1.189% of its consumption to move to an economy with a completely smooth consumption schedule. Such difference comes from both the mean and variance of consumption and unemployment under the presence of self-employment. The unemployment pool changes more dynamically due to not only workers being matched and separated but also from workers entering and exiting through the self-

[8] The series for the job finding rate is slightly shorter, ending at 2004:Q4.

employed sector. This leads to higher volatility in wages which, combined with profits of the self-employed, ends up at consumption being more volatile.

7 Structural Reforms when Solopreneurs Matter

7.1 Product and Labor Market Reforms

Utilizing the model introduced in Section 3, it is possible to conduct difference labor market- and product market-related reforms and study their effects. This is relevant in the current climate where the debate on structural reforms is still ongoing and solopreneurs are on the rise (see chapter 3 of World Economic Outlook (2019) for more details on structural reforms). I examine four possible policies: deregulation in hiring sector and self-employed sector, a decrease in unemployment benefits and worker's bargaining power. Here, deregulation is defined as a permanent reduction in regulation costs in each sector. All policy changes are permanent and perfectly observed by the household. Periods are still in quarters. In all cases, variables reach 80% of the changes by 15 years (60 quarters) and are at 90-95% of the new steady-states by 20 years (100 quarters) after the reform.

The results of the policy exercises are depicted in Figure 6 through Figure 9. Figure 6 and Figure 7 show that the direction of impact from deregulation in hiring and self-employed sectors is similar, since both lead to more firm entry. One major difference is in the profits of the self-employed. The relative size of the increase in the self-employed firms is large in Figure 7 – in fact, so large that this increased competition makes profits fall. In general, the size of changes in the self-employed sector is more modest since the whole industry is relatively smaller. Additionally, having more firms in the hiring sector increases demand for labor and thus employment in the standard sector. As a result, deregulation in the hiring sector has a greater effect on all accounts including consumption and output.

Since business creation is an occupational option for the workers, labor market policies also affect the self-employment sector (Figure 8 and Figure 9). Both the decrease in unemployment benefits and worker's bargaining power give more incentive towards firm creation in the self-employed sector. Nonetheless, the effect is more sizable in the case of unemployment benefits since it affects the value of unemployment today directly. On the other hand, worker's bargaining power affects wages, which is relevant only when hired by a firm, subject to the job finding probability. Unemployment falls by a lot more since staying unemployed is no longer as attractive as before. Whether it is through hiring sector or self-employment, more unemployed workers will try to switch to employment.

The results point towards policy implications in various angles. First, the effect of reforms varies depending on what fraction of the economic agents are affected. This is shown in Figure 10, where all four reforms are compared. Reducing entry cost of the self-employed has the smallest impact due to the sector itself being small with no other employees. A decrease in worker's bargaining power follows as it primarily affects wage earners. What is most interesting is the reduction in unemployment benefits being the most effective in boosting consumption in the short run but gradually being caught up by deregulation in the hiring sector in the long run. This reversal is due to unemployment benefits having an immediate impact on workers' value of being unemployed, giving rise to higher incentive for them to find a job, both through the standard labor market and self-employment. In comparison, a decrease in regulation cost for the hiring firms promotes entry of firms, which then hire workers to produce. Not only do workers benefit from higher employment and wages in the hiring sector but the self-employed also gain from relatively lower price of inputs. This whole process occurs gradually, with unemployment falling less but wage and profits rising by more, leading to consumption and output reaching higher levels.

The adequacy of government-funded subsidies for new entrants is also dependent on the type of firms affected from the said policies. For economies where obtaining capital is difficult, government programs such as the Entrepreneurs' Law (*Ley de Emprendedores*) that passed recently in Argentina are considered a hopeful push towards building a better entrepreneurial ecosystem. However, if all the government is doing is fueling the excessive entry of necessity-driven entrepreneurs, the economy also has a possibility to end up allocating resources inefficiently. Another example of this is the South Korean government using $1.6 billion to offer better credit to the self-employed in 2016. This particular policy resulted in the number of new entrepreneurs increasing by 33% compared to the year before. At the same time, even more firms exited the market, reaching a new record since 2011.

Furthermore, labor market-specific policies that affect compensation during unemployment or duration of unemployment becomes relevant to firm entry. If the unemployed are offered better unemployment benefits or if it is relatively easier to find a job, it reduces the incentive for these workers to become entrepreneurs. Meanwhile, it warns us of the drawback from blindly using unemployment rate as a measure of the labor market. As it becomes more difficult to be matched with a firm as a hired worker, there is a higher chance that the unemployed will become "employed" through entrepreneurship, leading to a relatively lower unemployment rate.

7.2 Effect of Relative Sector Productivity and Monopoly Power on Deregulation

Relative Sector Productivity Z_S/Z_H

Along the lines of deregulation in markets, one can ask if the effects of such structural reforms would vary if the average productivity of two sectors differs. For easier comparison, I define the (sectoral) productivity ratio as Z_S/Z_H and only vary Z_S while keeping Z_H constant at 1. If the consequences of policy reforms depend on relative productivity differences, this becomes an important question as we do observe concentration of self-employment in certain industries in reality.

Figure 11 and Figure 12 show the results of the same permanent 1% decrease in regulation cost in the self-employed and hiring sector respectively, but under varying sectoral productivity ratios. From comparing Figure 11 and Figure 12, it is observed that the magnitude of reforms is greater under deregulation of the hiring sector. This is mainly due to the participation of hiring firms in the labor market. A decrease in entry cost of the hiring sector allows more new entrants who stay in the market for longer due to lower exit rates. This increase in hiring firms implies more job creation. Combined with this change in demand for labor, the number of solopreneurs also rise as more final goods are demanded by the household. As a result, unemployment falls by more, and consumption and output rises by more compared to deregulation in the hiring sector. This points to structural reforms being much more effective if done to firms that actively hire employees, rather than soloprenuers. On the other hand, the degree of effectiveness does not vary much according to the productivity ratio since the major changes are through the hiring sector.

In comparison, the effect of deregulation in the self-employed sector is greater as productivity ratio is lower. Due to low productivity, the entry cost of self-employment is already low. Decreasing the cost of entry even more allows more new entrants to enter the market, as the threshold of switching to self-employment is lower. Since more workers become employed through firm creation, household income and consumption rise. This leads to a positive spillover effect on the hiring sector through an increase in demand for both final and intermediate goods, but more so for lower productivity ratio case since the solepreneurs require using more intermediate goods. Unemployment falls by more for low Z_S/Z_H as more workers are absorbed by both sectors. Income rises but by less for low Z_S/Z_H because the relative lower increase in wages has a greater effect than the relatively lower decrease in profits (much more family members are hired by the hiring sector than the self-employed sector). Thus the impact of deregulation is larger in the hiring side as self-employment's sectoral productivity is lower.

In both cases, what drives the effectiveness of deregulation are the hiring firms and their impact on the job creation margin. Deregulation in the hiring sector is more effective than that in the self-employed sector by two magnitudes. Even when lowering the entry cost of solopreneurs, the reform works better when productivity ratio Z_S/Z_H is lower since the greater positive spillover effect on the hiring sector dominates.

Monopoly Power in Self-Employed Sector θ_S

Instead of productivity ratios, I also test whether monopoly power of the solopreneurs affects the policy reform results. Lower θ_S implies greater monopoly power and higher markups. θ_S of 6.38, 5, 3.8, and 2.9 imply 112%, 100%, 92%, and 87% of hiring sector's markup respectively. The benchmark was 87% following empirical evidence. The result of the exercise is described in Figure 13 and Figure 14. Since the structural reform itself is same as before (1% decrease in regulation cost), the direction of the reforms is not very different. However, now in both cases of hiring and self-employed sectors, the policies are more effective when the solopreneurs have higher monopoly power and are able to put higher markups. This indicates that solopreneurs are more important for reforms if they have a relatively higher monopoly power and are able to produce more differentiated products.

8 Conclusion

Motivated by the rise of very small firms in the recent years, this paper explores how the existence of necessity-driven businesses can impact macroeconomic dynamics, efficiency, and the outcomes of structural reforms. To do so, I develop a two-sector, dynamic stochastic general equilibrium model with endogenous producer entry and search and matching frictions. By doing so, I contribute towards a deeper understanding of firm creation, which usually have been focused on large firms with active employment. I shed light on how having necessity-driven businesses can lead to macroeconomic inefficiency and higher welfare costs. Furthermore, under this extra channel of employment present, structural reforms on either labor or product markets vary in terms of effectiveness, with deregulation on the hiring sector being the most effective in boosting consumption and output. Firms' relative productivity and monopoly power also matter since the same structural reform is more successful when the self-employed are less productive or when firms produce more differentiated products.

