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Nicola Curci

Matricola n. 38117

Essays on Entrepreneurship and Labour Markets

Nicola Curci
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Contents

I would like to thank my mum, Lucia, my dad, Giuseppe, my sisters, Anna and Grazia, my supervisor, Pietro Garibaldi, my colleagues and friends, Giuseppe and Paolo, and all my other friends for having sustained me in very demanding years like those of a PhD in Economics. I am in debt with each one of them.

Introduction

Firms' creation is a prime cause of economic development. Since Schumpeter's contribution, it is recognized as a force pushing innovation through the *creative destruction* process. This innovation is a fundamental source of economic growth and social welfare. Nonetheless, the attention that economic literature has given to firms' creation in the past seems not particularly relevant, expecially in terms of attempts to build theoretical models with individual decisions about future alternative income sources.

The first two parts of this doctoral thesis try to partially fill the gap.

In the first part, we supply a review of the economic literature about entrepreneurship, from a theoretical and empirical perspective. While politicians and public opinion attribute a great importance to the entrepreneurial role, economics traditionally gave less attention to the topic of entrepreneurship and firm formation. I analyze the main theoretical contributions and judge the relevant implications, comparing them with empirical findings. This analysis suggests that more has to be done. In fact, on one side, theoretic traditional works are at odds with more recent patterns of entrepreneurship (or self-employment) rates in OECD countries. On the other side, some questions profoundly treated in this literature have not yet completely assessed, as the correlation between self-employment and unemployment rates.

The second part is devoted to present the main theoretical contribution of the thesis. The individual decision of starting up a new firm is related to individual employment status. Inspection of cyclical movements in job creation and job destruction US data reveals that the variability of job creation in start-up firms is higher than the variability of job creation in continuing firms. To explain this fact, we build a model in which more individuals start up a new firm in booms than in recessions. This leads to a more pronounced variability in job creation for start-ups. The model is inspired by a similar work by Fonseca, Lopez-Garcia and Pissarides (2001) and extends it to take into account cyclical movements in output. We report a calibration of the model to US economy and use it to simulate the dynamics in order to test the ability to explain the mentioned empirical fact. The results are satisfactory.

The third part comes back to a more traditional topic of economic literature. In the last decade, the Non-Accelerating Inflation Rate of Unemployment, known with the acronym of NAIRU, became more and more popular in US public debates about the conduction of economic policies. In this paper, I review the main theoretical framework in which this concept arises: that of good markets with monopolistic competition and labour markets with frictions. The theoretical setup helps in specifying a testable model, using which the main empirical contributions have found out an estimate of the NAIRU. A review of these empirical works follows, organized around the three most used methodologies: the structural methods, the pure statistical methods and the reduced-form approach. Finally a flavour of the NAIRU's policy use is given in the conclusion.

Part I

Entrepreneurship in empirical and theoretical economic literature

Chapter 1

Entrepreneurship in empirical and theoretical economic literature

Nicola Curci
Bocconi University, Milan

Abstract

The paper supplies a review of the economic literature about entrepreneurship, from a theoretical and empirical perspective. While politicians and public opinion attribute a great importance to the entrepreneurial role, economics traditionally gave less attention to the topic of entrepreneurship and firm formation. I analyze the main theoretical contributions and judge the relevant implications, comparing them with empirical findings. This analysis suggests that more has to be done. In fact, on one side, theoretic traditional works are at odds with more recent patterns of entrepreneurship (or self-employment) rates in OECD countries. On the other side, some questions profoundly treated in this literature have not yet completely assessed, as the correlation between self-employment and unemployment rates.

1.1 Introduction

Entrepreneurship is a field of economics with many questions about which there is no consensus. Strangely enough, this is true even for the definition of entrepreneurship.

In a large part of the literature, entrepreneurs are simply persons who do not work as dependent from anyone. This definition comes from considering entrepreneurs as individuals that work and possess the capital needed to work. As an example, the man who opens up a small grocery with one employee is an entrepreneur, according to this definition. It is somewhat disapponting that the half-million-dollar-per-year CEO, whose wife is a customer of the grocery, is not considered entrepreneur. In general, a definition of entrepreneurship that allows to distinguish beteween the shopkeeper, the manager and the entrepreneur is almost rare. However a satisfactory definition of entrepreneurship has to be able to deal with such a distinction.

On the other side, there are authors which claim that self-employment is a broad definition in which even entrepreneurship enters. Each innovative entrepreneur, even Bill Gates, started and remains self-employed, even if he hired thousands of employees, after the heroic phase of his fortune. In this line, self-employment can be treated as a proxy of entrepreneurship. There can be also a theoretical reason for justifying the closeness of entrepreneurship and self-employment. Since the outcome of entrepreneurship is highly risky and cannot be ascertained *ex-ante*, it is subject to the abuse of moral hazards and adverse selection. Then none is willing to hire entrepreneurial services at predetermined prices. As a consequence, entrepreneurship is always self-motivated and self-employed.

In general, we can give two categories of entrepreneurship's definitions: one which has to do with the entrepreneurial fuctions, the other which deals with innovation. Hébert and Link (1989) gives a noticeable example of the first type definition saying that: "the entrepreneur is someone who specializes in taking responsibility for and making judgmental decision that affects the location, form, and the use of goods, resources or institutions" (Hébert and Link (1989), p. 213). On a similar line, Lazear (2003) argue that "entrepreneurs have a comparative disadvantage in a single skill, but have more balanced talents that span a number of different skills". Hence, entrepreneurship is a multi-task working status and talent is needed to the entrepreneur to address it. On the other side, which focuses on innovation, more emphasis is given to creativity. For example, Wennekers and Thurik (1999) give a 'Schumpeterian' definition, focusing on the entrepreneurs' ability to exploit new economic opportunities: this ability is fundamental for economic development because it allows the introduction of new ideas in the market.

Given this debate for defining only the concept, measuring entrepreneurship is an even more difficult task. Different countries use different measures and international comparisons are not always possible. One can have a static or a dynamic perspective in measuring entrepreneurship. Self-employment or business ownership rate may be a good static indicator of the level of entrepreneurship. On the other hand, dynamic considerations involve the start-up activity, as well the net entry rate and the turbolence rate (total entries and exits).

In the static perspection of self-employment two definitions can be distinguished. The first refers to people leading to unincorporated business: these people have profits as income source. The second refers to owner-managers who gain a share of the profits as well as a salary from an incorporated business. Each country has different tradition in aggregating these categories. Some, e.g. France, the Netherlands and the United Kingdom, consider only the first category as self-employment ; others, e.g. Germany, Denamark, Ireland, Portugal and Spain, use the broader second category to define self-employment.

A harmonized international database including 23 OECD countries for 1972-1998 period was set in the Compendia 2000.1 data set of EIM in Zoetermeer, The Netherlands. In it the second broad definition of self-employment (and hence static entrepreneurship) is taken, but excluding family workers and wage-and-salary workers operating a side-business as a secondary work activity. It is reported in table 1[1].

Table 1 shows a difference in the rate of entrepreneurship between countries like Luxembourg, Denmark, Norway, Austria, Sweden and Finland and countries like Greece, Italy, Portugal and Australia. The first group has rates of entrepreneurship below 8.5% in 1998. The second conversely shows rates above 15%. Taken as a whole the number of business owners increased from about 29 million in 1972 to about 45 million in 1998.

[1]Table 1 is taken by Verheul et al. (2001).

	levels			growth		country percentage in total business owners		
	1972	1984	1998	1972-84	1984-98	1972	1984	1998
Austria	9.3	6.5	8.0	-2.8	1.5	0.96	0.58	0.69
Belgium	10.5	10.2	11.9	-0.3	1.7	1.35	1.13	1.15
Denmark	8.2	6.6	6.4	-1.6	-0.2	0.68	0.48	0.40
Finland	6.6	6.6	8.2	0.0	1.6	0.49	0.45	0.46
France	11.3	9.8	8.5	-1.5	-1.3	8.40	6.31	4.92
Germany (West)	7.6	6.8	8.5	-0.8	1.7	7.05	5.20	7.56
Ireland	6.9	8.0	11.2	1.1	3.2	0.26	0.28	0.41
Italy	14.3	16.5	18.2	2.2	1.7	9.56	9.77	9.52
Luxembourg	10.7	8.3	5.9	-2.4	-2.4	0.05	0.04	0.03
The Netherlands	10.0	8.1	10.4	-1.9	2.3	1.99	1.38	1.80
Portugal	11.3	10.6	15.2	-0.7	4.6	1.38	1.28	1.69
Spain	11.8	11.3	13.0	-0.5	1.7	5.28	4.20	4.75
Sweden	7.4	7.2	8.2	-0.2	1.0	0.99	0.84	0.78
United Kingdom	7.8	8.6	10.9	0.8	2.3	6.70	6.24	7.04
Iceland	11.1	9.1	13.2	-2.0	4.1	0.04	0.03	0.04
Norway	9.7	8.7	7.1	-1.0	-1.6	0.56	0.47	0.36
Switzerland	6.6	6.8	9.1	0.2	2.3	0.80	0.67	0.81
USA	8.0	10.4	10.3	2.4	-0.1	24.17	31.91	31.90
Japan	12.5	12.6	10.0	0.1	-2.6	22.04	19.96	15.10
Canada	7.9	10.0	14.1	2.1	4.1	2.50	3.44	4.92
Australia	12.6	16.0	15.5	3.4	-0.5	2.50	3.06	3.24
New Zealand	10.2	11.0	14.2	0.8	3.2	0.45	0.47	0.59
Weighted average	9.8	10.6	10.9	0.8	0.3			
Total business owners in thousands						29,390	37,430	44,927

Table 1.1: Entrepreneurship as a percentage of the labour force in 23 OECD countries

Data of dynamic indicators of entrepreneurship are scarce. Recently for selected countries harmonized data for entries and exits in the period from 1972 trough 1997 have been collected: we refer to the USA, the UK, the Netherlands and Germany.

This paper aims at surveying theoretical and empirical literature over entrepreneurship. A lexical *caveat* is now in order: we will often use entrepreneurship, self-employment and business ownership as synonimous. The reasons should result clear by previous discussion. First of all, the borders between the three concepts are quite indefinite, even in the definitions. Second, theretical considerations about moral hazard and adverse selection in supply entrepreneurship services in the market sustain the fact that entrepreneurs are always self-employed (even though the reverse is not true!). Third, internationally comparable measures exist about self-employment but not about the other two concepts: then in empirical works self-employment data are often used for measuring entrepreneurship.

The literature review is organized as follows. In section 2 we start by considering reasons that explain why theories of entrepreneurship are not very common in the literature. Then we move to present the few theoretically cornerstone contributions and their main macroeconomic implications. We will see that these implications are not always empirically supported, mainly in the last two decades data. We review possible motives of this changing in the expalanatory power of the traditional theories. Hence in section 3 we consider some micro-econometric contributions to explaining entrepreneurship. We will focus in particular over the importance of liquidity constraints that seem to play a relevant role in determining individual decisions of starting up its own business instead of working in the wage sector. Finally in section 4 we conclude, pointing out possible future developments in this line of research.

1.2 Why do people become entrepreneurs?

In this section we will try to respond to this question. Again, doing this is not easy. It is well known that there are a lot of contradictory results in the literature about the determinants of firm formations. These studies usually deal with the problem going directly to the data. What lacks is a well founded theory of working status choice. Without this theory, analyzing data is largely ineffective. Many questions arise. Which data to use? Are self-employment indicators good proxies of entrepreneurship? Which correlations do we have to test?

We can start asking ourselves: why are theories of entrepreneurship so rare? Thurik and Wennekers (2001) provided a nicely answer, based on historical considerations. The relevance of firm formations was evolving over time. During the first decades of the last century, small businesses were both a vehicle for entrepreneurship and a source of income and wealth. In this environment, Schumpeter conceived his theory of economic development: new businesses compete with incumbent firms by introducing new products and new production processes, that push the incumbent to react or die. It is the well know process of *creative destruction* that allow a country's economic development. During the post-war years, small businesses still counted, but increasingly less than giant corporations. Obviously small businesses continued to keep a very important role of employment creation. But the emphasis on economic efficiency of small enteprises was diminishing, while theories favourable to large corporations became predominant. Again Schumpeter was one of the most responsible of this situation, given his new book *Capitalism, Socialism and Democracy* (Schumpeter, 1942), in which he described how large firms outperform their smaller counterparts in the innovation and appropriation process in a creative accumulation in which there is a positive loop from innovation to higher R&D expenditures. Since 1970s, world changed again. Small businesses in high-tech sector became fomidable incubators of new ideas and projects. Again new emphasis has been put on the capacity of small firms to spread out innovation around economic environment. Hence only recently a new attention is increasing around determinants of entrepreneurship and small business.

As now, we can only review the literature, trying to start by theoretical temptatives of modelling entrepreneurship.

1.2.1 The traditional theoretical contributions

After a long period of silence, in the last decades the entrepreneur has re-emerged for economic theory as coordinator of production (Lucas, 1978) and as risk bearer (Kihlstrom and Laffont, 1979).

Lucas (1978) analyzes the implications of heterogeneous and limited managerial talents for the distribution of firm sizes. He started from the suggestion that this distribution is the solution to the problem of allocating productive factors over managers of different abilities so as to maximize output. The hypothesis that Lucas makes is that each agent has her own managerial talent but there are diminishing returns to the "span of control". These diminishing returns rule out a situation in which the most talented individual remains the sole entrepreneur. An allocation is then defined as a threshold managerial talent and a pair of functions describing relationship between individual talent and workers and capital managed, such that people with talents less than the threshold are employees and people with talents higher than the threshold will be managers. In this way a distribution of firm sizes arises, but only given the distribution of persons by managerial talent. Hence Lucas points out that, without knowing the talent distribution, it is impossible to make inference about the stochastic process which governs firm growth.

However, for our purpose, the main implication of Lucas (1978) model is another one. The equilibrium threshold managerial talent allows to calculate the average size of the firm, simply as the ratio between employees and managers: this ratio will be higher for higher values of the threshold. As it is shown in the paper, the equilibrium value of the threshold is increasing in the capital-labour ratio, provided that the elasticity of substitution between capital and labour is smaller than one. Since the capital-labour ratio goes up with economic development, this implies that average firm size increases with economic development. This implication was tested empirically in the Lucas' paper and the test confirmed the theory. The intuition is the following: with development, increasing real wages make working for some one else more and more lucrative than the return to making managerial decisions for a single, small business.

Starting from different hypotheses, Otani (1996) obtained the same result for the linkage between economic development and firm size. The aim of the paper is to explain the concept of entrepreneurial capacity in terms of human capital theory. The author borrows ideas from well known theories of Hayek and Coase, in order to show that firms cannot either expand infinitely or break down in smaller and smaller parts. In particular, Hayek (1945) predicted that the centrally planned economy would not work, given that for its efficient functioning knowledge about each production unity is essential and the planner's ability of collecting and properly using this knowledge for each plant is limited. Using the same argument, Otani defined entrepreneurial capacity as a manager's knowledge about the firm's constituent elements. Acquiring this knowledge through apprenticeship is expensive. This cost limits the size of the firm, that remains finite. However, why do firms not break down in smaller parts? To answer this question, Otani resuscitated Coase's problem of whether transactions can be made more efficiently within the integrated firm than between separate firms. In particular, he borrows the idea of the existence of a non-tradable externality that arises because the ability that a manager acquires with apprenticeship about one component of the firm makes it easier for him to learn about another component, while such learning experience cannot be easily transferred to others in the market. This creates a scale economy in learning and makes smaller firms with fewer elements inefficient.

