Financial Fragility, Heterogeneous Agents' Interaction, and Aggregate Dynamics

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Abstract. *This paper analyzes the emergence of economic fluctuations using a dynamic model where the economy is populated by heterogeneous interacting agents. We stress the fact that in such a setting it is possible to observe a lack of proportionality between causes and effects of business fluctuations. Our main point is that the strength of the propagation mechanism changes in time and grat consequences of small shocks are possible when propagation is strong. The main cause for this is a change in the average financial condition of firms. High financial fragility implies a worsening of credit conditions and a high probability of default for the firm. The main focus of the paper is twofold: 1) modeling the bank behavior in order to derive endogenously the credit market equilibrium and 2) stressing the importance of entry and exit processes of firms on the market to understand the business cycle.*

1 Introduction

According to the traditional view of the business cycle, large fluctuations are due to some impulses propagated throughout the entire economy (the so-called impulse-propagation approach). One of the puzzles it has to face is why large fluctuations arise without large shocks, since empirical evidence shows that there is not such a causal connection (Balke and Fomby 1994).

Since small idiosyncratic shocks have, by definition, a zero mean, in the aggregate they produce no effects because of the law of large numbers. This law does not hold if there are strong non linearities (Allen 1982) or non-price interactions among "non representative", or heterogeneous, agents (Brock and Durlauf 1999).

In the last few years, the representative agent framework has been under the attack of growing criticism, beginning with Kirman 1992 (see also the papers in Gallegati and Kirman 1999, Delli Gatti *et al.* 2000, Kirman and Zimmerman 2001). Theoretical research and applied investigation demonstrate that macroeconomics is not equivalent to the simple "summation and averaging" process of individual agents. Since the aggregate can be (and under very general conditions it is) different from the sum of its components, it is misleading to analyze the behavior of a representative agent as if it were representing the whole economy. Very restrictive analytical (and empirically implausible) conditions are required to have exact aggregation. Recent empirical work shows that heterogeneity can explain aggregate dynamics: idiosyncratic shocks affect the rate of change of macroeconomic quantities (Davis et al. 1996, Davis and Haltinwanger 1996, Caballero et al. 1997).

In this paper we analyze a model in which interaction and financial fragility are the source of heterogeneity. The presence of interaction makes the economic system a "complex" one, in the sense that there are no definite long run dynamics.[1]

The presence of asymmetric imperfections involves a setting where agents are heterogeneous and their average and distribution evolve dynamically. Moreover, because of heterogeneity, agents interact outside the market identifying a self-reinforcing mechanism. In the following, we put forward a

[1]The concept of complexity we refer to is partially different from the traditional one (surveyed for instance in Rosser, 1999). It's the result of rather recent research mainly carried on at the Santa Fe Institute. The main point is that there are some dynamical systems showing non standard endogenous dynamics characterized by sudden big changes in the state variables not caused by changes in the parameter of the system or by exogenous shocks, Bak (1997). The concept of equilibrium makes no sense in a setting with many interacting agents and in which periods of stasis are broken by short boosts of activity. The concepts of *metastability* or *punctuation of the equilibrium* describe such situation. E.g. according to the Santa Fe perspective, business cycle asymmetries are due to negative factors that cumulate during the upswings bringing the economy to a critical situation. When a critical level sets in, they dissipate spreading rapidly throughout the entire economy. Only when the recovery sets in, the negative factors begin to cumulate again.

model in which the mean and the distribution of the financial positions of firms generate business fluctuations. Each firm sells its output at a random price, which is the idiosyncratic shock of the model, whose effect on aggregate activity is amplified by the financial position. Fast growing research on empirical evidence shows that the firms' birth-death process drives employment fluctuations. Following this insight, Delli Gatti *et al.* 2001, consider the entry-exit process as the main factor affecting the distribution (and aggregate dynamics). Since the amplification mechanism is a function of financial fragility, which evolves during the business cycle, this class of models predict fluctuations to be "state dependent": as the propagation mechanism is sensitive to the state of financial robustness the economy reacts differently to the same shock. We explicitly model firms' turnover and the interaction of banks and firms through the dynamics of the interest rate.[2]

The paper is organized as follows. In section 2 we describe the model: after having exposed the behavior of the firm (2.1), we analyze the bank behavior as stemming from agents' interactions (2.2) and the entry-exit process (2.3). Section 3 analyzes the dynamics of the model through some simulations. Section 4 concludes.