The main message of the paper is that firm creation as an occupational choice can make firm dynamics be more closely related to the state of the labor market. Once I allow for the unemployed to use entrepreneurship as an occupational choice, excessive entry to self-employment occurs. Since employment occurs in both sectors, as hired workers and self-employed, unemployment falls by more initially and consumption is higher. However, this leads to higher welfare cost from business cycles. More factors also contribute to inefficiency as neither hiring firms nor workers internalize the effect of their choices on the aggregate economy. As a result, understanding what type of firms are targeted matters when analyzing the effectiveness of structural reforms.

There exist possible extensions that one can continue to explore. First is opening up the economy and allowing international trade. It is observed in the data that the self-employed are mostly skewed towards industries that produce non-traded service goods. Thus, if there is more entry in the self-employed sector, it would imply an asymmetric impact on tradables versus nontradables. This concentration is even more evident in some small open economies such as Korea. Extending the model to an open economy setting will allow me to analyze such issues in detail.

Additionally, while in this paper I have the self-employed use goods from the other sector as intermediate goods, it might be more plausible to include hours of work as the cost for the self-employed. This is in line with the empirical evidence that there is more intensive margin rather than extensive margin in small businesses, mostly due to extra costs that arise when hiring employees. Put differently, it is easier for the entrepreneur to put in extra hours of work rather than hiring another worker for the firm. I leave these extensions for future work.

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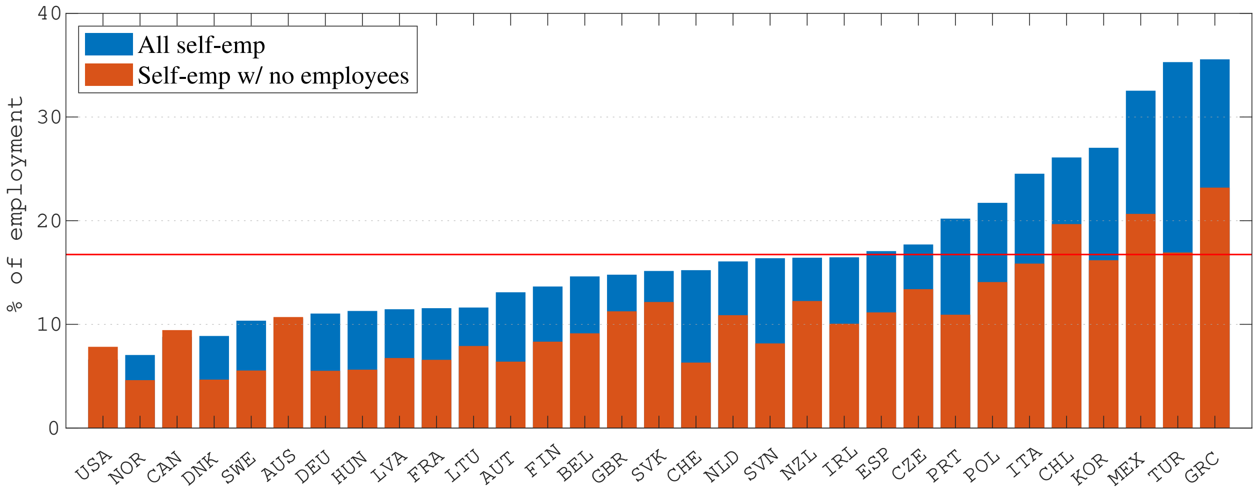
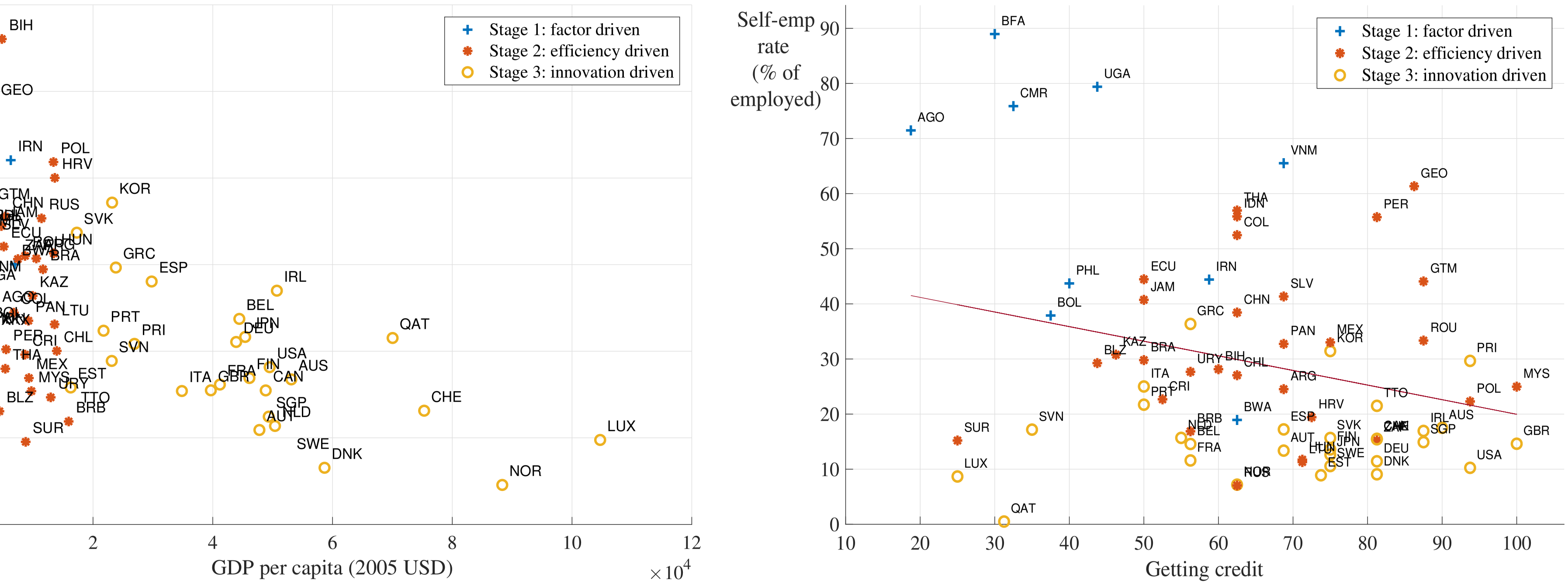


Figure 1. Self-employment rates (as % of total employment). Average of annual data for 2010-2017. Source: OECD (2019). [cited on page 2]



(a) Necessity-driven businesses by GDP per capita

(b) Necessity-driven businesses by Getting Credit index

Figure 2. Self-employment, necessity-driven business, and their relationship with other factors. **Factor-driven**: least developed, mostly subsistence agriculture and extraction businesses, with heavy reliance on (unskilled) labor and natural resources; **Efficiency-driven**: increasingly competitive, with more-efficient production processes and increased product quality; **Innovation-driven**: most developed, businesses more knowledge-intensive, and the service sector expands. **Getting credit index** measures (i) strength of legal rights index, (ii) depth of credit information index, (iii) credit bureau coverage (% of adults), and (4) credit registry coverage (% of adults). Higher values indicate ease of getting credit. Source: GEM APS, WB World Development Index (2010-2014). [cited on page 2]

Table 1. Main motive for starting one's own business in the U.S. Data for TEA, averaged over 2010-2015. TEA: Total Early Stage Entrepreneurship; involved in a nascent firm or young firm or both. Mixed motivation includes a combination of opportunity and necessity and having a job but seeking better opportunities. Source: GEM APS, World Bank World Development Index. [cited on page 2]

Necessity or maintain income	Increasing income	Being independent	Mixed motivations
27.6%	36.3%	26.9%	9.1%

Table 2. Cyclical correlation of self-employment with output. Source: author's calculations. Self-employment refers to own-account workers and business owners with less than 5 employees, as share of the working-age population. All series are annual, logged, and HP-filtered with smoothing parameter 100 for annual. [cited on page 2]