Even this model theoretically founds the historical positive correlation between economic development (measured by accumulation of capital) and the average firm size. The reason is different from Lucas (1978). While Lucas stresses heterogeneity in exogenous innate managerial ability, Otani has homogeneous individuals and diversity in entrepreneurial capacity is made endogenous by the time-consuming apprenticeship (an investment). Then, a reduction in the interest rate arising from an accumulation of physical capital induces a longer apprenticeship and further accumulation of human capital. Longer apprenticeship results in larger firms.

A third possible theoretical model which implies the negative relationship between economic development and number of entrepreneurs si given by Gifford (1993). He distinguishes between entrepreneurial ability and managerial ability. The former is defined as the ability to maintain the profitability of current operations, that is, to manage projects after thay have been adopted. The latter is the ability to recognize new profit opportunities and to acquire resources to begin the exploitation of the opportunity. Then each self-employed entrepreneur must allocate his time between two possible forms, an innovation rule and a managerial rule. In the first case, current operations are never evaluated and improved but are discontinued once profits go to zero. In the second case, each current project is periodically evaluated for possible improvements and only if no current project requires evaluation a new one is evaluated. The choice between the two rules depends on the probability of success in the two kinds of operations and the probabilities are related with individual's abilities. The optimal career choice is then made, comparing three values: the value of being a salaried employee, that of being an innovative entrepreneur and that of being a managerial entrepreneur. After determining the optimal allocation, an interesting implication of the model is that as the productivity of employed labour increases, the number of innovative entrepreneurs falls to zero and the wage rate will be paid by the remaining managerial entrepreneurs. Thus, as economic development goes on, innovative entrepreneurship decreases but still managerial entrepreneurship remains and more and more fraction of innovative activity relies on it. Thus again the average firm size enlarges.

Another stream of research with the same implication as before has followed to the pioneer work of Kihlstrom and Laffont (1979). They argued that entrepreneurs are less risk-averse than other in society. Since entrepreneurship is a risky activity, this individual feature is the condition to meet in order to choose entrepreneurship instead of a salaried work. Iyigun and Owen (1998), starting from the same consideration, conclude that in developed economies supply of more insured paid jobs crowds out entrepreneurship, since risk-averse agents tend to choose salaried jobs. Again economic development (now in the sense of more availibility of insurance) implies less entrepreneurial activity.

All this reviewed literature shares some drawbacks.

First of all, they do not clearly define what an entrepreneur is. For example, in Lucas (1978) the entrepreneur is quite undefined: he is an individual that possesses enough managerial ability, whose nature is exogenous to the model and not explained. Only in Gifford (1993) a temptative to set a difference between entrepreneurs and managers is positively made. In general, all these works share the incapacity to distinguish between the entrepreneur that is involved in the very important but difficult task of Schumpeterian creative distruction and the self-employed business owners (like a shopkeeper) that limit themselvew to more managerial tasks. I argue that this is one of the most important problem that impedes the creation of a well accepted framework for modelling entrepreneurship.

Second, they share the conclusion that economic development is accompanied by a diminishing rate of entrepreneurship and a consequent increasing average firm size. However, as table 1 partially shows, the secular movement of reduction in the rate of self-employment has been gradually substituted in the last two decades by an upward trend. Several authors provided evidence of the reversal of the trend towards less self-employment. Acs et al. (1994) showed that, out of 23 OECD countries, 15 had increasing rates of self-employment during the 1970s and 1980s. Carlsson (1989) provides data on the share of the Fortune 500 companies in total manufacturing. He shows that this share in total manufacturing employment dropped from 78.7% in 1975 to 72.5% in 1985. In the same period the share of these firms in total shipments dropped from 83.2% to 77.2%.

1.2.2 A regime switch towards small businesses and its possible explanations

Carree et al. (2002) and Bosma et al. (2003) furnish a convincing review of possible explanations for these last empirical findings. They identify different orders of motivation that explain a reversal trend in favour of small businesses and self-employment.

As for *economic factors*, most industrialized countries have witnessed an increasing variety of new products. On the other hand, Jovanovic (1993) showed a decrease in firm diversification, suggesting that large enterprises were not able to fully exploit this ample consumers' love for variety: new room in the market became disposable for small firms. The increase in demand variety can be considered as a part of natural world economic development. Three phases of development can be identified. In phase 1 the population is largely self-employed and there are no large enough firms that can exploit scale economies and hire many workers to match the demand for goods. This is the situation of many developing countries, characterized by a high number of self-employed and a tiny amount of large firms. In phase 2 personal incomes have risen to a level at which it is possible to buy products on the market and big firms can exploit scale economies. In this case the productive structure of the economy is characterized by more and more large firms that produce large consume goods, like refrigerators, televisions, cars. Phase 3 views higher income levels than it is necessary for buying the full range of standardized products: then money is left for specific preferences. Hence scale economies become less important and consumer markets become more fragmented. This is the phase of demand variety: again a large amount of small and tiny businesses are necessary to match this demand. Hence self-employment starts to rise again.

Another economic factor that helps explaining self-employment is unemployment. A high level of unemployment can theoretically result in more start-ups, but can also negatively influence the exits of entrepreneurs (few job alternative). The evidence about this push effect is conflicting, even if recently Carree et al. (2002) found out an empirical evidence for a sample of 23 OECD countries that there is a positive puch effect of unemployment over entrepreneurship. However caution has to be posed because welfare system may well restrain this effect, when it is particularly generous and not work-incentivating.

In general, important economic factors are all those that affect the evaluation of the expected wage income versus the expected entrepreneurial income. For example, Bosma et al. (2003) argue that the wage moderation in Netherlands after the 1982 agreement between employers' organizations and unions may explain, at least partially, the high increase in self-employment rate in that country. As well, a higher risk of dismissal as paid worker, after labour market reforms towards flexibility, can have the same effect, when comparison with the risk of entrepreneurial failure is favourable to entrepreneurship. Other authors[2] stress the role of real interest rate in affecting the opportunity costs of entrepreneurship. A higher interest rate may induce people to invest in alternative investment opportunities than entrepreneurship. At the same time, when financing is needed, a higher interest rate increases the costs of financing, discouraging entrepreneurship.

Among *technological factors*, we have to mention the advent of new technological paradigms, such as most notably the information and communication technology (ICT) revolution, creating a wave of process and product innovation. On one hand, this revolution tends to decrease scale economies, creating the possibilities for small firms. It has an effect over transaction costs too, thus stimulating outsourcing and favouring networks of independent producers above large corporations. On the other hand, since new industries usually have room for a relatively large number of enterprises, the development of new products may cause an increase in the number of new firms.

Demographic characteristics of the population may affect the self employment rate, as propensities towards entrepreneurship varies across ages and genders. For example, people in the middle age cohorts have the highest prevalence of incumbent entrepreneurs. Evans and Leighton (1989) show that relatively many entrepreneurs start a business in their mid-thirties and that the average age of an entrepreneur is over 40 years. Storey (1994) reports that people tipically start their own business when they are between 25 and 40 years old. These findings should be considered with some cautions, given that it is not easy to distinguish between a possible age effect and a cohort effect. Another demographic aspect that can have some influence is immigration. The tendency and ability to become self-employed may vary

[2] See Evans and Jovanovic (1989) and Parker (1996)

between native people and immigrants. Immigration involves taking risks and this is also the case for entrepreneurship. Moreover, specific factors may influence this better attitude, like the fact of being in a backword position in society. One way to escape this position is to become self-employed, even to avoid involving in a "secondary" labour market. The female labour participation rate is another factor of interest. Female self-employment rates in OECD countries are generally lower than self-employment rates of men (OECD, 1998).

All the factors we have just listed may have had a temporary effect only. For example, current waves of outsourcing and deregulation may dry up. On the other hand, there are factors that seem quite "deep", like the increasing variety of demand. In conclusion, however, literature still does not agree over whether this reversal trend is a permanent effect or a temporary one.

1.3 Some microeconometric works

We have seen that aggregate measure of self-employment (as proxy for entrepreneurship) not always give consistent results about the evolution of business ownership over time. All the factors we have analyzed seem conceptually well posed in order to explain secular movements of entrepreneurship rates but still empirical evidence does not agree, not only about the quantitative effect but also about the sign of the effect. Hence it could be interesting to analyze microeconometric literature to stress the role of different factors over the individual decision of starting up a new business.

A survey conducted at the end of 1980s[3] showed that a huge part of working population in different countries would prefer to be self-employed, for example 63% of Americans (out of 1,453 asked), 48% of Britons (out of 1,297) and 49% of Germans (out of 1,575). However the number of individuals who actually were self-employed in those countries averaged at approximately 15%. Hence these data raise a puzzle, stated by Blanchflower and Oswald (1998) and Blanchflower (2000): why do not more individuals follow their desire of working as self-employed? The more studied factor explaining this gap between aspirations and reality is the effect of liquidity

[3]The International Social Survey Programme in 1989 asked random samples of individuals from eleven countries the question: "*Suppose you were working and could choose between different kinds of jobs. Which one of the following would you choose?*" Possible responses were: "*(i) Being an employee, (ii) Being self-employed, (iii) Can't choose*"

constraints. We analyze this strand of literature in details.

1.3.1 The role of liquidity constraints

Why is important to assess the role of liquidity constraints on business formation? Evans and Jovanovic (1989) give three answers to this question. First of all, liquidity constraints can help in explaining why self-employment rate are almost constant across different ages. Second, the believe that capital markets are not able to fully finance new businesses is the rationale behind the choice of many Governments to subsidize firm creation. Third, from an historical perspective, the liquidity constraints are important in the dispute between Knight's and Schumpeter's vision of entrepreneurship. Knight (1921) argues that bearing risk is an important entrepreneurial task, given the relative difficulties that entrepreneurs have to afford to raise money in capital markets for moral hazard and adverse selection reasons. Then they finance themselves and bear the risk of failure. Schumpeter (1934, 1950), on the other hand, stress the innovative function of entrepreneurship, separating entrepreneurs and capitalists: given the modern capital markets, entrepreneurs find always capitalists ready to finance their innovations.

The model that the authors estimate presents heterogeneous individuals endowed with different entrepreneurial ability and assets that may be correlated. Liquidity constraints arise because the amount of financial capital they can devote to start-up their businesses is a multiple of these assets. Hence it is a parameter that measures the degree of liquidity constraints. In particular, liquidity constraints in the model are L-shaped: this is technically convenient for the solution but some reported evidence seems to justify the choice. Then the model is estimated with data on 1,500 US white males who were wage workers in 1976 and either wage workers or self-employed workers in 1978[4]. Maximum likelihood estimates of the key parameters of the model are reported. They are the degree of liquidity constraint, the returns to capital in entrepreneurship, the mean and variance of the distribution of entrepeneurial ability in the population, and the correlation between entrepreneurial ability and assets. The main result is that a person cannot use more than 1.5 times his or her initial assets for starting a new venture. This confirms Knight against Schumpeter: most individuals face binding

[4] Data were drawn from the National Longitudinal Survey of Young Men.

liquidity constraints and use a suboptimal level of capital to start-up their business.

Evans and Jovanovic (1989) results rely on data about flows in self-employment. A rather different approach to the same question about the role of liquidity constraints in determining self-employment is taken by Blanchflower and Oswald (1998). They develop a theoretical model in line with Knight's vision of entrepreneur as a risk-bearing individual. They point out that their model is genuinely in this vision, differently from works, like Kihlstrom and Laffont (1979). While the last stresses the role of individual risk-aversion as the main determinant of the choice towards entrepreneurship, assuming that the distribution of business opportunities is *ex ante* known, Blanchflower and Oswald assume, as Knight, that this distribution is not known and hence risk-aversion does not play any role. What counts is the ability to recognize business opportunities.

There is a fraction of the population that possesses this ability and a fraction that does not. There is an array of potential entrepreneurial projects not yet exploited in the economy that require an amount of capital. Individual with entrepreneurial ability may be short of assets to run the potential business: in this case they can ask a banker to have a loan but unfortunately the probability of obtaining an unsecured loan is less than one. The carrer choice is made by comparing utility obtained as self-employed and utility obtained as employee. There exists then a threshold amount of personal wealth over which individuals choose self-employment. Equilibrium in this economy can take two different forms. In one the market for entrepreneurship clears: the number of people with entrepreneurial ability is such that there is a marginal entrepreneur which earns utility exactly equal to that from working in the wage sector. In the other equilibirum, the number of potential entrepreneurs is low and markets for entrepreneurship does not clear: in this case there are insufficient entrepreneurs to drive to zero the surplus from running the marginal business and hence people with entrepreneurial ability and capital earn a rent. This distortion might be viewed as a result of the asymmetric information - about whether a project is good - between bankers and individuals with entrepreneurial vision. The main testable implications of the model are two: (i) some potential entrepreneurs are constrained, by lack of capital access; (ii) individuals who run their own enterprises have higher utility than those who are employee in the wage sector.

As said before, the approach to the empirical test of the model is very different from previuos works. Blanchflower and Oswald in fact study the effects of earlier inheritances upon the cross-section probability of being self-employed. They use data from the National Child Development Study (NCDS) that takes as subjects all those living in Great Britain who were born between March 3 and 9, 1958. These children were surveyed at birth and at ages 7, 11, 16, 23 an 33. In the sample there is evidence of a clear positive correlation between the size of inheritances/gifts and the incidence of self-employment. This effect is found both at age 23 and at age 33 but it is decreasing with age, probably because older individuals find more sources of financing than younger. Hence even with a rather different model and empirical test, liquidity constraint results playing an important role for business start-ups.

1.3.2 Conclusion

In this paper we have reviewed some theoretical and empirical contributions to economic literature about entrepreneurship. The general conclusion is that, while a large amount of papers try to approach the problem asking data to speak, very few proceed in the more correct manner of setting a plausible theory of entrepreneurship determinants and then testing this theory. Fortunately, those works that do this find a set of regularities, like the effect of economic development over self-employment rates and the influence of liquidity constraints over individual decisions, that can help in building a framework for entrepreneurship theory.

Much more researches must however be conducted. In particular, the linkage between self-employment and unemployment rates is not well explained and empirical results are contradictory. For example, Evans and Leighton (1989) found that white men who are unemployed are nearly twice as likely as wage workers to enter self-employment. On the contrary, Blanchflower and Oswald (1998) estimated that the log of the county unemployment rate entered negatively in a cross-section self-employment probits for british young people age 23 in 1981 and for the same people age 33 in 1991. Then, who prevails? The so called 'push effect' (higher unemployment leads to higher entrepreneurship) or the 'pull effect' (higher unemployment, as symptom of a depressed economy, decreases self-employment)?

A temptative of further theoretical analysis on this last subject is done in a companion paper (Curci, 2005), in which a model of career choice is set, using a matching and searching framework to describe labour markets. This line of research can contribute to set a better theory of firm formation. More works are however in order, in particular from an empirical perspective, to test the validity of this setup.