2 The model

The model analyzes a closed economy with no Government expenditure populated by many heterogeneous firms operating in a competitive market, and a banking system characterised by imperfect information. Firms produce a homogeneous good and sell it at a random idiosyncratic price, whose mean equals the general price level.[3] Capital is the only input and technology is characterized by constant returns to scale. Investment is financed either by retained profits or debt, since there is equity rationing. The equity-capital ratio is firm specific: it is the major source of heterogeneity and the main factor of financial fragility. Bank-firm relationships are of a long run nature, since the evolution of stock variables (such as debt, equity and capital) is involved. Asymmetric information is the source of non-price interaction. Because of it, the bank, which finances a multiplicity of firms, does not know the financial condition of each single firm, but only the mean equity ratio. Therefore,

[2]According to the definition of complexity we follow, one can say that the negative cumulating factor is the firms' indebtedness. During upswings it goes up bringing the economic system to an *out of equilibrium* critical position. Idiosyncratic shocks and financial fragility cause bankruptcies that, due to economic interdependencies among firms, spread in the economy. The resulting dynamics are non standard since depth and length of recessions and expansions varies from period to period.

[3]We take this hypothesis from Greenwald and Stiglitz, 1993

credit supply depends on the firms' mean equity ratio. Interactions are thus global and indirect. Each firm affects the mean leverage value, and the bank extends its influence to all the other firms. A "field effect" (Aoki 1996) is at work in the economy: when the mean equity ratio decreases, the burden of worse credit conditions negatively affects financially robust firms because the rate of interest rises. In a sense, bad firms push good ones out of the market.

2.1 Firms' behavior

Each firm produces output (Y_{it}) using capital according to a linear production function:

$$Y_{it} = \phi K_{it}$$

where ϕ is capital productivity. Firms sell their output at an uncertain price because of their limited knowledge of market conditions. The individual selling price, p_{it}, is a random variable with expected value $E(p_{it}) = P_t$ and finite variance. P_t is the market price, uniform across firms. As a consequence, the relative price, $u_{it} = p_{it}/P_t$, is a positive random variable with expected value $E(u_{it}) = 1$ and finite variance. Real revenue from sale is thus $u_{it}Y_{it}$.

The balance sheet of the firm is

$$K_{it} = L_{it} + A_{it} \tag{1}$$

where K_{it} is capital, A_{it} is the equity base and L_{it} the debt of i-th firm at t. In the following we will refer to $a_{it} \equiv \frac{A_{it}}{K_{it}}$ as the "equity ratio" and $\beta_{it} \equiv \frac{L_{it}}{K_{it}}$ as the "debt ratio".

The firm has two cost components:

- the financing costs

$$CF_{it} = r_{it}(K_{it} - A_{it}) + r_A A_{it-1} = r_{it} L_{it} + r_A A_{it-1} \tag{2}$$

  where r_{it} is the interest rate and r_A is the remuneration of the equity base

- the (quadratic) capital adjustment costs (Mussa, 1977)

$$CA_{it} = \frac{\gamma}{2} \frac{(K_{it} - K_{it-1})^2}{K_{it-1}} \tag{3}$$

  where γ is the inverse of the propensity to invest.

Profit, π_{it}, is the difference between revenue $(u_{it}Y_{it})$ and cost $(CF_{it} + CA_{it})$:

$$\pi_{it} = u_{it}Y_{it} - r_{it}L_{it} - r_A A_{it-1} - \frac{\gamma}{2}\frac{(K_{it} - K_{it-1})^2}{K_{it-1}} \tag{4}$$

Expected profit therefore is:

$$E(\pi_{it}) = Y_{it} - r_{it}L_{it} - r_A A_{it-1} - \frac{\gamma}{2}\frac{(K_{it} - K_{it-1})^2}{K_{it-1}} \tag{5}$$

Maximizing (5) with respect to K_{it} we obtain

$$K_{it}^d = K_{it-1} + \frac{K_{it-1}}{\gamma}(\phi - r_{it}) \tag{6}$$

Investment is defined as:

$$I_{it}^d = K_{it}^d - K_{it-1} \tag{7}$$

and therefore

$$I_{it}^d = \frac{K_{it-1}}{\gamma}(\phi - r_{it}) \tag{8}$$

where the superscript d stands for "demand".