	USA	Korea	Italy	Turkey
$Corr(SE_t, Y_t)$	0.06	0.29	-0.23	-0.68

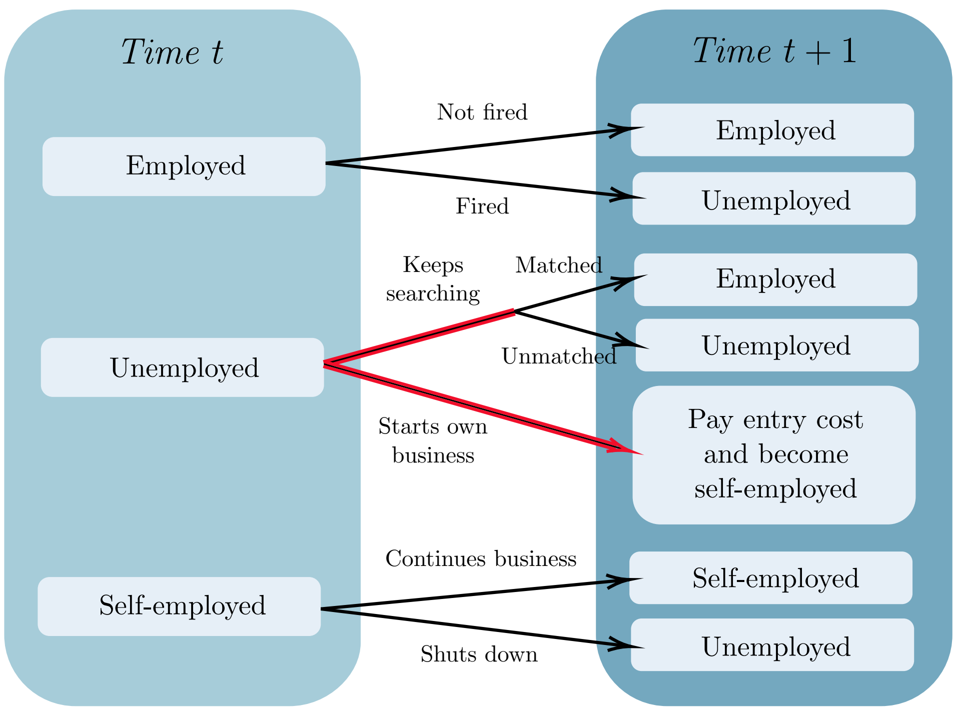


Figure 3. Three-state labor market [cited on page 12]

Table 3. Model summary [cited on page 23]

Description	**Equation**
Matching function	$M_t = \chi U_t^{\xi} V_t^{1-\xi}$
Job finding probability	$\iota_t = M_t/U_t$
Vacancy filling probability	$q_t = M_t/V_t$
Unemployment	$U_t = 1-(1-\lambda)l_{h,t}N_{H,t} - N_{S,t}$
Law of motion	$l_{h,t} = (1-\lambda)l_{h,t-1} + q_t v_t$
Law of motion for firms	$N_{S,t} = (1-\delta_S)N_{S,t-1} + N_{SE,t}$
	$N_{H,t} = (1-\delta_H)N_{H,t-1} + N_{HE,t}$
Free entry condition	$f_{rs} = e_{s,t}$
	$f_{eh,t} = e_{h,t}$
Entry cost for H firms	$f_{eh,t} = f_{rh} + \kappa v_{E,t}$
Value of H firm	$e_{h,t} = d_{h,t} + (1-\delta_H)\,\mathbb{E}_t\,\beta_{t,t+1}e_{h,t+1}$
Value of SE firm	$e_{s,t} = d_{s,t} + (1-\delta)\,\mathbb{E}_t\,\beta_{t,t+1}e_{s,t+1}$
Profits of H firm	$d_{h,t} = \frac{1}{\theta_H}(1-\alpha)\rho_{h,t}^{1-\theta_H}\mathcal{P}_{H,t}^{-\phi}Y_t$
Profits of SE firm	$d_{s,t} = \frac{1}{\theta_S}\alpha\rho_{s,t}^{1-\theta_S}\mathcal{P}_{S,t}^{-\phi}Y_t$
Job creation	$\frac{\kappa}{q_t} = \varphi_{h,t}Z_{H,t} - w_t + (1-\delta_H)(1-\lambda)\,\mathbb{E}_t\,\beta_{t,t+1}\frac{\kappa}{q_{t+1}}$
Real wage	$w_t = \eta\varphi_{h,t}Z_{H,t} + (1-\eta)\bar{\omega}_t$
Outside option	$\bar{\omega}_t = u_b + (1-\delta_H)\frac{\eta}{1-\eta}\,\mathbb{E}_t\,\beta_{t,t+1}\iota_{t+1}\frac{\kappa}{q_{t+1}}$
Vacancies by H entrants	$v_{E,t} = l_{h,t}/q_t - v_t$
Aggregate vacancies	$V_t = v_t N_{H,t} + v_{E,t}N_{HE,t}$
Marginal costs	$\rho_{h,t} = \frac{\theta_H}{\theta_H-1}\varphi_{h,t}$
	$\rho_{s,t} = \frac{\theta_S}{\theta_S-1}\varphi_{s,t}$
Real prices	$\rho_{h,t} = N_{H,t}^{\frac{1}{\theta_H-1}}$
	$\rho_{s,t} = N_{S,t}^{\frac{1}{\theta_S-1}}$
Price sub-indices	$\varphi_{s,t} = \mathcal{P}_{H,t}/Z_{s,t}$
	$1 = (1-\alpha)\mathcal{P}_{H,t}^{1-\phi} + \alpha\mathcal{P}_{S,t}^{1-\phi}$
Production functions	$y_t(h) = Z_{H,t}l_{h,t}$
	$y_t(s) = Z_{S,t}M_{s,t}$
Sectoral output	$Y_{h,t} = (1-\alpha)\mathcal{P}_{H,t}^{-\phi}Y_t$
	$Y_{s,t} = \alpha\mathcal{P}_{S,t}^{-\phi}Y_t$
Output clearing	$Z_{H,t}l_{h,t} = (1-\alpha)\rho_{h,t}^{-\theta_H}\mathcal{P}_{H,t}^{-\phi}Y_t + \rho_{h,t}^{-\theta_H}M_{s,t}N_{S,t}$
	$Z_{S,t}M_{s,t} = \alpha\rho_{s,t}^{-\theta_S}\mathcal{P}_{S,t}^{-\phi}Y_t$
Aggregate demand	$Y_t = C_t + \kappa V_t + f_{rs}N_{se,t} + f_{rh}N_{he,t}$

Table 4. Calibration [cited on page 21]

Parameter		Value	Parameter		Value
Discount factor	β	0.99	Matching elasticity	ξ	0.5
Intertemporal elasticity of substitution	γ	2	Matching efficiency	χ	0.82
Elasticity of substitution for variety (H)	θ_H	3.8	Total unemployment benefits	u_b/w	0.9
Elasticity of substitution for variety (S)	θ_S	6.38	Vacancy filling rate	q	0.9
Elasticity of substitution bet. sectors	ϕ	0.5	Worker matching rate	ι	0.75
Share of goods from SE sector	α	0.3	Regulation cost (H)	f_{rh}	0.42
Firm exit rate (H)	δ_H	0.05	Regulation cost (S)	f_{rs}	0.68
Firm exit rate (S)	δ_S	0.1	Vacancy cost	κ	0.06
Exogenous separation rate	λ	0.035	Persistence of TFP shock	ρ_Z	0.95
Worker's bargaining power	η	0.5	Std. of TFP shock	σ_Z	0.0072

Table 5. Business cycle statistics, benchmark, and model with no self-employment dynamics. Data = US 1977:Q1 - 2007:Q4 (1977:Q1 - 2004:Q4 for job finding rate, 2001:Q1 - 2007:Q4 for JOLTS), logged and HP-filtered with smoothing parameter 1600; Model I = benchmark with self-employment; Model II = no entry/exit in self-employment. Data-consistent variables used for model-generated moments. Source: US FRED, BLS, JOLT, and data constructed by Robert Shimer (for additional details, please see Shimer (2012) and his webpage http://home.uchicago.edu/~shimer/data/flows/). [cited on page 23]

	σ_X			σ_X/σ_Y			$corr(X,Y)$		
Var	Data	Model I	Model II	Data	Model I	Model II	Data	Model I	Model II
$\tilde{Y}$	1.35	1.42	1.44	1.00	1.00	1.00	1.00	1.00	1.00
$\tilde{C}$	1.05	0.76	0.54	0.77	0.53	0.54	0.85	0.99	0.99
L	0.74	0.38	0.36	0.55	0.27	0.25	0.86	0.94	0.94
ι	9.17	3.87	3.74	6.77	2.73	2.59	0.80	0.99	0.99
q	16.31	4.65	4.49	12.06	3.28	3.11	-0.33	-0.99	-0.99