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Part II

Entrepreneurship and Economic Cycles in a Matching Model Framework

Chapter 2

Entrepreneurship and Economic Cycles in a Matching Model Framework

Nicola Curci
Bocconi University, Milan

Abstract

The individual decision of starting up a new firm is related to individual employment status. Inspection of cyclical movements in job creation and job destruction US data reveals that the variability of job creation in start-up firms is higher than the variability of job creation in continuing firms. To explain this fact, we build a model in which more individuals start up a new firm in booms than in recessions. This leads to a more pronounced variability in job creation for start-ups. The model is inspired by a similar work by Fonseca, Lopez-Garcia and Pissarides (2001) and extends it to take into account cyclical movements in output. We report a calibration of the model to US economy and use it to simulate the dynamics in order to test the ability to explain the mentioned empirical fact. The results are satisfactory.

2.1 Introduction

Firms' creation is a prime cause of economic development. Since Schumpeter's contribution, it is recognized as a force pushing innovation through the *creative destruction* process. This innovation is a fundamental source of economic growth and social welfare. But what are the combinations of individual attitudes and economic situation that push individuals to start up a new enterprises? In other words, how do business cycles, with their fluctuations, influence individual choice between entrepreneurship and searching for a job, as a dependent worker? The attention that economic literature has given to this theme in the past seems not particularly relevant, expecially in terms of attempts to build theoretical models with individual decisions about future alternative income sources.

The question assumes relevance if you consider data on entrepreneurship in the last years. Looking at U.S. data elaborated by the Office of Advocacy, U.S. Small Business Administration, based on data provided by U.S. Census Bureau, the amount of employers (excluding self-employed) increased a lot between 1989 and 2000,as Table 2.1 shows. In twelve years the number of employers increased by almost 13% and the number of their employees moves up by more than 25%. Obviously, the stock of the firms depends on the flows into and out of entrepreneurship, that is the firm births and deaths. These flows are high: on average in these years a share near 11% of businesses are new each year; conversely almost 10% of firms go bankrupt.

This empirical evidence was accompanied in the last decade public debate by a consensus view about a greater role for small businesses as job creators, pushing policy makers in various countries to study the implementation of policies enhancing the start-up process. It is important then to have a theory of the entrepreneurship determinants as a guide for policy-making processes.

Equilibrium unemployment literature gives the right environment to develop this theory. In fact, among the forces that drive the individual decision of starting-up a new firm, employment opportunities is probably primary. This decision can be modelled as a comparison between expected employment status and entrepreneurship status along life-time horizon. There are several factors that influence employment status of an individual: wage pro-

years	Employers	Employees	Firm births	Firm deaths	Birth rate	Death rate
1989	5021315	91626094	584892	531400	11.65	10.58
1990	5073795	93469275	541141	546518	10.67	10.77
1991	5051025	92307559	544596	521606	10.78	10.33
1992	5095356	92825797	564504	492651	11.08	9.67
1993	5193642	94773913	570587	503563	10.99	9.70
1994	5276964	96721594	594369	497246	11.26	9.42
1995	5369068	100314946	597792	512402	11.13	9.54
1996	5478047	102187297	590644	530003	10.78	9.68
1997	5541918	105299123	589982	540601	10.65	9.75
1998	5579177	108117731	579609	544487	10.39	9.76
1999	5607743	110705661	574300	542831	10.24	9.68
2000	5652544	114064976	585140	553291	10.35	9.79
average	5328383	100201164	576463	526383	10.83	9.89

Table 2.1: Employers, employees, firm births and firm deaths in US

file, unemployment probability, unemployment duration[1].

All these factors can be well analyzed in the equilibrium unemployment framework. Furthermore, inserting the individual choice between entrepreneurship and dependent working can improve this literature in one of its explanatory deficiencies, that is the source of the vacancies. We can summarize this drawback with the following question: who runs the vacancies in models *à la* Mortensen and Pissarides (1994)? Where do these vacancies come from? This question has been answered in some recent works like Fonseca, Lopez-Garcia and Pissarides (2001) or Pissarides (2001) in which entrepreneurs and unemployed are considered as coming from the same pool of individuals and the linkage between start-up decision and labour market is fully explored.

What is still not well studied is the cyclical pattern of startups. In the literature two main points of view have been followed.

The so-called "recession push" school of theories assumes that self-employment, and hence entrepreneurship, is largely an opportunistic choice that individuals are pushed to make, given that high unemployment does not allow an easy finding of an alternative salaried job. As a consequence, periods of high unemployment are also periods of high entrepreneurship. There is

[1]For a survey of the theoretical and empirical literature on the determinants of entrepreneurship, see the companion paper (Curci, 2005).

some empirical evidence about it[2]. Opposite to the "push" hypothesis is the commonly known "entrepreneurial pull" school of thought. According to it, entrepreneurs are individuals with particular skills that motivate them to assume a risky activity. Hence it is natural to assume no relation between entrepreneurship and unemployment. Even a negative relation is possible as it is argued that unfavourable economic conditions make more likely a failure of a new enterprise. Again there is huge empirical evidence supporting this strand of literature. Among others, Audretsch (1995) finds that, for the U.S., in a pooled cross-section estimation, using the number of new firm start-ups in each industry for each year, as the dependent variable, and other cross-sectional or time-varying variables, as regressors, the macroeconomic growth is very significant and positively influencing the start-up process. Then a good overall rate of economic growth is associated with an increase in the number of start-ups.

Hence, there are two opposite conclusions about the effect of business cycles over the start-up process. The former predicts that start-ups are more abundant in recessions, the latter in booms. One of the main finding of this paper is that, at least from a theoretical point of view, procyclicality of start-ups, that is in line with the "pull" school, follows even from opportunistic considerations that lie behind the recession push theories. These opportunistic considerations are about different income sources, such as a salaried job or profits from owned enterprises. In some sense, this is a contribute for a reconciliation between the two schools. In fact, in the model, ingredients from both are present: on one side, the choice between entrepreneurship and start-up is made comparing the present values of the two options (opportunistic view of entrepreneurship); on the other, "entrepreneurial skills", given by the managerial ability of each individuals, drive all the model, being the variable that makes agents heterogeneous.

The model I present builds on the Fonseca, Lopez-Garcia and Pissarides (2001) contribution, which in turn uses more seminal ideas about entrepreneurship, like the Lucas' (1978) "span-of-control" model. In this reference, each individual can decide to start-up her own firm or searching for a job. The key variable is a managerial ability that influences the number of jobs one can manage making positive profits, provided that she chooses to start-

[2]See, for example, Acs, Audretsch and Evans (1994), Alba-Ramirez (1994), Evans and Leighton (1989), Highfield and Smiley (1987)

up. It is proved that the decision follows a reservation rule with good managers becoming entrepreneurs and less able managers becoming dependent workers. In fact, good managers have a higher permanent income from being entrepreneurs than from being unemployed, while for bad managers the reverse is true.

The question tackled in the following comes at this stage: given that in this theoretical model both entrepreneurship's revenue and employment's revenues move along times with business cycles, how does the carrer choice outcome change with changing in cycles? The answer we find is that during booms more people choose entrepreneurship. This may help in explaining a new empirical finding that regards the variability of job creation in startups relative to the corresponding in continuing firms. We find that startups have a much more variable job creation than continuing firms. This fact is exposed in detail in section 2.

Section 3 presents the theoretical model. First, it solves it for the simple case in which output is constant, as in Fonseca, Lopez-Garcia and Pissarides (2001). This model is calibrated to match the US economy average employment and "entrepreneurship" rate. Using this calibration, we conduct a comparative statics excercise that shows that the number of startups increases when the labor productivity goes up. Then, we move to the more interesting case of cyclical match productivity, represented by two values, a high and a low one. We exploit the preceding results to simplify the analysis and find two conditional steady states. At the end, we simulate the dynamics of the model by means of a Markov process that generates movements in productivity. We evaluate standard deviations of the model-generated job creation in startups and in continuing firms and compare them with the empirical values found in section 2. The comparison is quite satisfactory: even in the model the variability of the job creation in startups is much bigger than the variability of the job creation in continuing firms.

Section 4 concludes, giving some intuitions about future works that can improve the explanatory power of the model.

2.2 The empirical analysis

This study was inspired by the analysis of job creation and job destruction rates over time. Total job creation (destruction) at time t is defined as the sum of the employment gains (losses) over all plants that expand (contract) or start-up (shut down) between period $t-1$ and period t. The rate is given dividing this quantity by the average employment in $t-1$ and t. The business cycle properties of total job creation and destruction are well known (see Davis, Haltiwanger and Schuh, 1996). Job destruction is more volatile than job creation and both are far more volatile than employment. Job creation and destruction have negative contemporaneous correlation. Job creation lags reduction in employment and leads future employment and the reverse holds for job destruction.

It is interesting to extend this analysis in order to consider possible different patterns for continuing plants and startups/shutdowns. In order to do that, we use disaggregated quarterly series from the Longitudinal Research Database (LRD henceforth) by the U.S. Bureau of the Census, extensively documented in Davis, Haltiwanger and Schuh (1996). The sample period runs from the second quarter of 1972 to the end of 1993. Total job creation can be splitted in job creation for continuing plants and job creation for start-ups. Total job destruction can be differentiated between job destruction for continuing firms and job destruction for shutdowns. In this paper, only the job creation disaggregation in continuing plants and startups is considered. Consequently the model presented below has exogenous job destruction and exogenous firms exit. Endogenizing job destruction and firms exit, in particular, has been left for future works.

Since the goal is studying cyclical properties of these series, they have been Hodrick -Prescott filtered[3]. This procedure returns data in deviations from their own trend. Hence it does not emphasize the different magnitude that exists between job creation in continuing plants and job creation in start-ups, which is on average around eight times in favour of the former. It should be noticed, however, that for some technical problems in LRD's data the contribution of job creation in startups and job destruction in shutdowns to total job creation and destruction respectively is not completely reliable[4].

[3] As Shimer (2005), we use a large smoothing parameter equal to 10^5

[4] Job creation rate for startups (and job destruction rate for shutdowns) at a quarterly frequence are reconstructed series, in the database elaborated by Davis, Haltiwanger and Schuh from LRD data. In fact, these quarterly series in LRD show a disproportionate concentration in the first quarter of each year. This depends by the methodology used in acquiring data by the Annual Survey Manufactures (ASM). As pointed out in the technical appendix in Davis, Haltiwanger and Schuh (1996), this problem was overcome reallocating part of the first quarter plants' birth and death to previous quarters, using weights that

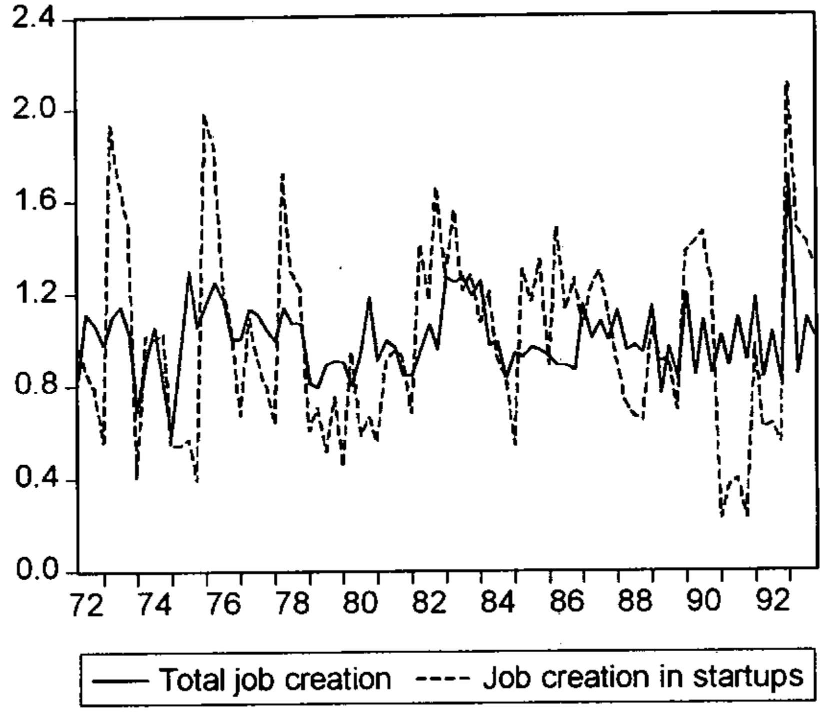

Figure 2.1: Job creation in all firms and in new startups. Data are Hodrick-Prescott filtered.

Nonetheless some important aspects of startups and shutdowns over the business cycle may be pointed out.

In fig. 2.1 two series are reported: total job creation rate and job creation rate in startups, both in detrended format. From a graphical inspection, it looks evident the greater variability of the job creation rate for startups with respect to the total rate, whose predominant part is given by continuing firms. Table 2.2 shows that the series of startups' creation is two times and a half more volatile than the same series for continuing plants.

Variation in total job creation along economic cycles has been studied

reproduce the quarterly patterns exhibited by continuing plants. Hence caution must be used in making conclusion about the contribution of startups and shutdowns to total creation and destruction respectively. Nonetheless, the quarterly time series for startup creation and shutdown destruction are reliable for analysis of the cyclical behaviour of startups and shutdowns.

Variables (x)	SD (%)
JC (continuing)	16.40
JC (startups)	41.36
ratio	2.52

Table 2.2: Standard deviation of job creation in continuing and startup firms. Empirical data (1972-1993)

in classical contribution, like Mortensen and Pissarides (1994) and Cole and Rogerson (1999). Two components affect total job creation during time: the change in the probability of matching and the movement in the stock of unemployed workers. Job creation in startups is moved by these same components as well as by another one: the number of startup firms. In this paper a model in which the number of startups is procyclical will be presented. This further source of procyclicality helps in explaining why job creation in start-ups is much more volatile than job creation in continuing firms.

2.3 The model

The economy is populated by a unit mass continuum of agents, who survive each period with probability $1-\delta$. Each period a fraction δ of new individuals is born. Hence the total population is always of measure 1. The individuals can be either entrepreneurs or workers and decide about their status at the birth. They differ each other for an innate managerial ability, x, that is distributed in the population according to a known distribution, $F(x)$, in the range $[x_0, x_{\max}]$ with $x_0 > 0$ and $x_{\max}$. This ability affects positively the managerial costs of the firm: hence lower xs denote better managers, i.e. individuals that are able to run a firm at a low managerial cost. It should be noted that individual ability does not influence the productivity of the manager or the worker.

The cost of managing α jobs is given by $C(x, \alpha)$, irrespective of whether the jobs are vacant or filled. The relevant conditions on the derivatives of C are the following: $C_x > 0$, $C_a > 0$, $C_{\alpha\alpha} > 0$, $C_{xx} > 0$, $C_{\alpha x} > 0$. These are quite intuitive: managerial costs are increasing in both the managerial ability and the number of managed jobs, with increasing marginal costs. The last condition implies that the cost of the marginal posted jobs is increasing in x, that is, worse managers afford higher costs in running the marginal job than better managers. Better managers, i.e. lower xs, are able to manage the same number of jobs at a lower cost. For computational convenience, we assume the following functional form for the costs:

$$C(x, a) = xg(\alpha)$$

with $g(\alpha) = \gamma\alpha^2/2$. Once created, the posted jobs cannot be destroyed; they simply change their status from vacancies to filled jobs and viceversa. Each posted job terminates only when the corresponding firm exits and this happens at a rate δ, the death rate of the entrepreneur. With infinite horizon, the total management cost paid by an individual x who creates α jobs is $x\gamma\alpha^2/2(r+\delta)$.

In defining how individuals decide about their working status, a backward procedure is used. The first step is to analyze the dimensional decision, that is the decision about the optimal size of the firm. It has to be noticed that this decision is taken once and for all at the startup moment; hence the size of the firm is given by the number of posted jobs at the startup moment and will result depending on managerial ability of potential entrepreneur. Afterwards, the individual chooses her status, given the optimal size of the firm she can afford with her managerial ability.