The demand for credit is:

$$L_{it}^d = L_{it-1} - \pi_{it-1} + I_{it}^d \tag{9}$$

Substituting (8) into (9) we get

$$L_{it}^d = L_{it-1} - \pi_{it-1} + \frac{K_{it-1}}{\gamma}(\phi - r_{it}) \tag{10}$$

In this framework, bankruptcy occurs if net worth becomes negative

$$A_{it} < 0 \tag{11}$$

i.e., when the current loss is higher than the equity base inherited from the past,

$$A_{it-1} + \pi_{it} < 0 \tag{12}$$

Substituting equation (4) into (12) we have

$$A_{it-1} + u_{it}\phi K_{it}^d - r_{it}L_{it} - r_A A_{it-1} - \frac{\gamma}{2}\frac{(K_{it}^d - K_{it-1})^2}{K_{it-1}} < 0 \tag{13}$$

After some substitutions and algebraic manipulations, we end up with

$$u_{it} < \frac{r_{it}L_{it}}{\phi K_{it}^d} - \frac{(1-r_A)A_{it-1}}{\phi K_{it}^d} + \frac{\gamma}{2}\frac{(K_{it}^d - K_{it-1})^2}{\phi K_{it}^d K_{it-1}} \equiv \bar{u}_{it} \tag{14}$$

Bankruptcy occurs if the realization of the random relative price u_{it}, falls below the critical threshold, $\bar{u}_{it}$. For the sake of simplicity, we assume that u_{it} is a uniform random variable with support (0, 2). In this case, the probability of bankruptcy becomes,

$$Pr(u_{it} < \bar{u}_{it}) = \frac{\bar{u}_{it}}{2} = \frac{r_{it}L_{it}}{2\phi K_{it}^d} - \frac{(1-r_A)A_{it-1}}{2\phi K_{it}^d} + \frac{\gamma}{4}\frac{(K_{it}^d - K_{it-1})^2}{\phi K_{it}^d K_{it-1}} \tag{15}$$

Equation (15) states that the probability of bankruptcy is affected positively by an increase of the interest rate and a decrease of the equity ratio.

The next section illustrates how the rate of interest is endogenously determined by the working of the banking system.

2.2 Bank's behavior

Total revenues for the bank are $r_{it}L_{it}$. Since the bankrupted firm does not refund (loans are fully collateralised), revenues are $r_{it}L_{it}(1 - Pr(u_{it} < \bar{u}_{it}))$. Profit for the bank is:

$$\Pi_t^b = r_{it}L_{it}(1 - Pr(u_{it} < \bar{u}_{it})) \tag{16}$$

For the sake of simplicity, we assume that only one bank is present.

Substituting (15) in (16) we obtain

$$\Pi_t^b = r_{it}L_{it} - \left[\frac{(r_{it}L_{it})^2}{2\phi K_{it}^d} - \frac{r_{it}L_{it}(1-r_A)A_{it-1}}{2\phi K_{it}^d} + \frac{r_{it}L_{it}\gamma}{4}\frac{(K_{it}^d - K_{it-1})^2}{\phi K_{it}^d K_{it-1}}\right] \tag{17}$$

Maximizing (17) with respect to L_{it} one gets the first order condition

$$\frac{\partial \Pi_t^b}{\partial L_{it}} = r_{it} - \frac{r_{it}^2 L_{it}}{\phi K_{it}^d} + \frac{r_{it}(1-r_A)A_{it-1}}{2\phi K_{it}^d} - \frac{r_{it}\gamma}{4}\frac{(K_{it}^d - K_{it-1})^2}{\phi K_{it}^d K_{it-1}} = 0 \tag{18}$$