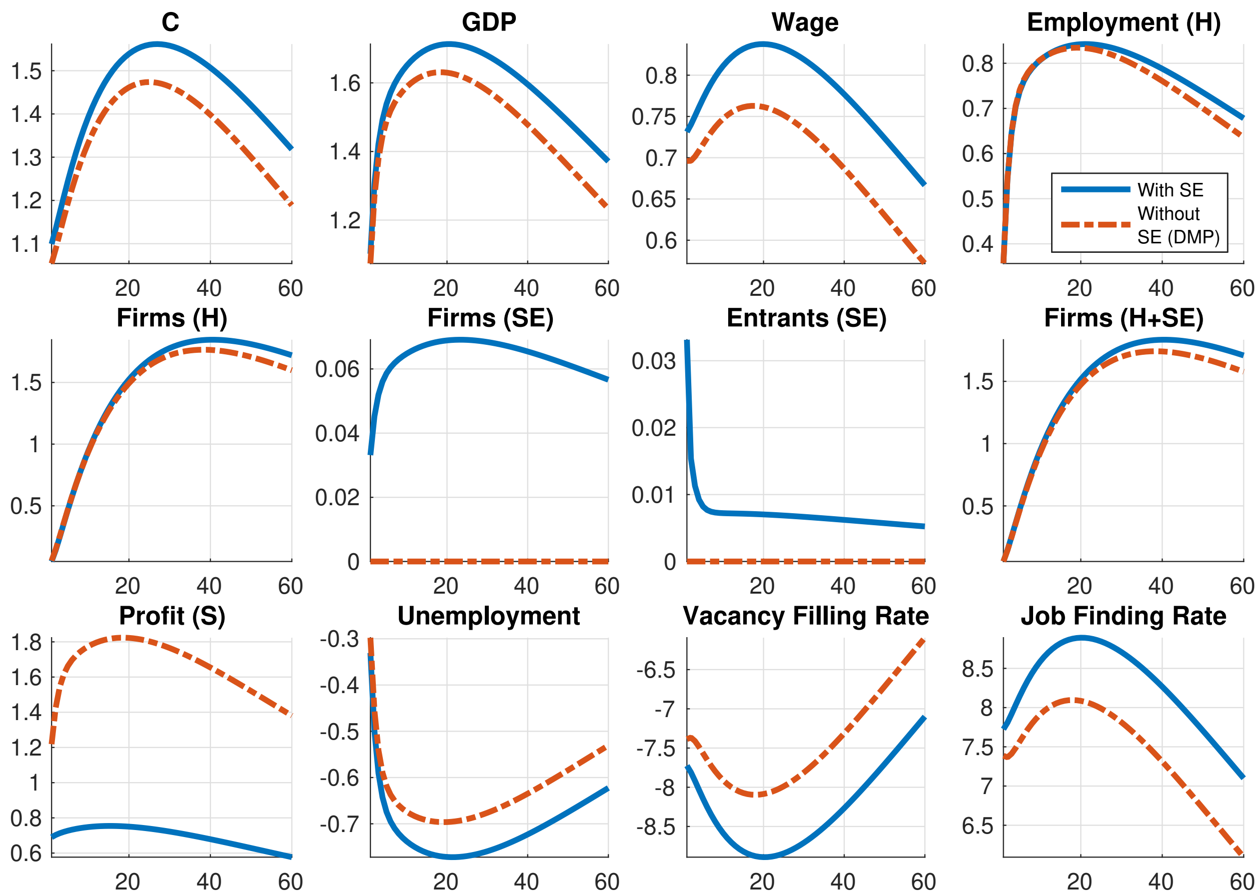


Figure 4. Productivity shock in the hiring sector. Responses show percentage deviations from steady state after a one standard deviation productivity shock. Unemployment is in deviations from steady state. [cited on page 21]

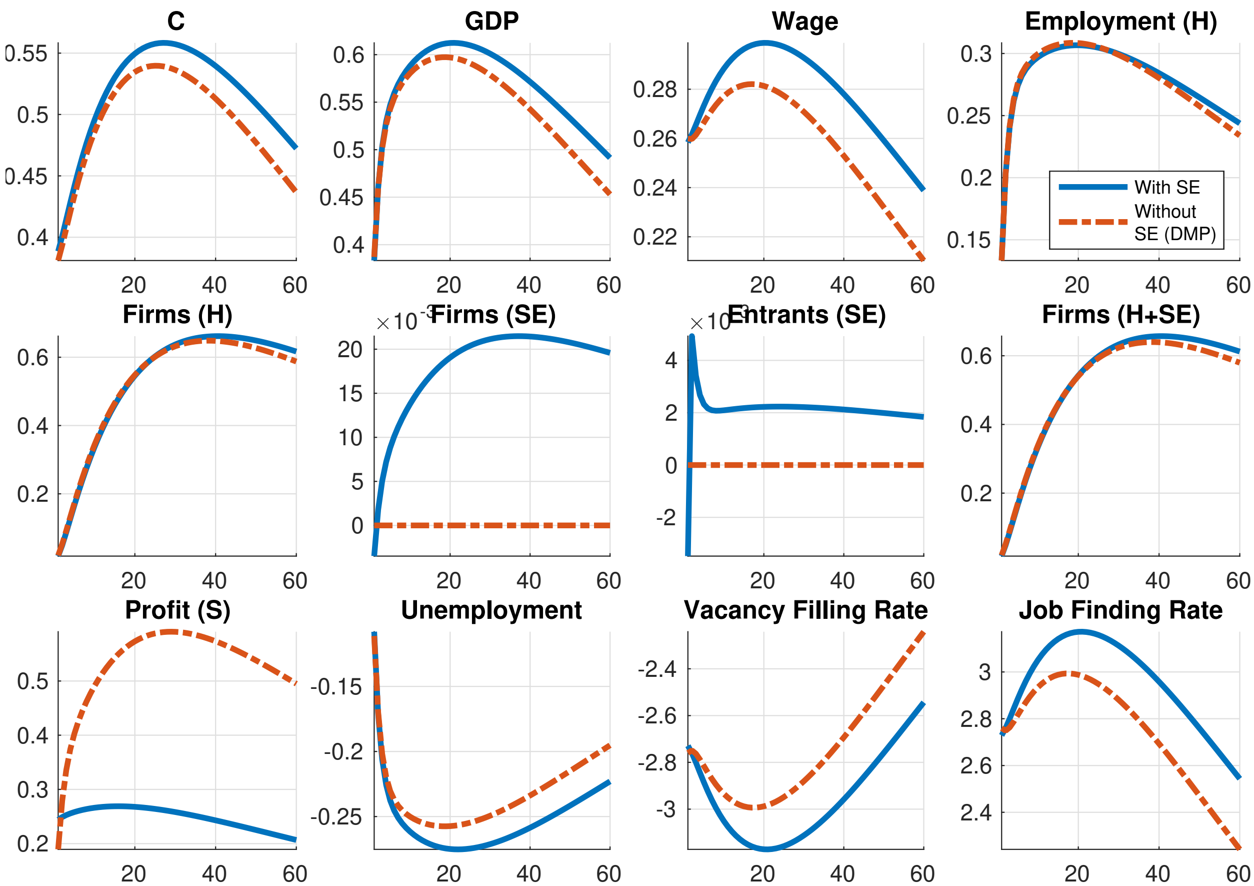


Figure 5. Productivity shock in the self-employed sector. Responses show percentage deviations from steady state after a one standard deviation productivity shock. Unemployment is in deviations from steady state. [cited on page 22]

Table 6. Comparison of margins between decentralized and centralized economies. [cited on page 19]

Decentralized	
Job Creation	$1 = \frac{q_t}{\kappa}\left(\varphi_{h,t} Z_{H,t} - w_t\right) + (1-\lambda)(1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1} \frac{q_t}{q_{t+1}}$
Product Creation (H)	$1 = \frac{1}{(f_{rh}+f_{Th})}\left[\frac{1}{\theta_H}\rho_{h,t}\mathcal{P}_{H,t}\, Z_{H,t} l_{h,t} - \kappa v_{E,t}\right] + (1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1}\frac{e_{h,t+1}}{f_{rh}}$
Product Creation (S)	$1 = \frac{1}{(f_{rs}+f_{Ts})}\left[\frac{1}{\theta_S}\rho_{s,t}\mathcal{P}_{S,t}\, Z_{S,t} M_{S,t} + (1-\delta_S)\, \mathbb{E}_t\, \beta_{t,t+1} e_{s,t+1}\right]$