The optimal number of posted jobs an individual can run is calculated by maximizing the initial expected payoff, given by the benefit of α jobs minus their expected costs. Then the problem that a manager faces is:

$$S(x) = \max_{\alpha} \left\{ \alpha V - \frac{x\gamma\alpha^2}{2(r+\delta)} \right\} \tag{2.1}$$

The FOC for this problem is the following:

$$\frac{x\gamma\alpha(x)}{r+\delta} = V \tag{2.2}$$

It has an intuitive explanation: the manager posts a number of vacancies that equalizes the life-time marginal costs of one more vacancy, reported in left-hand side of the equation, with its marginal revenue, V. We represent

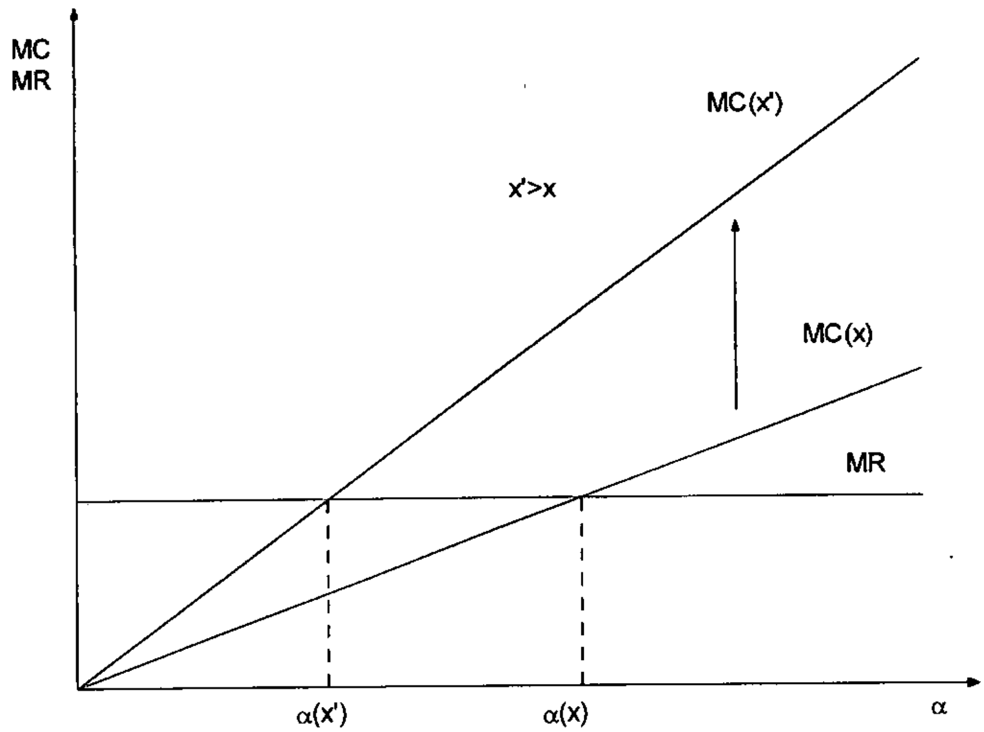

Figure 2.2: The optimal size of the firm for managers x and x'

this problem in fig. 2.2.

The horizontal line is the marginal revenue by each vacancy or the permanent income that each vacancy produces. It does not depend on managerial ability; hence, its position does not change with different individuals. The positively sloped lines are the one-period cost of managing α jobs for each individual x. In particular, two lines are reported: one associated to a manager with ability x, and the other associated to a worse manager with ability x': then $x' > x$. The choice of the optimal size of the managed firm for each individual is made equating marginal costs to marginal revenues. Hence the optimal number of posted jobs for each individual corresponds to the crossing of the two lines. It is evident that the better manager, x, runs the larger firm: the size of the firm is decreasing in x. From this condition the distribution of jobs across the managers is easily derived:

$$\alpha(x) = \frac{(r+\delta)V}{x\gamma} \tag{2.3}$$

Substituting [2.3] in the objective function returns $S(x)$, the optimal value of a start-up, which is a function of the managerial ability:

$$S(x) = \frac{(r+\delta)V^2}{2x\gamma} \tag{2.4}$$

This optimal value is decreasing in x as we should expect. Better managers enjoy a higher value from starting-up a new firm. It is an optimal value in the sense that refers to the optimal size of the firm start-up, run by individual x.

Given this dimensional problem, the individual decision about the working status can be rationalized. This decision obviously depends on the relative advantage of entrepreneurship with respect to unemployment, which represents the initial step towards dependent working. In particular, let's indicate with U the value of being unemployed and hence searching for a job and define with $\pi(x)$ the payoff of a start-up net of the value of unemployment:

$$\pi(x) = S(x) - U(x) = \frac{(r+\delta)V^2}{2x\gamma} - U(x) \tag{2.5}$$

Then the decision is taken according to the following rule. An individual x becomes entrepreneur if $\pi(x) > 0$ otherwise she searches for a job. Our goal is to study the function $\pi(x)$ to establish whether a reservation rule for this problem exist or not.

Unemployed individuals search for a job. With a certain probability they match with an unfilled vacancy. Each match produces an output equal to y. We start considering the simplest case in which this output does not change at all. In this static world, people that decide to search for a job, choosing the dependent working career when they are born, do not have any reason to shift to entrepreneurship after some time. In this simple case, the rule described above is a general one and the decision is once for all. In fact, individuals that start-up their own firm will post immediately the optimal number of vacancies $\alpha(x)$. Of these, some are filled (let's say $n(x)$, that indicates occupation in firm x) and some remain vacant. Of course, the value of a filled vacancy is not lower than the value of a vacant one; hence, after the starting-up period, the overall value of the firm will increase. If an individual have already chosen entrepreneurship, *a fortiori* she will prefer entrepreneurship after some time, when vacancies are filling. In a similar way, if an individual have preferred searching for a job and finally got the job, she will keep on preferring dependent working to entrepreneurship, given that the value of working is higher than the value of unemployment, which was already higher than the value of entrepreneurship. It can be concluded that once a decision about the working status is taken, it is taken forever[5]. All this greatly simplifies the study of function $\pi(x)$, because in this case U is independent of x.

The situation is different when we approach the more complex problem of an economy in which output produced by each match jumps probabilistically between two values, y_l and y_h, with $y_h > y_l$, at a constant rate μ. When this rate μ is positive, individuals are anticipating that economy will be affected by productivity shocks. In this case the value of unemployment does depend on x. There are in fact unemployed individuals which know that, when the economy changes, there can be room for them to become entrepreneur. In other words, when the economic situation improves, there could be unemployed workers that stop searching and start-up their own firm, finding it now more convenient. Hence the decision rule now leads to a different result. There are two different reservation values: one for good states and the other for bad states. The number of entrepreneurs is higher in good state than in bad state, given that the reservation value in the former case is higher than in the latter.

Hence unemployment in this model is a sort of parking status. At the birth individual has two options: to start-up a new firm or to search for a job. Two factors affect the decision: the first is the innate managerial ability, the second is the overall economic situation. For extreme values of the innate managerial ability, the overall economic situation is ininfluent in the decision. Very good managers choose to start-up and very bad managers choose to search, indipendently from the economic situation. For more central values of the ability, the influence of economic situation is much more important: individuals with these central values will become entrepreneurs, if the choice is taken in booms, and dependent workers if the choice is taken in recessions.

[5]See Pissarides (2001)

It should be noted that in this discussion there are fundamental hypotheses about the three possible individual status, which make the problem more tractable.

First of all, entrepreneurship is a life-lasting activity: individual who have chosen entrepreneurship at some point never changes her mind.

Secondly, dependent workers do not voluntarily leave their jobs, unless they are destroyed, which happens only when the entrepreneurs who run those jobs die or when exogenous real shocks hit the matches. In other words people do not leave their job to start-up a new firm. The only individuals that can open a new business are new born or unemployed workers.

Thirdly,e unemployment is always a "parking" status, which means that unemployed individuals are always either looking for a job or waiting for a change in the economic condition to start-up their own business, if they are good enough as managers.

Hence, the main focus of the model is on the flows between unemployment and entrepreneurship. Futher analysis about flows between paid jobs and entrepreneurship is left for future works.

In the following section the constant output case is considered. After that, the analysis focuses on the more complex case of economic cycles.

2.3.1 The constant output case

When the output is constant, the relevant value functions of the problem are easily written. In order to do that, we start to describe the process through which unemployed workers and job vacancies match each other. As usual in this strand of the literature, the matching process is governed by an aggregate matching function, $m(v,u)$, with constant returns to scale. As showed in Pissarides (2000), under this assumption, the key variable of the arrival process is the labour market tightness, $\theta \equiv v/u$, where v denotes the job vacancies and u the unemployed workers, such that: workers arrive to a job at a Poisson rate $q(\theta) \equiv m(v,u)/v$ and jobs arrive to unemployed workers according to a related Poisson rate $\theta q(\theta) \equiv p(\theta) = m(v,u)/u$. The elasticity of $q(\theta)$ is denoted by η and lies in the interval (-1,0); the exposed properties imply that the elasticity of the job finding rate $p(\theta)$ be $1-\eta$. Other usual assumptions are the following:

$$\lim_{\theta\to\infty} q(\theta) = \lim_{\theta\to 0} p(\theta) = 0 \tag{2.6}$$

$$\lim_{\theta\to 0} q(\theta) = \lim_{\theta\to\infty} p(\theta) = \infty \tag{2.7}$$

The model diverges by the usual device that determines the wage paid to the workers. Instead of having a Nash-bargaining rule to split the surplus arising from the match, we assume that the wage is fixed and equal to a fraction β of the output y. This is done to simplify the analysis, especially for the case of cyclical output[6].

Value functions

Given this assumption, the value of a vacancy satisfies the following:

$$(r+\delta)\,V = q\,(\theta)\,(J-V) \tag{2.8}$$

where J is the value of a filled job. With a perfect capital market and infinite horizon, the valuation of the asset V is such that the capital cost $(r+\delta)\,V$ is equal to the rate of return of the asset, $q\,(\theta)\,(J-V)$, assuming for simplicity that the cost of hiring is zero for the firm.

With the same interpretation the value of a filled job reads:

$$(r+\delta)\,J = y(1-\beta) - (\lambda+\delta)(J-V) \tag{2.9}$$

where $y(1-\beta)$ is the operational one period profit that each match earns for the firm, given that βy is the (fixed) wage paid to the worker. The match is destroyed with an exogenous probability $\lambda+\delta$, where λ can be interpreted as a real shock, such as a shift in either tastes or technology that makes no more profitable production, and δ measures the probability of worker's death.

The value functions for the worker follow. Again they do not depend on x, as emphasized above. The value of being unemployed satisfies the following:

$$(r+\delta)\,U = b + p\,(\theta)\,[W-U] \tag{2.10}$$

[6] Pissarides (2001) has a more general model with a Nash-bargaining rule. However, his analysis is limited to the constant output case.

where b is the unemployment benefit and W is the value of being employed, which in turn satisfies:

$$(r+\delta)W = \beta y - (\lambda+\delta)[W-U] \tag{2.11}$$

where the rate of return of the asset W is given by the wage βy minus the loss suffered when the match is destroyed, that again happens at a rate $\lambda+\delta$.

As it is clear, the function $\pi(x)$ in this case is easy to study. In fact, neither V nor U depend on x. Hence, the function is monotonically decreasing in x. Furthermore, $\pi(x_0) > 0$ and $\pi(x_{\max}) < 0$ for values of $x_{\max}$ high enough. Then there exists a value of x, say R, such that individuals with a $x < R$ start up their own firm and individuals with a $x \geq R$ search for a job. In terms of function $\pi(x)$ this reservation rule is expressed as:

$$\begin{aligned} \pi(x) &> 0 \qquad \text{if } x < R \\ \pi(x) &< 0 \qquad \text{if } x \geq R \end{aligned} \tag{2.12}$$

Equilibrium

Let's call E the number of entrepreneurs. Then an equilibrium is defined as a reservation managerial ability R, a value of market tightness θ and distributions of jobs and employments $(\alpha(x), n(x))$ across managers that, given the distribution of abilities $F(x)$, satisfy:

1. the value functions for the firm and the worker, [2.8] - [2.11]
2. the career choice rule, given by [2.12]
3. the FOC of the dimensional problem, [2.2]
4. the equation for the evolution of filled vacancies, n_f:

$$\dot{n}_f = (1-\delta)\left[q(\theta)\left(\int_{x_0}^{R}\alpha(x)\,dF(x) - n_f\right) - \lambda n_f - \delta n_f\right] - \delta\frac{n_f}{E} \tag{2.13}$$

5. the equation for the evolution of employed workers, n_w:

$$\dot{n}_w = (1-\delta)\left[p(\theta)(1-F(R)-n_w) - \lambda n_w - \delta\frac{n_w}{E}\right] - \delta n_w \tag{2.14}$$

Equations [2.13] and [2.14] need some comments. They describe the evolution of employment looking at the matching process from the points of view of the two different parts involved in it: the firms and the workers respectively. Starting with [2.13], the term in square brackets measures the variation of filled vacancies in the market for the fraction of entrepreneurs who survive in that period ($(1-\delta)$ is the survival rate). This variation equals the number of vacant jobs eventually filled, given by $q(\theta)\left(\int_{x_0}^{R}\alpha(x)\,dF(x)-n_f\right)$, minus the matches that are destroyed, either for a real shock, which hits at a rate λ, or for the death of the worker, which happens at a rate δ. The last term considers the expected variation in n_f caused by the entrepreneurs' death: it is given by the probability of the death times the average number of filled jobs managed by each entrepreneur, i.e. n/E. As well, looking at [2.14], the variation in n_w is given by two components: the first is related to the fraction of workers who survive and the second has to do with those who die. The surviving workers contribute to the variation of n_w positively by matching with unfilled vacancies, $p(\theta)(1-F(R)-n_w)$, and negatively with the destruction of operating matches, either for a real shock or for the death of the entrepreneur, which again implies on average a loss of matched workers equal to $\delta n_w/E$. The workers who die cause a negative variation equal to δn_w.

The equilibrium values of θ and R can be calculated using two equilibrium relationships between them. The first one derives directly from [2.5] evaluated at $x=R$ and reads:

$$R(\theta)=\frac{(r+\delta)V(\theta)^2}{2\gamma U(\theta)} \tag{2.15}$$

Given our assumptions about the matching fucntion, $q'(\theta)<0$ and $p'(\theta)>0$: then $V'(\theta)<0$ and $U'(\theta)>0$ and hence the curve [2.15] is negatively sloped in the (R,θ) space: if the job market is tighter, unemployed workers will find it easier to meet a vacancy while entrepreneurs will experience difficulties in finding workers for their vacancies; hence more individuals will choose a career as dependent workers *ceteris paribus*. We refer to this curve as 'entreprenurship'. The limits to this curve are calculated as follows. When $\theta=0$, the value functions [2.8] and [2.9], together with the conditions to the limit of $q(\theta)$ and $p(\theta)$ stated in [2.6] and [2.7], imply that $(r+\delta)V=y(1-\beta)$ and $(r+\delta)U=b$. Then the maximum feasible value of R is given by $y^2(1-\beta)^2/2\gamma b$. It also follows from [2.1] and [2.5] that for any choice of $\alpha(x)$, in a feasible equilibrium $\alpha(x)V(\theta) \geq U(\theta) + \frac{x\gamma\alpha(x)^2}{2(r+\delta)} > 0$. Defining $\widetilde{\theta}$ by $V\left(\widetilde{\theta}\right) = 0$ and θ_0 by $\alpha(x_0)V(\theta_0) = U(\theta_0) + \frac{x_0\gamma\alpha(x_0)^2}{2(r+\delta)}$, equilibrium is non-trivial only for values of θ such that $\theta \leq \theta_0 < \widetilde{\theta}$. Notice that $\widetilde{\theta}$ is the equilibrium value of the market tightness in models *à la* Pissarides (2000), which derive the demand for labor from a zero-profit condition on the value of a new vacancy. Instead θ_0 is a value of the market tightness at which finding a new worker is so difficult that only the best manager (that with ability x_0) will choose to become entrepreneur.