The second order condition for a maximum is satisfied:

$$\frac{\partial^2 \Pi_t^b}{\partial L_{it}^2} = -\frac{r_{it}^2}{\phi K_{it}^d}$$

Solving (18) for L_{it} yields the bank's reaction function

$$L_{it}^{s} = \frac{1}{r_{it}}\left(\phi K_{it}^{d} + \frac{(1-r_A)A_{it-1}}{2} - \frac{\gamma}{4}\frac{(K_{it}^{d} - K_{it-1})^2}{K_{it-1}}\right) \tag{19}$$

Substituting (6) into (19), one gets

$$L_{it}^{s} = \frac{1}{r_{it}}\left[\phi K_{it-1} + \frac{(1-r_A)A_{it-1}}{2} + \frac{3\phi^2 K_{it-1}}{4\gamma}\right] + -\frac{r_{it}K_{it-1}}{4\gamma} - \frac{\phi K_{it-1}}{2\gamma} \tag{20}$$

In (20) we implicitly assume that the bank has a credit supply curve for each firm. In other words, the financial relationships between the bank and a firm does not influence the credit conditions of the other firms. Empirical evidence however suggests that this is a rather unrealistic assumption. Credit conditions vary according to the average indebtedness of the financed firms, i.e. with the *financial fragility* of the system. Firms with the same level of indebtedness may have different financial contractual conditions if they are located in zones with different degrees of financial fragility (Jackson and Thomas, 1995). Social interaction thus plays an important role (see Kirman, 1997). Hereafter we assume that the bank finances a multiplicity of firms. Imperfect information prevents the bank from exactly knowing the financial position of each single firm. Rather, we assume that it knows the mean financial position of the firms it finances. Thus the bank will use the mean financial position (denoted by $\bar{a}_t$) as a determinant of the credit supply. Dividing (20) by K_{it-1}, one gets:

$$\beta_{it}^{s} = \frac{1}{r_{it}}\left[\phi + \frac{(1-r_A)\bar{a}_{t-1}}{2} + \frac{3\phi^2}{4\gamma}\right] - \frac{r_{it}}{4\gamma} - \frac{\phi}{2\gamma}$$

where $\beta_{it}^{s} \equiv \frac{L_{it}^{s}}{K_{it-1}}$. The bank's reaction function depends positively on the firms' average equity ratio. It depends negatively on the interest rate that is, when the bank rises the interest rate, its cost goes up more than the revenue and the optimal volume of lending goes down.

Credit market is in equilibrium when (10) equals (20). The rate of interest is endogenously determined solving a quadratic equation in the rate of interest. We are now facing a problem of equilibrium selection among the two possible solutions. Obviously the one chosen by the bank will be that with a higher profit. This happens to be that with a higher rate of interest:

$$r_{it}^{*} = \frac{-\alpha_2 + \sqrt{\alpha_2^2 - 4\alpha_1\alpha_3}}{2\alpha_1}$$

with $\alpha_1 = \frac{3K_{it-1}}{4\gamma}$, $\alpha_2 = -\left(L_{it-1} - \pi_{it-1} + \frac{3\phi K_{it-1}}{2\gamma}\right)$ and $\alpha_3 = K_{it-1}\left(\phi + \frac{3\phi^2}{4\gamma} + \frac{(1-r_A)\bar{a}_{t-1}}{2}\right)$.

Financial fragility depends upon the distribution and the average of the equity ratio *and* the level of the rate itself. Asymmetric information leads to indirect global interaction: if the financial position of some firms deteriorates the supply of credit shrinks. These feedback effect identifies a propagation mechanism through which idiosyncratic shocks may have aggregate consequences. Macroeconomic effects of the shocks depend crucially on the situation of the economy, i.e. fluctuations are *state dependent*. The distribution of firms by financial position changes through time because of inner dynamics and the entry-exit process.[4]

2.3 The entry and exit processes

Recent applied literature has shown that most of the employment and macroeconomic fluctuations depend upon the process of firms' entry-exit. In our model we assume that a firm enters the market provided that

- expected profitability is greater than the current rate of interest;[5]
- there are empty positions on the market.