Social Planner	
Job Creation	$1 = \frac{q_t}{\kappa}(1-\xi)\rho(N_{H,t})Z_{H,t}\left[A_t\left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-\frac{1}{\phi}} + \left(\frac{\rho(N_{H,t})Z_{H,t}L_{H,t}}{(1-\alpha)Y_t}\right)^{-\frac{1}{\phi}}\right] -(1-\lambda)\xi\iota_t + (1-\lambda)(1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1}\left(\frac{1+A_t}{1+A_{t+1}}\right)\frac{q_t}{q_{t+1}}$
Product Creation (H)	$1 = \frac{1}{(f_{rh}+f_{Th})}\left[\frac{\theta_H}{\theta_H-1}\rho(N_{H,t})Z_{H,t}l_{h,t}\left\{A_t\left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-\frac{1}{\phi}} + \left(\frac{\rho(N_{H,t})Z_{H,t}L_{H,t}}{(1-\alpha)Y_t}\right)^{-\frac{1}{\phi}}\right\}\right] +(1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1}\left(\frac{1+A_t}{1+A_{t+1}}\right)$
Product Creation (S)	$1 = \frac{1}{(f_{rs}+f_{Ts})}\left[\frac{\theta_S}{\theta_S-1}\rho(N_{S,t})Z_{S,t}M_{S,t}\left\{A_t\left(\frac{C_{S,t}}{\alpha C_t}\right)^{-\frac{1}{\phi}} + \left(\frac{\rho(N_{S,t})N_{S,t}Z_{S,t}M_{s,t}}{\alpha Y_t}\right)^{-\frac{1}{\phi}}\right\} -A_t\left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-\frac{1}{\phi}} M_{S,t} - \frac{\xi}{1-\xi}\iota_t\frac{\kappa}{q_t}\right] + (1-\delta_S)\, \mathbb{E}_t\, \beta_{t,t+1}\left(\frac{1+A_t}{1+A_{t+1}}\right)$

Table 7. Welfare cost under different scenarios. Δ_{BC} = welfare cost of business cycles (% of steady-state consumption in benchmark model). [cited on page 24]

	Δ_{BC}	
Shock	Benchmark	No Entry/Exit in SE
H sector	1.189%	0.046%
S sector	0.050%	0.046%
Both sectors	1.237%	1.065%

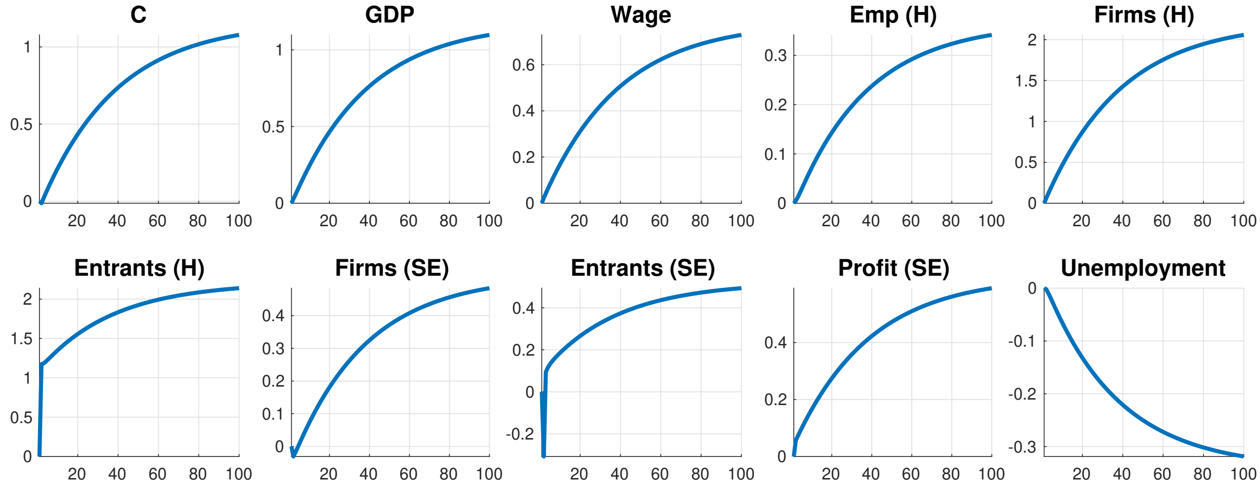


Figure 6. Permanent 1% decrease in regulation cost for the hiring sector. [cited on page 25]

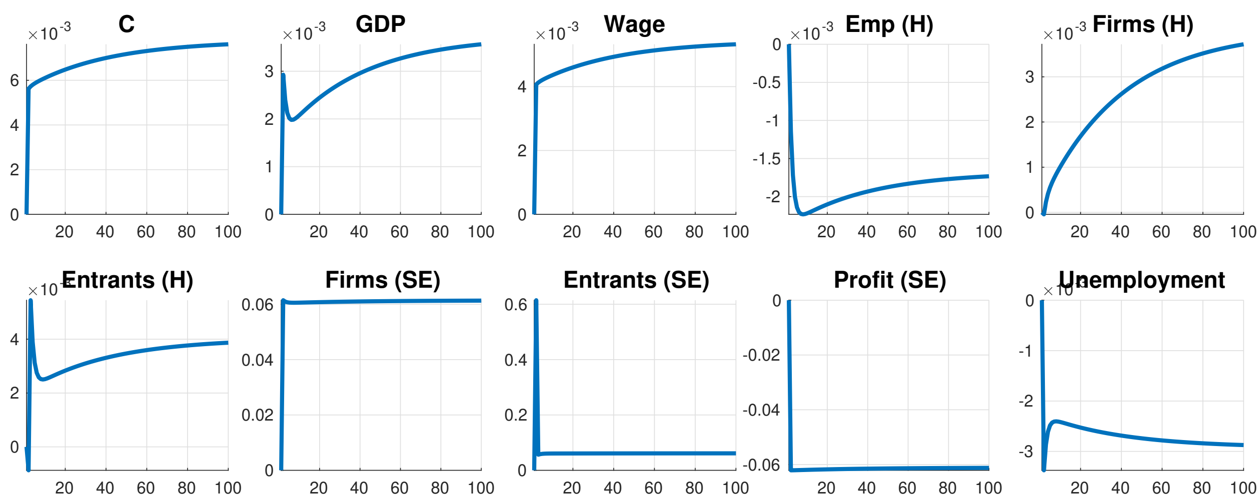


Figure 7. Permanent 1% decrease in regulation cost for the self-employment sector. [cited on page 25]

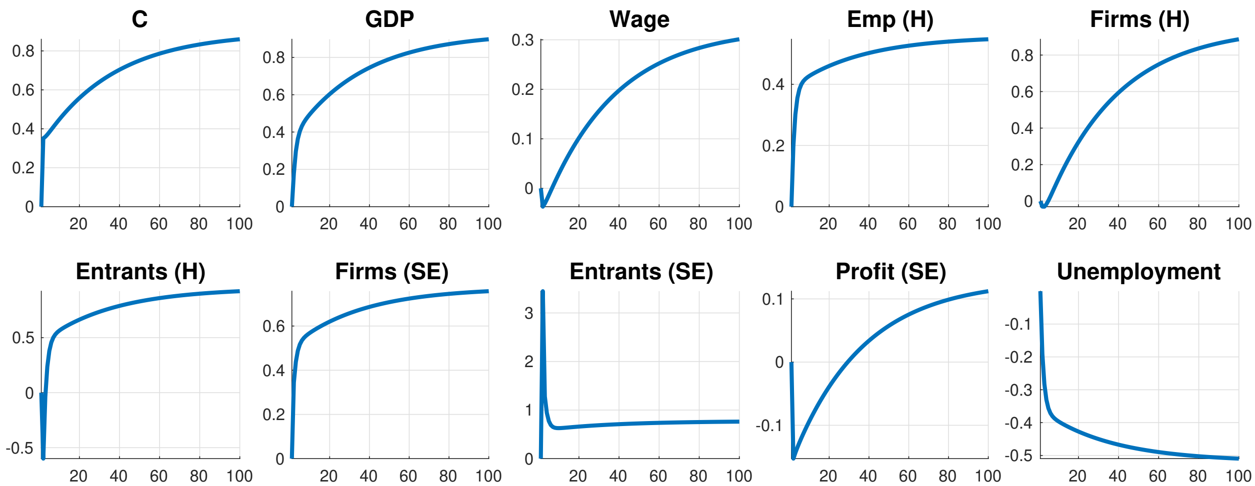


Figure 8. Permanent 1% decrease in unemployment benefits. [cited on page 25]