The second equilibrium relationship can be derived by evaluating equation [2.13] and [2.14] at the steady state and imposing the equality between the two steady state values. The steady state value of the filled vacancies is:

$$\overline{n}_f = \frac{(1-\delta)q(\theta)}{(1-\delta)(q(\theta)+\lambda+\delta)+\delta/E}\int_{x_0}^{R}\alpha(x)\,dF(x)$$

As well, the steady state value of the employed workers reads:

$$\overline{n}_w = \frac{(1-\delta)p(\theta)}{(1-\delta)(p(\theta)+\lambda+\delta/E)+\delta}(1-F(R))$$

To close the model, we have to impose $\overline{n}_f = \overline{n}_w \equiv \overline{n}$, that is in equilibrium the number of filled vacancies must be equal to the number of employed workers. This condition yields our second equilibrium relationship:

$$\frac{(1-\delta)(p(\theta)+\theta\lambda+\theta\delta)+\theta\delta/E}{(1-\delta)(p(\theta)+\lambda+\delta/E)+\delta} = \frac{\int_{x_0}^{R}\alpha(x)\,dF(x)}{(1-F(R))} \tag{2.16}$$

To study this relationship, it has to be noticed that $\alpha(x)$ is a positive function of $V(\theta)$ (see eq. [2.3]): then $\partial\alpha(x)/\partial\theta < 0$. Then total differentiation of [2.16] gives $d\theta/dR > 0$: more individuals choose entrepreneurship (and less employment), more jobs are created for each job seeker, then θ must be higher. We refer to this curve in the (R,θ) space as 'job creation'.

The equilibrium solution is now straightforward to obtain. In fact, R and θ are given by the intersection of the two curves 'entreprenurship' and 'job creation': these values are unique. Knowing θ, it is possible to calculate V and then $\alpha(x)$ for each firm x. At this point it is easy to find the equilibrium value of n and of the unemployment as well, given that each individual can be entrepreneur, employed or unemployed and so $F(R) + n + u = 1$.

Calibration

In order to test the implication of the model, we pursue a calibration strategy, so that the static model could match the observed aggregates of the US economy. We suppose that $F(x)$ is uniform over the interval $[x_0, x_{\max}]$. Furthermore, we need a functional form for the matching function: as standard in the literature, we impose a Cobb-Douglas specification, with constant returns to scale: so $q(\theta) = A\theta^{-\eta}$ and $p(\theta) = A\theta^{1-\eta}$.

Hence there are 11 parameters in the model: δ, λ, r, β, y, b, η, A, γ, x_0, $x_{\max}$. We choose to fix some of them to values that are quite standard in the literature: r is fixed to 0.01 which reflects historical US values. Not having better informations, we set the wages to a half of the output per match: so $\beta = .5$. As a convention y is fixed at the unity, while the value of ratio b is fixed at 0.2, so that the benefit replacement ratio is at 40%. Looking at historical data about population dynamics, a value of δ equal to 0.0022 is deducted: in years 1989-2000[7] that was the average death rate per quarter and we impose the same value for the birth rate. Then we fix the exogenous job destruction rate λ to 0.1, a value that is normally used in the literature, following Abowd and Zellner's (1985) corrected worker flows data. We are left with the parameters of the matching function, the parameter of the managing cost function and the support of $F(x)$.

We choose to fix the elasticity of the rate at which a firm meets a worker, η, to the value of 0.5, that is typical even in the empirical literature[8]. At the same time, we set x_0 at the very small but positive value 0.00001: changing this choice does not affect in any way the property of the model, but only the calibrated value of $x_{\max}$.. Then we calibrate the other three parameters, A, γ and $x_{\max}$, in order to match three empirical average values: the employed to population and the employers to population ratios and the monthly value of job market tightness (the ratio between vacancies and unemployed). On average, between 1988 and 2001, the annual employment (to population) rate in US was 63% while the annual employers to population ratio was 2.7% over the same period. Notice that this last ratio can be interpreted

[7]Source: Department of Health and Human Services, National Center for Health Statistics; National Vital Statistics Reports, vol. 52, no. 3, Sept. 18, 2003

[8]see Petrongolo and Pissarides (2001)

as an "entrepreneurship rate"[9], that is the share of the population who has some dependent workers to manage. The job market tightness was at an average of 0.3702 on a monthly basis between december 2000 and september 2005[10]. Table 2.3 summarizes our choices about the parameters: the results of the calibration for this "static" model will be used in the next section to perform a simulation of the dynamic version of the model.

Parameters	Meaning	Value	Explanation
r	discount rate	0.01	Historical US value
β	wage share of output	0.5	Lack of better information
y	output per matching	1	Normalization
b	value of leisure	0.2	Benefit replacement ratio 40%
δ	birth and death pop rate	0.0022	Historical quart. rate (1989-00)
λ	matching separation rate	0.01	Abowd and Zellner (1985)
η	matching function elastic.	0.5	Petrongolo and Pissarides (2001)
x_0	l. support of the man. ability dist.	0.00001	Discretionary choice
Calibrated parameters			
$x_{\max}$	u. support of the man. ability dist.	1096.2	"Entrepreneurship" rate at 2.68%
A	matching function parameter	0.30842	Job market tightness at 0.3702
γ	managing cost function parameter	0.007323	Employment rate at 63%

Table 2.3: Parameter choices

At the end of this section, a comparative static exercise may be conducted, in order to understand how the model works. We can ask ourselves what happens to the aggregate values of employees, unemployed workers and employers when output y increases? Studying the effect of a change in y over our two curves is not easy: then we make use of our choices for the parameters in order to evaluate how an increase in y affects the equilibrium values of the stocks of unemployed, employees and employers. We find that an increase of 1% of the match productivity y in equilibrium implies an increase of 0.12% of the "entrepreneurship rate", while the employment rate moves up by 0.67%: as a consequence the unemployment rate shrinks by 0.79%. While these results appear strong, it has to be reminded that in the model not-employers individuals are either employed or unemployed. Hence

[9] Data for employers are from US Census Bureau (Statistics of US Business) and refer to only private sector. Instead the employment rate is from US Bureau of Labor Statistics (Current Employment Statistics)

[10] To calculate the ratio between vacancies and unemployed, we make use of the Job Openings and Labor Turnover data about the vacancy level (that are available only for the indicated period).

the stock of unemployed workers contains also those workers that in the real world are out of the labor force. Then the variation of the unemployment rate in the model should be taken with caution.

For the analysis of the next section, our exercise is very useful: in fact, it emphasizes that an increase in y shifts the reservation managerial ability up. This will be important to write the value functions for the case of economic cycles.

2.3.2 The case of economic cycles

In this section a simulation exercise is conducted in order to assess wheter the model is able to explain the higher variability of job creation in startups with respect to job creation in continuing firms. The economy is assumed to jump probabilistically between two states: a good state and a bad state. The shock governing this process is assumed to follow a symmetric two-state Markov chain, in which μ is the probability of changing the state and $1-\mu$ is the probability of remaining in the same state for two consecutive periods. The only difference between the two states is the match productivity: it jumps between y_l and y_h with $y_h > y_l$. No other parameters of the model move. The influence of the changing output over the structure of the model is strong, since now the distribution of posted jobs, [2.3], the optimal value of a start-up, $S(x)$, and the net value of entrepreneurship, $\pi(x)$, all depend on the state of the economy because the relevant value functions, which will be presented shortly, depend on it. This dependence is indicated with a subscripted index.

At the end of the preceding section, we found that the number of entrepreneurs in steady state is higher in periods of a booming economy than in periods of recessions. Hence the reservation value of x, i.e. the value of managerial ability such that people choose entrepreneurship, is lower during periods of low activity than during periods of high activity. Figure 2.3 depicts the partition of $F(x)$ that follows from this result.

Individuals who are born with a x lower than R_l are entrepreneurs and individuals who are born with a x higher than R_h are dependent workers (either unemployed or employed). Individuals with a x between R_l and R_h chooses entrepreneurship if the decision is taken in booms and searching for a job if the decision is taken in recessions. The existence of this region in the ability distribution grants the procyclicality of start-ups and the higher

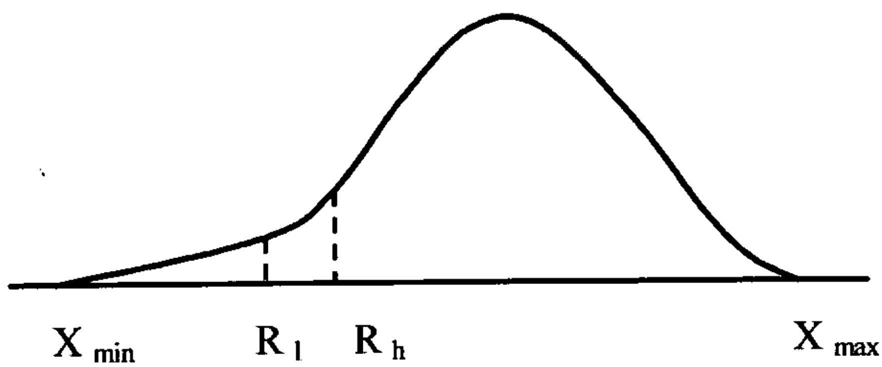

Figure 2.3: The partition of the population between workers and entrepreneurs.

variability of the job creation process in them with respect to the case of continuing firms.

Value functions

The value functions have to take into account the jumping in the value of output. There will be different values for different states, that will be denoted by the subscripts h and l, for an upturn and a downturn respectively. The value of a vacancy, in booms and recessions respectively, reads:

$$(r+\delta)\,V_h = q\,(\theta_h)\,(J_h - V_h) + \mu(V_l - V_h) \tag{2.17}$$

$$(r+\delta)\,V_l = q\,(\theta_l)\,(J_l - V_l) + \mu(V_h - V_l) \tag{2.18}$$

The main difference now is that the rate of return on asset V_h depends on V_l and vice versa because the economic situation is anticipated to change at a rate μ. It has to be emphasized that, as before, V_i $(i = h, l)$ is independent of x. In other words, once posted, a vacancy cannot be destroyed, because individuals who became entrepreneurs do not have the chance of changing their status: the destruction happens only when the employer dies. The only persons who have the option of choosing between a dependent working life and entrepreneurship are newborn people. At the same time paid workers are not allowed to leave their job and open up their own firm. Hence J_i are also independent of x:

$$(r+\delta)\,J_h = y_h(1-\beta) - (\lambda+\delta)\,(J_h - V_h) + \mu(J_l - J_h) \tag{2.19}$$

$$(r+\delta)\,J_l = y_l(1-\beta) - (\lambda+\delta)\,(J_l - V_l) + \mu(J_h - J_l) \tag{2.20}$$

The main complication with respect to the constant output case relies on the value of unemployment. In fact, when output jumps, it could be that an individual who were searching for a job now find it more convenient to start up a new firm. When a positive shock to productivity hits, the individual has an option: either she continues in searching taking the new value of it, $U_l\,(x)$, or she starts-up a new firm, gaining a new value, $S_l\,(x)$. She chooses according to the relative magnitudes of the two values which are functions of x. Then the value equations for unemployment read:

$$(r+\delta)\,U_h(x) = b + p\,(\theta_h)\,[W_h(x) - U_h(x)] + \mu\,[\max\{S_l\,(x)\,, U_l(x)\} - U_h(x)] \tag{2.21}$$

$$(r+\delta)\,U_l(x) = b + p\,(\theta_l)\,[W_l(x) - U_l(x)] + \mu\,[\max\{S_h\,(x)\,, U_h(x)\} - U_l(x)] \tag{2.22}$$

At this point we use the main finding of the steady-state analysis, i.e. that $R_h > R_l$. A main implication of this result is that individuals who are unemployed in good state will remain unemployed in bad state as well; on the other side, individuals who are unemployed in bad state, with a managerial ability belonging to the interval (R_l, R_h), in the case that they had not found a job, will change their status when economy recoveries, opening up their own firm. Hence we can write again the two value functions above:

$$(r+\delta)\,U_h(x) = b + p\,(\theta_h)\,[W_h(x) - U_h(x)] + \mu\,[U_l(x) - U_h(x)]\ , \qquad x \geqq R_h \tag{2.23}$$

$$(r+\delta)\,U_l(x) = b + p\,(\theta_l)\,[W_l(x) - U_l(x)] + \mu\,[U_h(x) - U_l(x)]\ , \qquad x \geqq R_h \tag{2.24}$$

$$(r+\delta)\,U_l(x) = b + p\,(\theta_l)\,[W_l(x) - U_l(x)] + \mu\,[S_h\,(x) - U_l(x)]\ , \qquad R_l \leqq x \leqq R_h \tag{2.25}$$

The value of employment W depends on x, given that, in turn, it depends on $U\,(x)$. As emphasized above, we are imposing that no employed worker changes her status becoming entrepreneur when the economic situation changes. The only reason for a match-breaking is then exogenous job desctruction given by the parameter $\lambda + \delta$. Hence when the productivity shock hits, the only option available is to remain employed with the new value of employment:

$$(r+\delta) W_h(x) = \beta y_h - (\lambda + \delta) [W_h(x) - U_h(x)] + \mu [W_l(x) - W_h(x)] \quad (2.26)$$

$$(r+\delta) W_l(x) = \beta y_l - (\lambda + \delta) [W_l(x) - U_l(x)] + \mu [W_h(x) - W_l(x)] \quad (2.27)$$

Instead of solving analytically the model, we use the calibrated parameters of the static version to find a numerical solution for the relevant variables R_i and θ_i for $i = h, l$. The calculations involved are similar to those of the simpler case: in fact, we are assuming that employment, unemployment, the total number of jobs (filled and vacancies) fluctuate around *two conditional steady state* values, i.e. two values that reproduce themselves at the condition that the aggregate shock is repeatedly the same. In other words, a conditional steady state is defined as the value that a variable reaches if the aggregate shock takes on the same value repeatedly. This concept of steady state is mutuated by Cole and Rogerson (1999). Then we have to write the law of motions for the two different states, having in mind that the total population remains constant, i.e. $1 = n_i + u_i + F(R_i)$ for $i = h, l$ with $F(R_i)$ representing the measure of the employers. As in the constant output case, we write the law of motion of the filled vacancies, n_{fi}, and the law of motion of the employed workers, n_{wi}:

$$\dot{n}_{fi} = (1-\delta) \left[q(\theta_i) \left(\int_{x_0}^{R_i} \alpha_i(x)\, dF(x) - n_{fi} \right) - \lambda n_{fi} - \delta n_{fi} \right] - \delta \frac{n_{fi}}{E_i}$$

$$\dot{n}_{wi} = (1-\delta) \left[p(\theta_i) (1 - F(R_i) - n_{wi}) - \lambda n_{wi} - \delta \frac{n_{wi}}{E_i} \right] - \delta n_{wi}$$

From these two equations, we can calculate the two steady state values, $\overline{n}_{fi}$ and $\overline{n}_{wi}$. The equilibrium condition, $\overline{n}_{fi} = \overline{n}_{wi}$, can be used to find the equilibrium relationships between (R_i, θ_i) corresponding to the "job creation" curve of the constant output case. The other equilibrium relationship is similar as before:

$$R_i(\theta_i) = \frac{(r+\delta) V_i(\theta_i)^2}{2\gamma U_i(R_i, \theta_i)}$$

Solving numerically the model and assuming a high persistence of the process governing y ($\mu = 0.0262$), we find that for a value of y_h higher than that of y_l by 1%, the entrepreneurship rate in good state is higher by 0.33% while the employment rate is higher by 0.17%. With respect to the comparative static exercise exposed in the preceding section, this result shows that in equilibrium the entrepreneurship rate reacts more while the employment rate less than the constant output case. This effect is due to the anticipation of the change in match productivity by agents.