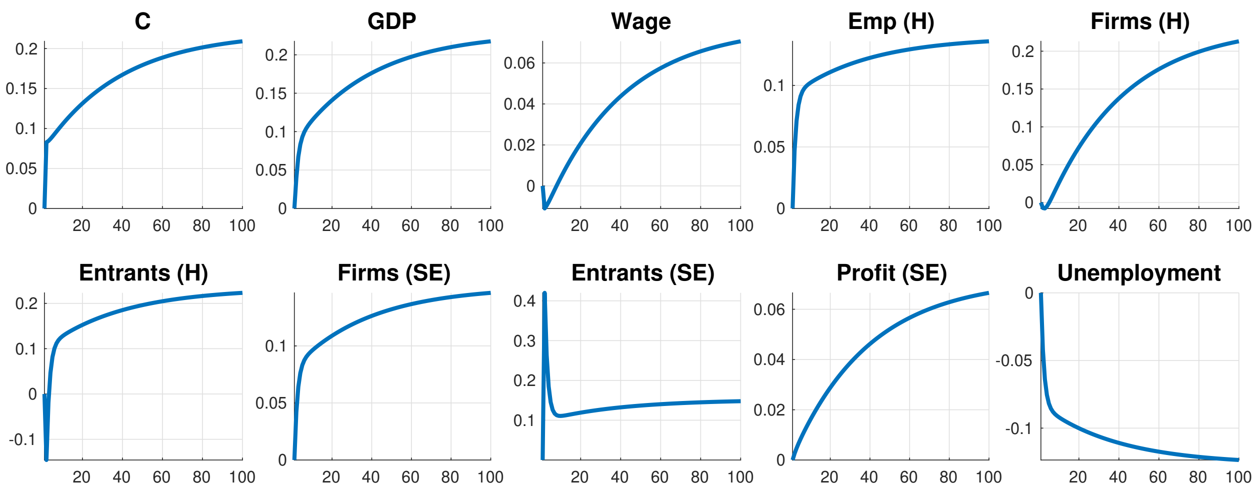


Figure 9. Permanent 1% decrease in worker's bargaining power. [cited on page 25]

Responses show percentage deviations from steady state after the respective permanent policy change. Unemployment is in deviations from steady state.

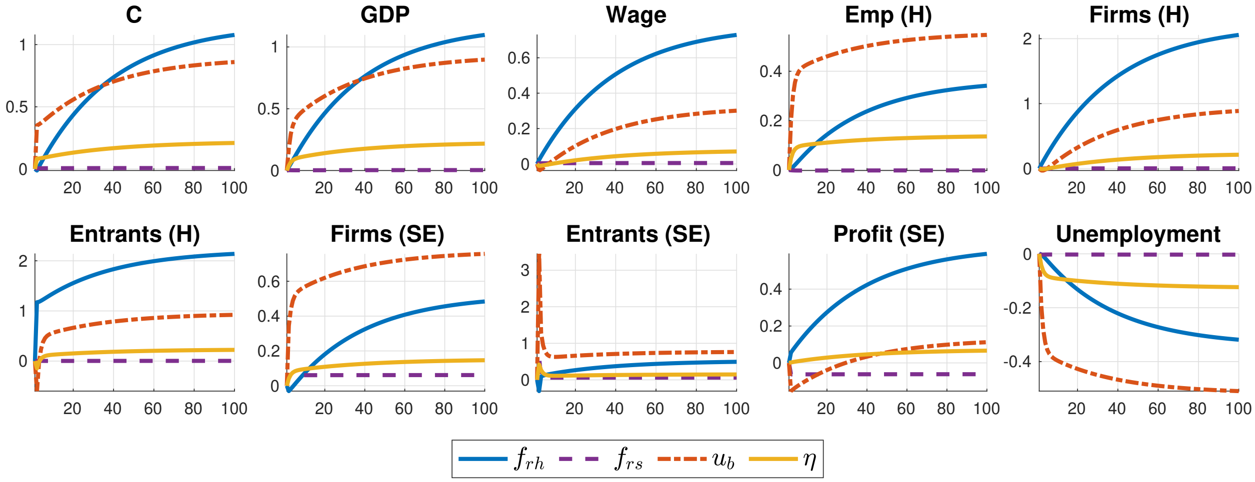


Figure 10. Comparison of four reforms: two product market policies (1% decrease in regulation cost in hiring and self-employed sectors) and two labor market policies (1% decrease in unemployment benefits and worker's bargaining power). [cited on page 26]

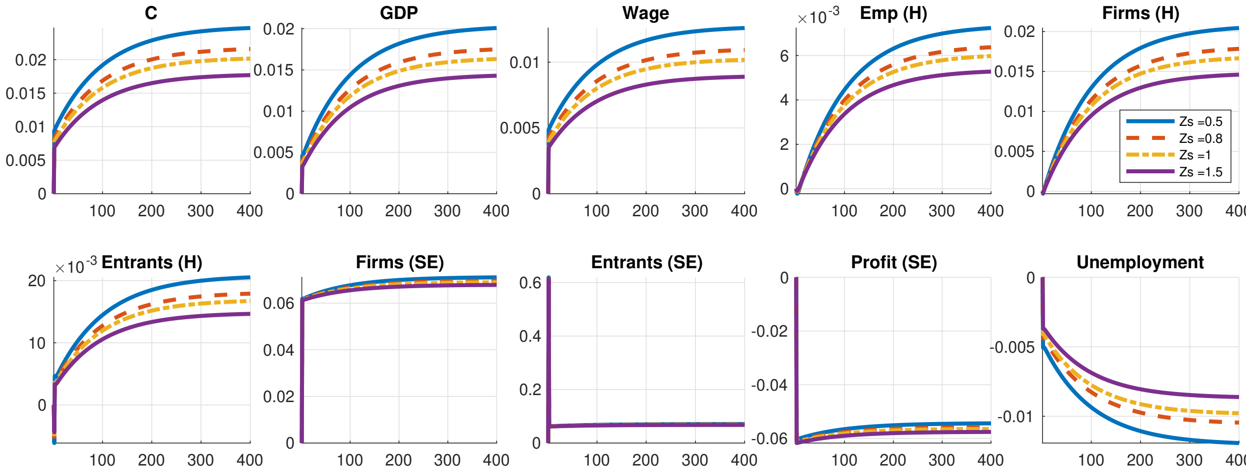


Figure 11. Permanent 1% decrease in regulation cost for the self-employment sector. [cited on page 27]

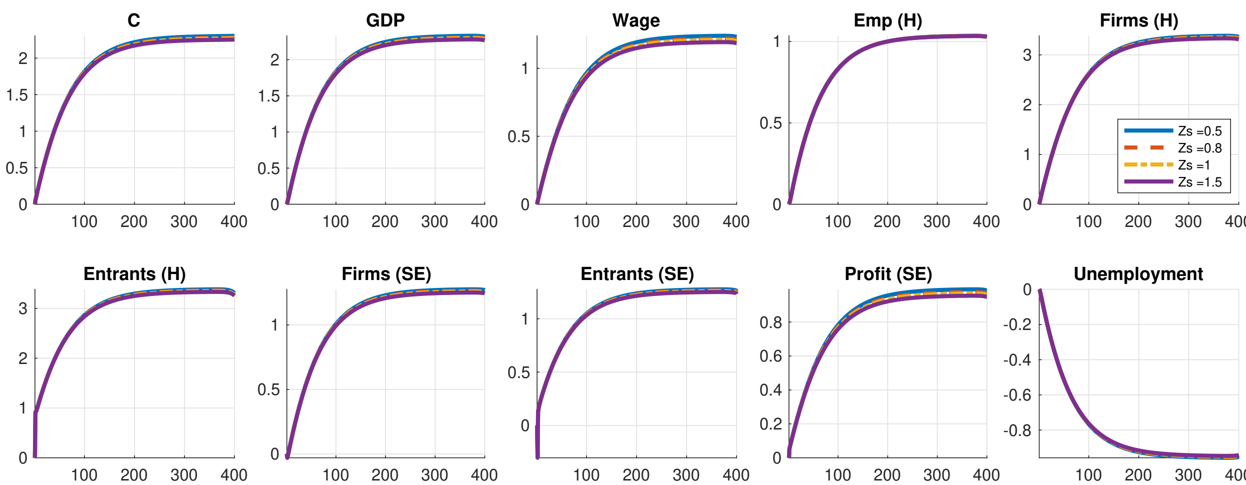


Figure 12. Permanent 1% decrease in regulation cost for the hiring sector. [cited on page 27]
Responses show percentage deviations from steady state after the respective permanent policy change. Unemployment is in deviations from steady state.