Simulation

With the values of $F(R_i)$ and n_i, we are now ready to simulate the dynamics of the economy. We assume a discrete time and create an artificial economy of 1000 periods, using a Markov chain to simulate the value of y in each period. The match productivity y is assumed to follow a first-order autoregressive process.Its mean is normalized to unity: then we use data on real output per hour in the non-farm business sector[11], to quantify the instantaneous stardard deviation and persistence of this variable. This translates into a two state Markov process for y, with values 1.0017 an 0.9983. The aggregate shock hits according to a Poisson process with arrival rate, μ, equal to 0.0262 per quarter.

In order to simulate the job creation rate, we need to write down the law of motion of the employment rate, n_t, the entrepreneurship rate, en_t, and the total number of managed jobs (sum of vacancies and filled jobs), denoted by tj_t. We are assuming that at the end of each period individuals die and are substituted by newborn ones, so that the total population remains constant. Another assumption is that any event that hits the economy follows a Poisson process. In this case the employment rate follows this law of motion:

$$n_t = e^{-\delta}\left(n_{t-1} - (1-e^{-\lambda})n_{t-1} - \left(1-e^{-\delta}\right)\frac{n_{t-1}}{E_{t-1}} + (1-e^{-p(\theta_t)})\left(1-n_{t-1}-F\left(R_{t-1}\right)\right)\right)$$

This is the analogous in discrete time of [2.14]. Now define some new variables:

$$\begin{aligned} \chi_c &= 1 \qquad \text{if } y_t = y_{t-1} \\ &= 0 \qquad \text{otherwise} \end{aligned}$$

[11] see Bureau of Labor Statistics *Major Sector Productivity and Costs* program

$$\begin{aligned}\chi_{hl} &= 1 && \text{if } y_t < y_{t-1} \\ &= 0 && \text{otherwise}\end{aligned}$$

$$\begin{aligned}\chi_{lh} &= 1 && \text{if } y_t > y_{t-1} \\ &= 0 && \text{otherwise}\end{aligned}$$

Thus χ_c is a function that indicates a period of constant productivity; χ_{hl} and χ_{lh} denote periods of shrinking and booming productivity respectively. Making use of these variables, we can write the law of motion for the entrepreneurship rate:

$$\begin{aligned} en_t &= e^{-\delta}(en_{t-1}) + \left(1-e^{-\delta}\right)(\chi_c en_{t-1} + \chi_{hl} en_l) + \\ &+\chi_{lh}\left[\left(1-e^{-\delta}\right)en_l + e^{-\delta}\left(F(R_h) - F\left(R_l\right)\right)\left(1-F\left(R_{t-1}\right) - n_{t-1}\right)\right] \end{aligned}$$

where the subscript l denotes the conditional steady state value for en in recessions. In period t, the number of entrepreneurs is given by the previous period value discounted by the death rate of individuals, plus the newborn individuals who choose entrepreneurship. The number of new entrepreneurs is equal to the previous period if the output is constant; it is en_l, if there is a recession; while if there is a boom, it is equal to the bad state level plus the fraction of unemployed who survived and had a managerial ability into the interval (R_l, R_h),because those with that managerial ability are dependent workers if they choose in bad times, but will be entrepreneurs if they they choose in good times. Consequently the law of motion of total managed jobs reads as follows:

$$\begin{aligned} tj_t &= e^{-\delta}tj_{t-1} + \left(1-e^{-\delta}\right)(\chi_c tj_{t-1} + \chi_{hl} tj_l) + \\ &+\chi_{lh}\left(\left(1-e^{-\delta}\right)\int_{x0}^{R_l}\alpha_h(x)\,dF(x) + e^{-\delta}\left(1-F\left(R_{t-1}\right)-n_{t-1}\right)\int_{R_l}^{R_h}\alpha_h(x)\,dF(x)\right) \end{aligned}$$

The total managed jobs at time t are given by those jobs managed by survived entrepreneurs (the first term) plus the total jobs (vacancies in this case) posted by newborn entrepreneurs (the other terms). These last amount to the same quantity of jobs destroyed for the entrepreneurs' death if productivity is constant; it goes down to tj_l if productivity is at a low level; it jumps up in case of growing productivity by an amount equal to the sum of the optimal posted jobs by employers with ability $[x_0, R_l)$ and the optimal posted jobs by previous survived unemployed who become now entrepreneurs, which have managerial ability in the range $[R_l, R_h)$. Notice that those "marginal" employers run also firms of small size on average. Their presence is however important to grant the higher variability of job creation for startups.

At this point we are able to write down the job creation rates in the two categories of firm, continuing and startups. Job creation in continuing firms, jcc, is given by:

$$jcc_t = \left(1 - e^{-q(\theta_t)}\right)(tj_t - n_t)$$

It amounts to the number of vacancies that match with workers with probability $1 - e^{-q(\theta_t)}$. On the contrary, job creation in startups, jcs, depends on the number of newborn entrepreneurs. Using the law of motion for tj_t and considering that the total managed jobs in startups are given by $tj_t - e^{-\delta}tj_{t-1}$, job creation in startups reads as follows:

$$jcs_t = \left(1 - e^{-q(\theta_t)}\right)\left(tj_t - e^{-\delta}tj_{t-1}\right)$$

To obtain the standard deviations of job creation in continuing and startup firms, we simulate the model for 1000 periods, discard the first 200 observations and then filter the series consisting of 800 observations. We repeat the experiment 500 times and compute averages for the 500 samples. We eliminate the first 200 observations to minimize the potential effect of initial conditions.

The results are summarized in table 2.4, in the second column.

Variables (x)	SD (%) base simulation	alternative simulation
JC (continuing)	0.10	0.72
JC (startups)	0.14	1.51
ratio	1.33	2.09

Table 2.4: Standard deviation of job creation in continuing and startup firms. Model-generated data.

Then the model is able to replicate the more variable job creation in startups than in continuing firms. On average job creation in startups is 33% more variable than job creation in continuing firms. This result is lower than the corresponding result for empirical observations. At the same time the two simulated standard deviations are much lower than the empirical ones. However the simulation excercise is based over a process for the match productivity that is consistently less variable than empirical data. In fact, while the empirical standard deviation of the labor productivity between 1992 and 2003 is equal to 0.017, the simulated y series has a standard deviation that is ten times lower. This may well explain both the lower standard deviations of both series and the lower ratio between the two with respect to the empirical results.

In order to show how the variability of the match productivity influences the result, we replicate the experiment with different values for the parameters of the Markov process generating y. In particular, the persistence of the process is lowered so that μ is now set equal to .05 while y now jumps between .9828 and 1.0172. This process generates a simulated series for y that has a standard deviation equal to 0.017, the value observed in data. In the third column of table 4, we show the results. Now the standard deviations are higher than before: the job creation in startups is more than ten times more variable than before, while the job creation in continuing firms is seven times more variable. For our goal, more important is the ratio between the two standard deviations: now the standard deviation of job creation in startups is more than twice the standard deviation of job creation in continuing firms. This substantially confirms that our model is able to replicate the empirical fact emphasized in the first section of the paper.

2.4 Conclusion

Empirical analysis of job creation flows disaggregated between continuing firms and startups suggests that variability over time is much higher in the latter than in the former. Then there must be an additional source of variability affecting job creation in startups along business cycles beyond to sources like congestion externalities operating in continuing firms.

The paper presents a theoretical contribution in explaining this fact. The additional source of variability is given by the fact that people who enter labour age or are unemployed always have the option of choosing between searching for a job and entrepreneurship. Changes in economic situation, given by the sequence of economic upturns and downturns, create different incentives for this option to be used by these people: this is the main source of variability of the job creation in startups. The model is calibrated to match empirical aggregates of US economy. With this calibration, we are able to show a simulation of the economy that replicate well the empirical bigger variability of job creation in startups. Then over business cycle the variability of job creation in startups is much higher than the variability of job creation in continuing firms, because the number of startups is by itself variable over time.

The model has room for further analysis. First of all, it gives some testable predictions about start-ups in business cycles, like the fact that firms starting in booms have a lower average size than firms starting in recessions. Furthermore, it can be interesting attributing firm creation option to occupied worker as well. This could influence the wage structure in equilibrium, once you allow a wage bargaining process, overcoming the restrictive hypothesis that wages are a fixed proportion of match productivity.

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Part III

The Theoretical and Empirical Literature about the NAIRU: a Brief Survey

Chapter 3

The Theoretical and Empirical Literature about the NAIRU: a Brief Survey

Nicola Curci
Bocconi University, Milan

Abstract

In the last decade, the Non-Accelerating Inflation Rate of Unemployment, known with the acronym of NAIRU, became more and more popular in US public debates about the conduction of economic policies. In this paper, I review the main theoretical framework in which this concept arises: that of good markets with monopolistic competition and labour markets with frictions. The theoretical setup helps in specifying a testable model, using which the main empirical contributions have found out an estimate of the NAIRU. A review of these empirical works follows, organized around the three most used methodologies: the structural methods, the pure statistical methods and the reduced-form approach. Finally a flavour of the NAIRU's policy use is given in the conclusion.

3.1 Introduction

Since 1950s and 1960s among the most famous concepts in economics, the Non-Accelerating Inflation Rate of Unemployment (henceforth NAIRU) became more and more popular even in the street man's perception, at least in US. The reason of this success is at least threefold, as Stiglitz (1997) emphasizes. First, it gives a good theoretical explanation of inflation, given it can be inserted in a broadly accepted setup with imperfect competition in good markets and presence of frictions in labour markets. Second, it is empirically useful to predict future inflation, in a very clear way. Third, it has properties that allow to use it as a general guideline for thinking and moving macroeconomic policies.

The story behind the NAIRU says how the economy behaves out of the equilibrium. When actual unemployment rate is below the NAIRU, workers are asking for real wages higher than those that firms are willing to pay (given prices and price expectations). This started a wage-price spiral in which both workers and firms see their respective desires not fulfilled. Consequently, inflation will be higher than price expectations, and, since inflation today is a good proxy for inflation tomorrow, inflation starts rising up to the point when expectations are fulfilled. This will happen only when unemployment reaches the NAIRU level. In other words, inflation is always a consequence of labour market disequilibrium, measured by the unemployment rate.

In this survey, I review this story in details. I present classical theoretical results, well explained by the very important book by Layard et al. (1991). I also consider the "hysteresis" approach to the unemployment rate, which can be viewed as a possible alternative setup, but in practice is used more as a way of integrating the "othodox" model without hysteresis. This will be done in section 1.

Then I review the empirical literature about the NAIRU, its successes and defects. Measuring the NAIRU is assuming more and more relevance, even thanks to its prominence in public debates. Measures of the NAIRU are becoming more and more sofisticated, allowing also to estimate a time-varying NAIRU, that was the main improvement of the last years' empirical literature on the subject.

Finally, in the conclusion, I will spend some words in explaining the policy use of NAIRU, looking at different situations in which it can act as guidance for policymakers.

3.2 The theoretical background

The more broadly accepted framework for the macroeconomic relation between wages, prices and employment is very clearly presented in Layard et al. (1991). We now present this setup in detail.

3.2.1 The firm

The economy is populated by many identical firms, that face a technology of the following form:

$$y_i - k_i = \alpha(n_i - k_i) + \varepsilon_i \tag{3.1}$$

Lower-case letters denote logarithms, y_i is the value added output, k_i is the capital stock, n_i is the firm's employment and ε_i stands for a technology shock. Since firms are identical, aggregation is very obvious:

$$y - k = \alpha(n - k) + \varepsilon \tag{3.2}$$

COnsidering now the demand side, let's define $\overline{y}$ as the level of output corresponding to the full utilization of resources:

$$\overline{y} - k = \alpha(l - k) \tag{3.3}$$

where l is the labour force, assumed constant for simplicity. As in a standard IS-LM model, the level of aggregate demand can be defined by the following equation:

$$y_d = \sigma_1 x + \sigma_2(m - p) \tag{3.4}$$

in which x is a measure of the fiscal stance, m is the money stock and p is the value added price. As firms are identical, if f is the log of the number of firms, demand for each is thus $y_d - f$. Then we can specify the demand curve that each firm faces:

$$y_{di} = -\eta(p_i - p) + y_d - f \tag{3.5}$$

where p_i is the price of the firm's output and η is the elasticity of demand. This demand curve can be theoretically derived as in the Dixit and Stiglitz (1977) model.

The decisions' timing is as follows: prices are set at the beginning of the period on the basis of expectations about future demand and costs; during the period, wages, output and employment are chosen. Output is completely driven by demand and then employment is derived by the production function. This timing allows some nominal inertia, without further complicating the setup. Obviously, the hypothesis that output reflects completely the demand is very strong, implicating no role for inventories or rationings. But, as long as we recognize the possibility of sharp increases in prices when full capacity is reached, the hypothesis is more innocuous when one aims at explaining unemployment and permits to meet a "real word" fact, that the majority of firms set prices and are willing to supply more output when demand increases.

Turning to the pricing behaviour of the firms, firms plan output and set prices in order to maximize their profits. Given [3.5], the planned output and the output price must satisfy:

$$y_i^p = -\eta(p_i - p^e) + y_d^e - f \tag{3.6}$$

with the superscript e denoting expectations. Expected marginal costs at this planned level of output can be expressed in this general way:

$$mc_i^e = w_i^e + b_2(y_i^p - k_i) + const. \tag{3.7}$$

where w_i^e is the expected labour costs per employee (including taxes). With constant returns to scale, b_2 must be non-negative. The price that maximizes output is then:

$$p_i = \log\left(\frac{\eta}{\eta - 1}\right) + mc_i^e \tag{3.8}$$

that is the usual markup of the prices over marginal costs. Here Layard et al. (1991) pointed out that markup may actually vary with demand[1].

[1]Cyclical movements in markup are suggested by many authors. For example, Bils (1989) suggests that when customers are very attached to the firms, firms tend to lower prices during the booms, in order to attract customers, thus reducing the markup. Similar arguments are used by Stiglitz (1984) and Ball and Romer (1990). Rotemberg and Saloner (1986) argue that collusion is more difficult during booms since undercutting is more

Making this consideration explicit gives

$$\log\left(\frac{\eta}{\eta-1}\right) = const. - b_1(y_d^e - \overline{y}) \tag{3.9}$$

Substituting [3.7] and [3.9] into [3.8] enables us to write the price equation:

$$p_i - w_i^e = b_0 - b_1(y_d^e - \overline{y}) + b_2(y_i^p - k_i) \tag{3.10}$$

Finally actual output is determined by ex post demand, that is,

$$y_i = -\eta(p_i - p) + y_d - f \tag{3.11}$$

and employment is then determined by equation [3.1].

Thus equations [3.1], [3.6], [3.10] and [3.11] completely describe the behaviour of the firms about prices, output and employment.

3.2.2 Determination of the wages

In order to close the model, we need to specify how wages are set. Layard et al. (1991) proposed a combination of "insider" factors and "outsider" factors in explaining wage formation.

Focusing first on the "insider" element, if firms expect to pay a wage w_i^e, then equation [3.10] gives the relationship between expected product wages and planned output. If planned employment, n_i^p, is defined as the level of employment needed to produce the planned output (i.e. $y_i^p - k_i = \alpha(n_i^p - k_i)$), then expected product wage and planned employment are related by:

$$p_i - w_i^e = b_0 - b_1(y_d^e - \overline{y}) + b_2\alpha(n_i^p - k_i) \tag{3.12}$$

If insiders are only concerned with raising wages up to the point at which their jobs are at risk, we can use equation [3.10] to define the "insider" wage, w_i^I:

$$w_i^I = p_i - b'_{0I} - b_2\alpha(n_{Ii} - k_i) \tag{3.13}$$

where n_{Ii} is the number of insiders and $b'_{0I} = b_0 - b_1(\overline{y}_d - \overline{y})$. Then this can be considered a sort of average wage at which firm's employment is stabilized. If there is a share of insiders that quits every period and denoting

attractive: again markup is countercyclical.

this share with δ, we have that the number of insiders is $n_{Ii} = n_{i,-1} - \delta$. Then substituting this into [3.13] yields:

$$w_i^I = p_i - b_{0I} + b_2\alpha(k_i - n_{i,-1}) \tag{3.14}$$

where $b_{0I} = b'_{0I} - b_2\alpha\delta$. Hence there is a negative relationship between the insider wage and the last period employment, because the more employees are party to the wage bargain, the less pressure may be exerted without risks of job losses.

However, even outsiders' consideration is important in determining the level of wages, because firms are constrained by the necessity to recruit, retain and motivate its workforce. Then it is important to define an "outsider" wage that depends on the general level of wage around, the disposability of employable labour force and other factors that determine the attractiveness of the unemployment status:

$$w_i^o = w^e + c_0 - c_1u - c_2\Delta u + c_3\widehat{z}_w \tag{3.15}$$

where u is the aggregate unemployment rate, Δu is the change in unemployment rate and $\widehat{z}_w$ are factors like the generosity and the coverage of unemployment benefits, that affects the attractiveness of the unemployment status. We have the change in unemployment, other than the level, to capture the fact that when unemployment is rising the competition for jobs is higher and then wages are lower, since more recent unemployed are both more active and more attractive for the firms than longer-term unemployed.

We suppose that the actual wage outcome of the bargaining is a weighted sum of the insider and outsider wages, with weight λ[2]:

$$\begin{aligned} w_i &= \lambda\left[p_i - b_{0I} - b_2\alpha(k_i - n_{i,-1})\right] \\ &\quad + (1-\lambda)\left[w^e + c_0 - c_1u - c_2\Delta u + c_3\widehat{z}_w\right] + \widehat{z}_{1w} \end{aligned} \tag{3.16}$$

There is just one more factor to be explained, $\widehat{z}_{1w}$. This can reflect a more powerful union that can affect positively the bargained wage in firm i; or the effect of changes in the tax wedge existing between the product wage and the consumption wage, that can cause a reaction by employees against any

[2] Layard et al. (1991) in chapter 4 emphasized that λ usually varies between 0 and 0.3 across different countries.

reduction in their living standards, thus leading to more wage pressures.

3.2.3 The aggregate economy

Since firms are identical and labour force is constant, aggregation is easy. We have the following system of equations, describing the aggregate economy:

$$y - k = \alpha(n-k) + \varepsilon \tag{3.17}$$

$$\overline{y} - k = \alpha(l-k) \tag{3.18}$$

$$y = y_d \tag{3.19}$$

$$y^p = -\eta(p-p^e) + y_d^e \tag{3.20}$$

$$y_d = \sigma_1 x + \sigma_2(m-p) \tag{3.21}$$

$$y_d^e = \sigma_1 x^e + \sigma_2(m^e - p^e) \tag{3.22}$$

$$p - w^e = b_0 - b_1(y_d^e - \overline{y}) + b_2(y^p - k) \tag{3.23}$$

$$\begin{aligned} w \;=\;& \lambda\left[p - b_{0I} - b_2\alpha(k - n_{-1})\right] \\ &+ (1-\lambda)\left[w^e + c_0 - c_1 u - c_2\Delta u + c_3\widehat{z}_w\right] + \widehat{z}_{1w} \end{aligned} \tag{3.24}$$

$$u = l - n \tag{3.25}$$

Equations [3.17] and [3.18] summarize the production side of the economy. Equation [3.19] states the equilibrium condition which excludes both inventories and rationings by the model. [3.20] indicates the relationship between plans about output, expected demand and prices, while equations [3.21] and [3.22] describe respectively actual and expected aggregate demand. Finally [3.23] and [3.24] are the price and wage setting respectively and [3.25] defines the unemployment rate.

In order to study the system of equations above, it is important to specify the list of the exogenous and predetermined variables, namely k, l, m, m^e, x, x^e, $\widehat{z}_w$, $\widehat{z}_{1w}$, n_{-1}, ε, w^e, p^e. Given these, we can determine expected demand by [3.22], the full capacity output by [3.18] and then [3.20] and [3.23] return the price level, which is set at the beginning of the period. During the period, actual demand is determined by [3.21], which determines actual output by [3.19] and, via [3.17], employment. Then unemployment is derived by [3.25] and finally wages can be calculated through [3.24]. It should be emphasized that nothing assures that expectations are fulfilled.

It can be useful to restrict the system above in three main equations, the first one for uneployment, the second one for prices and the last one for wages. Equations [3.17] - [3.19] together with [3.25] imply a direct relationship between demand and unemployment:

$$y_d - \overline{y} = -\alpha u + \varepsilon \tag{3.26}$$

This equations implies the somewhat tautological observation that unemployment, for a given ε, is always accompanied by a reduction of demand under the full capacity output level. This consideration has no causal implications.

The second relationship is the reduced-form price equation, obtained taking together [3.18], [3.20] and [3.23]:

$$p - w = b_0 + (b_2 - b_1)(y_d^e - \overline{y}) - (w - w^e) - b_2\eta\,(p - p^e) - b_2\alpha\,(k - l) \tag{3.27}$$

The price markup on wages depends on expected demand, wage and price surprises, which reflect the level of nominal inertia, and the capital-labour force ratio, that captures the trend productivity. Notice that we do not know a priori whether the effect of demand on the markup is positive or negative; here we make the very convenient hypothesis that it is positive, since in this way we have a unique equilibirum. Empirical evidence suggests however that, whatever the sign is, the magnitude of the effect is tiny.

The third reduced form relationship is the wage equation, given by [3.24] and [3.25]:

$$w - p = \gamma_0 - \gamma_1 u - \gamma_{11}\Delta u - \gamma_2\,(w - w^e) + b_2\alpha\,(k - l) + z_w \tag{3.28}$$

where γs are convolutions of the old parameters. The wage markup on value added prices depends on unemployment, the change in unemployment, the wage surprises, trend productivity and factors indicating wage pressure, such as union and benefit effects. Notice that the way in which trend productivity enters this equation is exactly equal to that of equation [3.27]. This has strong implications, as we will see.

The last three equations, together with [3.21], allow us to complete the analysis both in the long-run and eventually during the transition to the steady-state.

A long-run equilibrium is defined as a situation in which expectations are fulfilled and exogenous factors are kept fixed, together with the predetermined capital stock. Solving then the system, after imposing these restrictions, yields the following long-run equilibrium values for unemployment, real wages and demand.

$$u^* = \frac{b_0 + \gamma_0 + z_w}{\gamma_1 + (b_2 - b_1)\alpha} \tag{3.29}$$

$$(w-p)^* = \frac{[(b_2 - b_1)\alpha\gamma_0 - b_0\gamma_2]}{\gamma_1 + (b_2 - b_1)\alpha} + \frac{(b_2 - b_1)\alpha z_w}{\gamma_1 + (b_2 - b_1)\alpha} + b_2\alpha(k-l) \tag{3.30}$$

$$y_d^* = -\alpha u^* + \overline{y} \tag{3.31}$$

With this equilibirum, we will have a level of output and employment, given by [3.17] and [3.25]. Finally, monetary and fiscal policies will determine the price level from [3.21].

Some considerations about the equilibrium values are in order now. First of all, unemployment in the long-run depends only on the exogenous wage pressure variables and the parameters of the wage/price equations. Among these, something can be said about b_0, that is the constant part of the price markup over wages. If this rises exogenously, for a decreasing competition in the product markets, equilibrium unemployment will raise as well. Second, equilibrium unemployment does not depend on trend productivity which affects only real wages. This comes from the fact that trend productivity enters in the same manner both the wage- and the price equation and matches the very strong empirical fact of the absence of any secular trend in unemployment[1]. Third, the unemployment rate in the long-run is a "natural rate", i.e. demand factors do not influence its value. But from this consideration, it does not descend any policy ineffectiveness conclusion. In fact, policy makers have much to do in order to influence equilibrium unemployment, even if not with usual fiscal or monetary policies, but with other structural policies.

Finally some cautions are needed before any conclusion about the uniqueness of the equilibrium. The equilibrium unemployment in fact is that level

[1] Blanchard and Katz (1997) present a very clear graphical exposition of the effects of productivity on the natural rate of unemployment.

of unemployment that makes the real wages generated by the price-setting process consistent with the real wage generated by the wage-setting process. Only the linearity assumptions, that Layard et al. (1991) make, assure the existence of a unique equilibrium. But, as long as $b_2 - b_1$ is negative rather than positive, a sufficient nonlinearity can well lead to multiple equilibria, even if these cases have not strong support by the empirical literature[3].

3.2.4 The unemployment-inflation trade-off and the NAIRU

As yet, references to inflation have been very passing. In particular, we have not done any consideration about the link between unemployment and inflation, that is crucial in any policy's consideration in OECD countries since 1960s, when the theory of the trade-off between inflation and unemployment led to the introduction of the NAIRU as an important economic concept.

This "orthodox view" of the NAIRU and the structural rate of unemployment predicts the absence of any long-run trade-off between inflation and unemployment: unemployment depends only by structural variables, whereas inflation is a monetary phenomenon. Such a trade-off however exists in the short run: unemployment may fall short of NAIRU only at a cost of a rising inflation. The macroeconomic policy consequence is clear: fiscal policies aiming at stimulating demand for reducing unemployment lead to higher rates of inflation.

In contrast with this view, the "full hysteresis" alternative claims that inflation is affected by the rate of change in unemployment and not by its level. In this case, unemployment is not determined by structural variables but reflects cumulative effects of the past shocks. Empirical evidence goes strongly against this extreme hypothesis. But a weaker version of it must be considered as relevant.

Theoretically, the "hysteresis view" is sustained by two main approaches, both based on the hypothesis that labour markets can be segmented between "insider" and "outsider" individuals . Insiders are those in relatively secure employment and play an important role in wage setting. Outsiders are individuals that are unemployed (or even outside the labour force). These last usually do not play any role in determining wages, either directly or indirectly through unions, that instead mainly protect insiders.

[3]See Layard and Nickell (2001), p.370.

The first approach is referred to as the "insider-outsider theory" and is associated to papers by Blanchard and Summers (1986, 1987) and Lindbeck and Snower (1988b). While Blanchard and Summers assume the insider-outsider segmentation, Lindbeck and Snower give it a foundation with considering turnover costs, that make it expensive for a firm to make the desired turnover in its labour force. The second approach refers to the work by Layard and Nickell (1987) and it is usually defined as the "outsider ineffectiveness" hypothesis. Insiders yield a position rent, because the external market is at least partially composed by long-term unemployed who do not represent a viable substitute for incumbent employees. Regardless its source, labour market's segmentation permits the insiders to acquire a position rent, through which they preserve their workplace from the effect of a high unemployment rate.

Under full hysteresis, in the long-run there exists a trade-off between the change in inflation and the change in the unemployment rate. This view is, in some sense, more optimistic than the "orthodox" one. In fact, if unemployment for one year is under the natural rate, inflation rises but the acceleration is finite, because in the next year the new natural rate is the actual last year unemployment rate. We can say, with Dobbie (2004), that the natural rate is to some extent chosen by the policymakers.

Since the full-hysteresis hypothesis is rejected by data, we consider the "orthodox" view more in depth, both theoretically and empirically, and we will see how a weaker version of hysteresis can be incorporated in it.

A simplified model

Let's specify our model in a slightly different manner, in which we consider again a price-setting curve, a wage-setting curve and an equation for labour supply. We denote with a prime all the coefficients of this simplified model, in order to distinguish them from those of the preceding one.

Price-setting curve is by the following equation:

$$p - w = a'_0 + a'_1 n + a'_2 \Delta n - a'_3 (p - p^e) - q + ZL_p + ZT_p \qquad (3.32)$$

where q stands for the productivity and replaces the capital/labour ratio of the preceding model, ZL_p are long-run factors that affect the markup and ZT_p are temporary shocks to the price decisions. For example, among ZL_p

there are institutional factors that influence the competitive structure of the market; and among ZT_p we can consider temporary shocks like oil or import prices shocks. The difference between equation [3.32] and equation [3.27] are the following. First of all, we are imposing equal price and wage inertia, i.e. $p - p^e = w - w^e$. This is made just in order to simplifly the calculations, even if the degree of inertia in prices and wages may be very different in each country. The second main difference is the presence of the term Δn in [3.32]. This generalizes the specification assumed above, allowing us to do not stick to a very stringent timing decision hypothesis. Justifications to the presence of Δn are not rare in the literature. For example, Lindbeck and Snower (1988a) claim that adjustment costs on labour inputs may well cause lagged responses in employment. The last aspect that differentiates the two equations under analysis is the fact that the constant term b_0 in [3.27] is now replaced by $a_0' + ZL_p + ZT_p$, thus allowing to distinguish between different factors affecting pricing decisions.

Turning to the wage equation, the specification is the following:

$$w - p = b_0' - b_1'u - b_2'\Delta u - b_3'(w - w^e) + q + ZT_w + ZL_w \qquad (3.33)$$

where ZT_w and ZL_w are factors affecting wage setting decisions in the short- and in the long-run respectively. The presence of variations in unemployment can be justified by two theoretical views. One refers to the already seen "insider-outsider" hypothesis, according to which real wages are more responsive to large-scale redundancy and rising unemployment than to the level of unemployment per se. The other one considers that, when unemployment is rising, on average unemployment durations across unemployed individuals are shorter: in this case competition between unemployed and still employed workers may be harder, so pressuring wages downwards. Among ZL_w, there are factors affecting real wages in the long-run, such as unemployment benefits, bargaining strength of unions, degree of mismatch between skills and geographical location of job seekers and unfilled vacancies; if employees are able to resist to downward adjustment of their after-tax real wage compensations, factors like taxes or changes in trend productivity may be included. ZT_w represents temporary factors like term of trade effects.