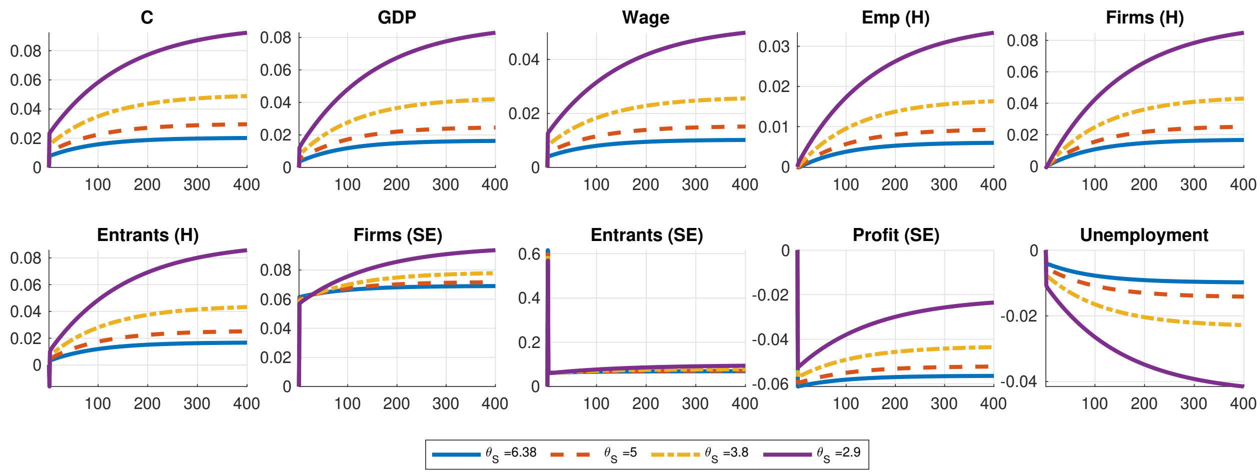


Figure 13. Permanent 1% decrease in regulation cost for the self-employment sector. [cited on page 28]

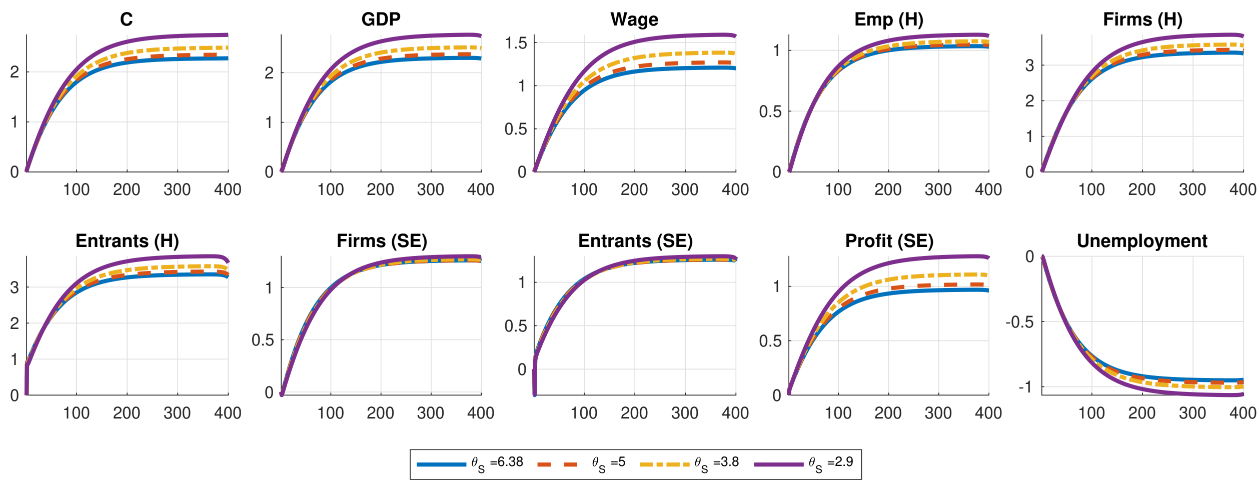


Figure 14. Permanent 1% decrease in regulation cost for the hiring sector. [cited on page 28]

Responses show percentage deviations from steady state after the respective permanent policy change. Unemployment is in deviations from steady state. Higher θ_S implies less monopoly power and smaller markup in S sector (112%, 100%, 92%, and 87% of H sector markup respectively).

Appendix

A Accounting Profit versus Economic Profit

The entrants in the self-employed sector are unique in that they are initially unemployed workers. In other words, whether an unemployed worker decides to enter the market as a firm or not is also dependent on the worker's value of unemployment and self-employment. Thus the value of self-employment to an individual is not only dependent on the profits one earns today but also on the outside option of the worker:

$$e_{s,t} = d_{s,t} - \bar{\omega}_{s,t} + \mathbb{E}_t \left[\sum_{j=t+1}^{\infty} (1-\delta)^{j-t} \beta_{t,j} (d_j - \bar{\omega}_j) \right] \tag{59}$$

where

$$\bar{\omega}_{s,t} = u_b + (1-\delta_S)\, \mathbb{E}_t\, \beta_{t,t+1} \iota_{t+1} S^W_{t+1} \tag{60}$$

Since switching to self-employment implies the worker is essentially giving up the unemployment benefits and the possibility of being matched to a hired job next period, the outside option $\bar{\omega}_{s,t}$ can be interpreted as the opportunity cost of self-employment.

The value of a hiring firm is the profit it earns this period plus the present discounted value of the firm:

$$e_{h,t} = d_{h,t} + (1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1} e_{h,t+1} \tag{61}$$

From this equation, using backward induction it is possible to show that $e_{h,t}$ equals the future discounted stream of profits:

$$e_{h,t} = \mathbb{E}_t \sum_{j=t}^{\infty} (\beta(1-\delta_H))^{j-t} \left(\frac{C_j}{C_t} \right)^{-\gamma} d_{j,t} \tag{62}$$

Furthermore, value of self-employed firm changes since the possibility of hiring firms exiting changes the outside option of self-employment ($\bar{\omega}_{s,t}$):

$$e_{s,t} = d_{s,t} - \bar{\omega}_{s,t} + (1-\delta_S)\, \mathbb{E}_t\, \beta_{t,t+1} e_{S,t+1} \tag{63}$$

where

$$\bar{\omega}_{s,t} = u_b + (1-\delta_S)(1-\delta_H)\, \mathbb{E}_t\, \beta_{t,t+1} \iota_{t+1} S^W_{t+1} \tag{64}$$

B Steady State Analysis

In steady state, from the definition of aggregate employment and law of motion,

$$\begin{aligned} L &= N_H l_h + N_S \\ &= N_H \left[(1-\lambda)l_h + qv\right] + N_S \\ &= (1-\lambda)(L - N_S) + qvN_H + N_S \end{aligned} \tag{65}$$

Matches are equal to vacancy filling rate times aggregate vacancies:

$$\begin{aligned} M &= qV \\ &= q(vN_H + v_E N_{HE}) \\ &= l_h N_H \delta_H + (1-\delta_H) qvN_H \\ &= (\delta_H + \lambda(1-\delta_H))(L - N_S) \end{aligned} \tag{66}$$

Since new matches are also equal to total number of separations ($M = qV = \lambda^{tot} L$), total separation rate λ^{tot} can be written as:

$$\lambda^{tot} = \left[\delta_H + \lambda(1-\delta_H)\right]\left(1 - \frac{N_S}{L}\right) \tag{67}$$

where $\frac{N_S}{L}$ is the self-employment rate as a fraction of total employment.

C Efficient Allocation

The social planner chooses $\{C_{H,j}, C_{S,j}, L_{H,j}, N_{S,j}, M_{S,j}, V_j\}_{j=t}^{\infty}$ to maximize the intertemporal utility function:

$$\mathbb{E}_t \sum_{j=t}^{\infty} \beta^{j-t} \left(\frac{C_j^{1-\gamma}}{1-\gamma} \right) \tag{68}$$

subject to the following constraints:

$$L_{H,t} = (1-\lambda)(1-\delta_H) L_{H,t-1} + \chi(1 - (1-\lambda)L_{H,t} - N_{S,t})^{\xi} V_t^{1-\xi} \tag{69}$$

$$Y_t = C_t + \kappa V_t + (f_{rh} + f_{Th}) \{N_{H,t} - (1-\delta_H) N_{H,t-1}\} + (f_{rs} + f_{Ts}) \{N_{S,t} - (1-\delta_S) N_{S,t-1}\} \tag{70}$$

$$\rho(N_{H,t}) Z_{H,t} L_{H,t} = C_{H,t} + M_{s,t} N_{S,t} \tag{71}$$

$$\rho(N_{S,t}) Z_{S,t} M_{s,t} N_{S,t} = C_{S,t} \tag{72}$$

where expressions for C_t and Y_t are:

$$C_t = \left[(1-\alpha)^{1/\phi} C_{H,t}^{\frac{\phi-1}{\phi}} + \alpha^{1/\phi} C_{S,t}^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}} \tag{73}$$

$$Y_t = \left[(1-\alpha)^{1/\phi} (\rho(N_{H,t}) Z_{H,t} L_{H,t})^{\frac{\phi-1}{\phi}} + \alpha^{1/\phi} (\rho(N_{S,t}) N_{S,t} Z_{S,t} M_{s,t})^{\frac{\phi-1}{\phi}}\right]^{\frac{\phi}{\phi-1}} \tag{74}$$

Note that the planner internalizes the variety effect on the relative price; hence $\rho(N_{H,t}) = N_{H,t}^{\frac{1}{\theta_H - 1}}$ and $\rho(N_{S,t}) = N_{S,t}^{\frac{1}{\theta_S - 1}}$. Law of motion on aggregate employment in the hiring sector (equation (69)) is derived by combining the firm-level equations. Recall the law of motion for hiring firm-level employment:

$$l_{h,t} = (1-\lambda) l_{h,t-1} + q_t v_t \tag{75}$$

Since $L_{H,t} = N_{H,t} l_{h,t}$, multiplying $N_{H,t}$ on each side and rewriting the equation gives us:

$$L_{H,t} = (1-\lambda) L_{h,t-1} \frac{N_{H,t}}{N_{H,t-1}} + q_t v_t N_{H,t} \tag{76}$$

Using the law of motion for hiring firms (eq. (15)), the expression above becomes:

$$\begin{aligned}
L_{H,t} &= (1-\lambda) L_{H,t-1} \frac{(1-\delta_H) N_{H,t-1} + N_{HE,t}}{N_{H,t-1}} + q_t v_t N_{H,t} \\
&= (1-\lambda)(1-\delta_H) L_{H,t-1} + (1-\lambda) \left(\frac{l_{h,t} - q_t v_t}{1-\lambda}\right) N_{HE,t} + q_t v_t N_{H,t} \\
&= (1-\lambda)(1-\delta_H) L_{H,t-1} + q_t v_{E,t} N_{HE,t} + q_t v_t N_{H,t} \\
&= (1-\lambda)(1-\delta_H) L_{H,t-1} + q_t V_t
\end{aligned}$$

Replacing q_t with the expression $M_t/V_t = \chi(1-(1-\lambda)L_{H,t} - N_{S,t})^{\xi} V_t^{-\xi}$ gives equation (69).

Let μ_t, λ_t, $\xi_{H,t}$, and $\xi_{S,t}$ denote the Lagrange multiplier on the law of motion for hiring sector employment, resource constraint, and output clearing equations in hiring and self-employed sector respectively. The first-order conditions with respect to $C_{H,t}$, $C_{S,t}$, $L_{H,t}$, V_t, $N_{H,t}$, $N_{S,t}$, $M_{s,t}$ are the following:

$$\xi_{H,t} - \left(C_t^{-\gamma} - \lambda_t\right) \frac{\partial C_t}{\partial C_{H,t}} = 0 \tag{77}$$

$$\xi_{S,t} - \left(C_t^{-\gamma} - \lambda_t\right) \frac{\partial C_t}{\partial C_{S,t}} = 0 \tag{78}$$

$$\mu_t \left(\frac{\partial M_t}{\partial L_{H,t}} - 1\right) + \xi_{H,t} \rho(N_{H,t}) Z_{H,t} + \lambda_t \frac{\partial Y_t}{\partial L_{H,t}} + \beta(1-\lambda)(1-\delta_H) \mathbb{E}_t \mu_{t+1} = 0 \tag{79}$$

$$\mu_t \frac{\partial M_t}{\partial V_t} - \kappa \lambda_t = 0 \tag{80}$$

$$\xi_{H,t}\left(\rho'(N_{H,t})Z_{H,t}L_{H,t} + \rho(N_{H,t})Z_{H,t}l_{h,t}\right) + \lambda_t \left(\frac{\partial Y_t}{\partial N_{H,t}} - (f_{rh} + f_{Th})\right) + \beta(1-\delta_H)\,\mathbb{E}_t(f_{rh} + f_{Th})\lambda_{t+1} = 0 \tag{81}$$

$$\begin{aligned} &\mu_t \frac{\partial M_t}{\partial N_{S,t}} - \xi_{H,t}M_{s,t} + \xi_{S,t}\left(\rho'(N_{S,t})Z_{S,t}M_{s,t}N_{S,t} + \rho(N_{S,t})Z_{S,t}M_{s,t}\right) \\ &+\lambda_t \left(\frac{\partial Y_t}{\partial N_{S,t}} - (f_{rs} + f_{Ts})\right) + \beta(1-\delta_S)\,\mathbb{E}_t(f_{rs} + f_{Ts})\mu_{t+1} = 0 \end{aligned} \tag{82}$$

$$-\xi_{H,t}N_{S,t} + \xi_{S,t}\rho(N_{S,t})Z_{S,t}N_{S,t} + \lambda_t \frac{\partial Y_t}{\partial M_{s,t}} = 0 \tag{83}$$

Combining the first-order conditions for $C_{H,t}$ and $C_{S,t}$ gives the marginal rate of substitution between the two sector goods:

$$\frac{\xi_{H,t}}{\xi_{S,t}} = \left(\frac{\alpha C_{H,t}}{(1-\alpha)C_{S,t}}\right)^{-1/\phi} \tag{84}$$

Using the same two first conditions and condition (83), one can simplify the expression further by defining A_t as

$$A_t \equiv \left(\frac{C_{S,t}}{\alpha Y_t}\right)^{1/\phi} \left[\frac{1}{\rho(N_{S,t})Z_{S,t}} \left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} - \left(\frac{C_{S,t}}{\alpha C_t}\right)^{-1/\phi}\right] \tag{85}$$

Then the Lagrange multiplier λ_t can be written as:

$$\lambda_t = \frac{C_t^{-\gamma}}{1+A_t}\ ; \quad \frac{\lambda_{t+1}}{\lambda_t} = \left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \frac{1+A_t}{1+A_{t+1}} \tag{86}$$

Combining conditions (80) and (79) and utilizing the expressions of λ_t above, the job creation equation is derived as:

$$\begin{aligned} \frac{\kappa}{q_t} = (1-\xi)\rho(N_{H,t})Z_{H,t} &\left[A_t \left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{H,t})Z_{H,t}L_{H,t}}{(1-\alpha)Y_t}\right)^{-1/\phi}\right] \\ - (1-\lambda)\xi\iota_t \frac{\kappa}{q_t} &+ (1-\lambda)(1-\delta_H)\,\mathbb{E}_t\,\beta_{t,t+1}\left(\frac{1+A_t}{1+A_{t+1}}\right)\frac{\kappa}{q_{t+1}} \end{aligned} \tag{87}$$

Rewriting the first-order conditions (81) and (82) using the expressions above for the Lagrange multipliers gives the free entry condition for the hiring and self-employed firms respectively:

$$(f_{rh} + f_{Th}) = \frac{\theta_H}{\theta_H - 1}\rho(N_{H,t})Z_{H,t}l_{h,t}\left[A_t \left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{H,t})Z_{H,t}L_{H,t}}{(1-\alpha)Y_t}\right)^{-1/\phi}\right]$$

$$+ (1-\delta_H)\,\mathbb{E}_t\,\beta_{t,t+1}\left(\frac{1+A_t}{1+A_{t+1}}\right)(f_{rh}+f_{Th}) \tag{88}$$

$$(f_{rs}+f_{Ts}) = \frac{\theta_S}{\theta_S-1}\rho(N_{S,t})Z_{S,t}M_{s,t}\left[A_t\left(\frac{C_{S,t}}{\alpha C_t}\right)^{-1/\phi} + \left(\frac{\rho(N_{S,t})N_{S,t}Z_{S,t}M_{s,t}}{\alpha Y_t}\right)^{-1/\phi}\right]$$

$$- A_t\left(\frac{C_{H,t}}{(1-\alpha)C_t}\right)^{-1/\phi} M_{s,t} - \frac{\xi}{1-\xi}\iota_t\frac{\kappa}{q_t} + (1-\delta_H)\,\mathbb{E}_t\,\beta_{t,t+1}\left(\frac{1+A_t}{1+A_{t+1}}\right)f_{rs} \tag{89}$$