The third equation describes the labour market participation.

$$l = c_0' - c_1'u + ZL_l \qquad (3.34)$$

For discouragement effect, unemployment affects negatively labour-force participation. ZL_l are factors that act in the long run, including some of the elements of the wage push (ZL_w).

Based on this simple model we can give three definitions of the NAIRU. One is a long-term equilibrium unemployment rate; the second refers to a medium-term rate and we will denote it as the NAIRU without any further qualification; the third is the short-term NAIRU and will be defined on the basis of the Phillips curve, as that unemployment rate that stabilizes inflation between two periods.

The long-term equilibrium unemployment rate

It arises when all expectations are met, temporary supply shocks completely disapperead, the unemployment rate is stabilized, i.e. $\Delta u = 0$, and the long-lasting supply factors are at their long-run values, denoted with lowercase letters. Applying these conditions and denoting the long-term equilibrium rate with ul^* yields:

$$ul^* = \frac{d_0' + a_1' zl_l + zl_p + zl_w}{d_1'} \tag{3.35}$$

where $d_0' = a_0' + a_1' c_0' + b_0'$ and $d_1' = a_1' + a_1' c_1' + b_1'$. Then the long-term equilibrium unemployment rate depends on the long-run values of the supply factors, i.e. zl_l, zl_w and zl_p, and by other factors shifting the wage- and price-setting and the labour supply curve, i.e. a_0', b_0' and c_0'.

Notice that if the price-setting curve is horizontal, i.e. $a_1' = 0$, the markup of prices over marginal costs is constant over the cycle and, for given long-run values of the relevant parameters, wage pressures result in ul^* higher than the case of cyclical mark-up. This comes from the fact that wage pressures in this case cannot be absorbed partially by increases in real wages and lead entirely to increased unemployment. While this 'normal-price' case is not very usual, the movements of the markup over the cycle may be not very strong, i.e. $a_1' \simeq 0$.

The NAIRU and the Phillips curve

When the long-lasting supply factors are at their current values, the unemployment rate that stabilizes inflation is the NAIRU, without qualification.

Hence the value is:

$$u^* = \frac{d_0' + a_1' ZL_l + ZL_p + ZL_w}{d_1'} \tag{3.36}$$

where now ZL_l, ZL_p and ZL_w are the current values of the supply factors.

In order to derive a Phillips curve which embodies the 'natural rate' theory, we must refer to this definition of the NAIRU. However we need also a hypothesis about inflation expectations. First notice that $p - p^e = p - p_{-1} - (p^e - p_{-1}) = \Delta p - \Delta p^e$ (and the same for w). Then it is easy to derive the following relation from [3.32], [3.33] and [3.34], using [3.36]:

$$\Delta p - (\Delta p)^e = \Delta w - (\Delta w)^e = -\frac{d_1'}{d_3'}(u - u^*) - \frac{d_2'}{d_3'}\Delta u + \frac{1}{d_3'}\left(ZT_w + ZT_p + a_2' \Delta ZL_t\right)$$

where $d_2' = a_2' + a_2' c_1' + b_2'$ and $d_3' = a_3' + b_3'$. We suppose that inflation follows an AR process, that is $\Delta p = \alpha(L)\Delta p_{-1} + \nu$ (with ν white noise). Then we can write:

$$(\Delta p)^e = \pi^e = \alpha(L)\Delta\pi_{-1}$$

This hypothesis about inflation is clearly not model-consistent or 'rational', in the sense of Lucas critique. Nevertheless it can be justified on the basis of empirical analysis that shows that inflation in OECD countries in the last decade presented actually a unit root.

Using this process for the inflation expectations, we can rewrite the above relationship as:

$$\Delta\pi = \alpha(L)\Delta\pi_{-1} - \frac{d_1'}{d_3'}(u - u^*) - \frac{d_2'}{d_3'}\Delta u + \frac{1}{d_3'}\left(ZT_w + ZT_p + a_2' \Delta ZL_t\right) \tag{3.37}$$

This is a Phillips curve, relating the change in inflation with the gap between actual unemployment and the NAIRU. The coefficient d_1'/d_3' measures the relative strenght of the influence of unemployment on the real wages, given by a_1 and b_1, respect to the influence of the nominal inertia, given by a_3 and b_3. Other terms enter the Phillips curve: past changes in inflation, given the adaptive expectations hypothesis; change in actual unemployment rate, which negatively affect the change in inflation, given our specification of the wage- and price-setting, in which we allowed for a "hysteresis" effect; temporary shocks, which have ex ante mean equal to zero.

Some more considerations about the hysteresis effect are now in order.

Hysteresis can have a strong influence on the short run inflationary pressure. For example, suppose that $u > u^*$ and is kept fixed at that level; this exerts a negative influence over $\Delta\pi$, which becomes negative and inflation is falling. But now consider an increase in the aggregate demand that reduces u back towards u^*. As long as $u > u^*$, deflationary pressures remain; however reducing unemployment has a direct effect on changes in inflation. In fact a reduction in u makes Δu negative and this increases inflationary pressures. If $d_2' > d_1'$, this second inflationary factor may overcome the deflationary one, giving the impression that the NAIRU is actually closer to the current level of unemployment than is actually the case.

To emphasize this point, another definition of the NAIRU can be given; the short-term NAIRU.

The short-term NAIRU

The short-term NAIRU, us^*, is that unemployment rate that stabilizes inflation over two consecutive periods. It is obtained as that rate u that solves [3.37] putting $\Delta\pi = 0$.

$$\begin{aligned} us^* &= \frac{d_1'}{d_1'+d_2'}u^* + \frac{d_2'}{d_1'+d_2'}u_{-1} + \frac{d_3'}{d_1'+d_2'}\alpha(L)\,\Delta\pi_{-1} \\ &\quad + \frac{1}{d_1'+d_2'}\left(ZT_w + ZT_p + a_2'\Delta ZL_t\right) \end{aligned} \tag{3.38}$$

Notice that the first two terms on the right-hand side are a weigheted average of the NAIRU and the past unemployment rate. The weights depend on the relative size of d_1' and d_2': the higher d_2', the closer the short-term NAIRU is to the past unemployment rate and hence the bigger the hysteresis effect is. The other terms entering [3.38] call for a role both inflation expectations and temporary supply shocks.

The policy implication of the hysteresis effect are clear. Policymakers can exploit the hysteresis effect when they have to raise unemployment, because it is below the NAIRU, in order to control inflation: in this case in fact the inflationary pressure coming from $u < u^*$ can be balanced by the deflationary pressure originated by $\Delta u > 0$. However the opposite happens when policies aiming at reducing unemployment are put at work. In this case, if the hysteresis effect is enough strong, it can result very difficult to reduce unemployment without a very high cost in inflation, because the deflationary effect of $u > u^*$ can be counterbalanced by the inflationary effect of $\Delta u < 0$. This hysteresis effect is often used to explain the puzzling movements in European unemployment in 1980s and 1990s.

Using now the short-term NAIRU, the Phillips curve can be rewritten in a different way, that is very useful for a monetary policy use.

$$\Delta\pi = -\frac{d_1' + d_2'}{d_3'}(u - us^*) \tag{3.39}$$

Similarly to Estrella and Mishkin (1998) results, this equation easily relates change in inflation with the gap between the actual unemployment rate and the short-term NAIRU, thus furnishing a very clear indicator for conducting monetary policy.

3.3 The empirical analysis

NAIRU is unobservable. Then it is very important to choose an estimation method in order to find out a reliable measure of this important indicator, as a support for policy decisions. The estimation methods can be broadly classified into three groups : the structural methods, the pure statistical methods and the reduced-form approach.

The structural methods start from the specification of wage- and price-setting curves and estimate them in order to calculate a structural unemployment rate. The pure statistical methods use statistical decompositions of time series between trends and cycles to insulate the trend around which unemployment rate varies over time. The reduced-form approach shows an intermediate view, given that it put together a "structural" Phillips curve with statistical de-trending techniques.

3.3.1 Structural methods

They usually involve estimations of a system of equations, like wage- and price-setting equations of the Layard et al. (1991)'s type. The equilibrium value of unemployment is then determined as the value that stabilizes inflation, accounting for the firms' and workers' decisions. In other words, it is that value of unemployment that makes compatible the firms' decisions about profits and the workers' decisions about the wages. Hence the so estimated NAIRU is very close to the above defined long-run equilibrium rate of unemployment.

Such empirical models present some drawbacks, however.

First of all, there is no consensus about the model to be used. In particular, the influence of real interest rates, taxation and productivity growth on real wages and equilibrium unemployment seems questionable. As for labour taxation, for example, Daveri and Tabellini (2000) pointed out that, even if many researchers stressed the role of labour taxation over unemployment, the results are not very reliable, so we cannot conclude that a strong causal relationship has been found out between labour taxes and unemployment.

Even without this lack of consensus over the model to be used, other specification problems arise with structural methods, since the number of potential explanatory variables is very high and sensitivity analysis demonstrates a high variability of results for different specifications.

Futhermore, there is an identification problem too. It is related to the fact that virtually all the variables entering the wage-setting equation enter the price equation as well. As pointed out by Bean (1994), it is difficult to have valid OLS estimates. Some researchers do not care at all about the problem, producing OLS estimations. Others prefer to make use of instrumental variables, like lagged values of unemployment, usually obtaining estimates very close to the OLS ones. This can be due to the well known fact that with a small sample and many instruments, IV estimates tend to OLS estimate.

Finally quantification of the main institutional variables used in these specifications is not unquestionable. Unemployment benefits, employment protection legislation, the degree of workforce unionization are all variables affecting the equilibrium long-run unemployment rate. While the sign of these effects is in general widely accepted, it is not easy to construct viable indicators of these factors, that vary across countries and periods.

As Richardson et al. (2000) pointed out, such estimation methods of the NAIRU do not lead a broad consensus about the specific contributions of each factor to the equilibrium unemployment. Furthermore the link between this NAIRU measure and inflation rates is only indirect (unlike the Phillips curve approach). Hence its effectiveness depends on the use: while for the monetary and fiscal policy assessment the last observation can create some troubles, for structural policies analysis it may be more innocuous, as long as one believes to someone of the underlying theoretical models.

3.3.2 Pure statistical models

The starting point is the consideration that there is no long-run trade-off between inflation and unemployment. Then unemployment must fluctuate around the NAIRU, thanks to self-equilibrating forces that bring unemployment back to trend.

Like the output decomposition between cyclical and trend components, unemployment is thus decomposed using similar methods. All of these however share a common drawback: the modeling hypothesis of the trend component is somewhat arbitrary, as well as its variance and relationship with the cyclical component. Furthermore, in estimating the NAIRU, the only relevant information is the actual unemployment rate. Neither variations in structural factors nor the linkage with inflation is in any way exploited for correctly estimating the NAIRU. As a consequence, these kinds of estimates go generally through the middle of the actual unemployment rate (especially when HP filtering procedure is implemented). Hence these methods are now seldom used since much better alternative procedures have become available.

3.3.3 The reduced-form approach

This is the most popular recently used method to calculate the NAIRU. It is based on the expectation-augmented Phillips curve . A large literature has attempted to estimate inflation equations of this form:

$$\pi_t = \pi_{t-1} - a\,(u - u^*) + \nu \tag{3.40}$$

This is similar to the Phillips curve [3.37], except that the hysteresis effect is ruled out, lagged inflation is used as a proxy for expected inflation and supply shocks are included in the residuals. From [3.40] it is possible to estimate the NAIRU, when we assume as identification assumptions that u^* is constant over time and that ν is not correlated with u. In this case, regressing the change in inflation over a constant and the unemployment rate it is possible to recover the NAIRU, dividing the estimated constant by the estimated unemployment coefficient. Ball and Mankiw (2002) implemented this exercise for annual US data over 1960-2000 years, using the consumer price index, and obtained a NAIRU estimate of 6.1 percent.

But: what can we say about the identification assumptions made? The first one, i.e. the constancy of u^* over time, is more or less acceptable, depending on the length of the time interval under studying. The second assumption is less easily justified, since we can imagine some supply shocks, contained in ν, that are contemporaneously correlated with unemployment. In this case instrumental variables can help to fix the problem but they are difficult to find.

However many economists do not agree with the assumption of a constant NAIRU. From a theoretical point of view, as we have already seen, the literature considers a constant NAIRU rather implausible. In fact, according to our theoretical classification, all the definitions of the NAIRU contain elements that vary over time, such as institutional factors or supply shocks. Thus variations in the NAIRU are likely, even if a priori we can accept that this variation is not very high in the short run. How can this time-varying NAIRU be estimated in practice?

To catch the point, we follow the simple, but very intuitive, method proposed by Ball and Mankiw (2002). Rewrite the Phillips curve equation [3.40] in the following form:

$$u^* + \frac{\nu}{a} = u + \frac{\Delta\pi}{a}$$

If we knew a, we could compute the right-hand side from the data, yielding an estimate of the left-hand side, that is the sum of the NAIRU plus a term proportional to the shorter-term supply shocks. It is natural then to extract from this estimate the trend component, interpreting it as the NAIRU, and to consider the cyclical component as the residual supply shocks.In order to extract the trend, Ball and Mankiw propose the use of a Hodrick-Prescott filter.

To implement the procedure, two parameters must be chosen. The first is the slope of the Phillips curve, a. They use the same value previously obtained from the estimation of a constant NAIRU, 0.63. They noted also that such a value is consistent with conventional wisdom about the costs of disinflation: for a one point percentage reduction in inflation, a 1.6 point-years of unemployment must be suffered. The second parameter to impose is the smoothing parameter of the Hodrick-Prescott filter. This last choice is less easy. It depends on the a priori intuition about how much movements in the NAIRU are smooth or are closer to the actual unemployment rate.

The authors check with two smoothing parameters, and the results are not very different.

With the more smoothing option, US NAIRU starts at 5.4% in 1960, peaks at 6.8% in 1979 and then falls to 4.9% in 2000. These results are very similar to those of Gordon (1997), that used a Kalman filtering procedure.

3.4 Conclusion

The importance of NAIRU in conducting macroeconomic policies should be now more evident, after looking at both theoretical and empirical vaste literature on the subject. In fact, NAIRU can have many practical use by policymakers, concerned with unemployment and inflation.

For a monetary policy use, what we have called short-term NAIRU seems to be the most promising, since it suggests inflationary developments in the short run. However, given its extreme volatility, it is not suitable to act as a target for monetary policy.

In assessing fiscal policies, the analysis of fiscal stance over the medium to long term calls the NAIRU for an important role. In fact, NAIRU helps to define the productive potential of the economy and hence the rate of labour utilization compatible with stable inflation. This in turn determines the output gap, which is very important to distinguish between cyclical and structural budget positions. In order to achieve this goal, the more relevant measure of the NAIRU should be the second one, given that the first results too volatile.

A third possible use of the NAIRU concept has to do with the evaluation of structural policies. This is becoming more popular now, especially in Europe where a big effort has been putting in reforming labour market institutions. In public debate, assessing the effect of structural policies over the natural rate of unemployment is very important, in view of a revision of the Stability and Growth Pact, which may be more or less relaxed even depending on the structural reforms implemented. As the previous theoretical discussion should have pointed out, the most correct NAIRU measure to use in this framework should be the long-term unemployment rate, defined as the rate that arise when expectations are fulfilled, temporary supply shocks disappeared and long-lasting supply factors are at their long run values.

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