Firms are arranged on an array with a constant number of positions. When a firm exits, it leaves empty its position for a new firm. The entry decision is stochastic in the sense that the probability that an empty position is filled is constant but it depends negatively on the mean interest rate:

$$Pr(entry) = \frac{1}{1 + exp[b(\bar{r}^*_{it} - c)]}$$

where b and c are constants.

The financial position of a new firm, i.e. its equity ratio, is drawn from a normal distribution with a higher mean than the population one. Other than being more leveraged (as empirical evidence shows) new firms are small. We fix their capital to a low level and we determine the other balance sheet variables using the equity ratio and the balance sheet relation.

A firm leaves (exits) the market when it goes bankrupt, i.e. when its equity base becomes negative. Exit of firms eliminates the ones with a bad

[4]Even if our model is not deterministic, a *systemic* path of the evolution of the distribution of financial condition of firms may be stressed.

[5]Note that a squeeze in credit availability, by rising the interest rate, discourages new entries, producing real effects.

financial condition abruptly changing the distribution.[6] There is a cleansing effect on the average equity ratio: when the more fragile firms exit, the mean equity ratio rises, the rate of interest goes down and this speeds up the entry process and favors capital accumulation by lowering debt commitments. The model is described by

1. the evolution of the state variables:

$$K_{it} = K_{it-1}\left(\frac{\gamma+\phi-r^*_{it-1}}{\gamma}\right) \tag{21}$$

$$L_{it} = L_{it-1} - \pi_{it-1} + K_{it-1}\frac{\phi - r^*_{it}}{\gamma} \tag{22}$$

$$A_{it} = K_{it} - L_{it} \tag{23}$$

2. The equilibrium interest rate:

$$r^*_{it} = \frac{-\alpha_2 + \sqrt{\alpha_2^2 - 4\alpha_1\alpha_3}}{2\alpha_1}$$

with $\alpha_1 = \frac{3K_{it-1}}{4\gamma}$, $\alpha_2 = -\left(L_{it-1} - \pi_{it-1} + \frac{3\phi K_{it-1}}{2\gamma}\right)$ and $\alpha_3 = K_{it-1}\left(\phi + \frac{3\phi^2}{4\gamma} + \frac{(1-r_A)\bar{a}_{t-1}}{2}\right)$.

3. The evolution of the flow:

$$\pi_{it-1} = u_{it-1}\phi K_{it-1} - r^*_{it-1}L_{it-1} - r_A A_{it-2} - \frac{\gamma}{2}\frac{(K_{it-1}-K_{it-2})^2}{K_{it-2}}$$

4. The entry process:

$$N^{entry} = Pr(entry)N^{empty}$$

Where N is the number of firms.

Since this map is analytically untractable, we analyze its dynamics through simulations by using the SWARM simulation tool in the following section.

3 Simulations

We consider an array of 400 positions where firms are located and have credit relations with one bank.[7] The variables we analyze are: aggregate

[6]Technically, there is a truncation of the distribution.

[7]The parameter of the simulation are the following: $\phi = 0.13$, $\gamma = 0.1$, $r_A = 0.13$.

production, the number of firms, the mean debt ratio ($\bar{\beta}_{it}$) and its standard deviation, the interest rate, and the entry and exit flows. For the sake of convenience, we classify firms as small, medium and large (safe, speculative and "Ponzi") according to their capital, K (debt ratio).[8]

We analyze fluctuations according to the classical NBER approach: periods of output growth in levels (expansions) followed by periods of contraction. Fluctuations are not deterministic in the traditional sense since business cycle phases are not sequential. Each phase doesn't necessarily evolve into the following, and they differ in amplitude, duration, deepness and their behavior is asymmetric[9]. Since the entry and exit process continuously modifies the environment, the concept of equilibrium loses its meaning and one cannot use the impulse-propagation framework any longer (since there is nothing like an equilibrium state where the dynamics converges).

Despite the fact that each cyclical episode is an *historical individual*, we can identify some regularities which refer to the size, the age and the financial position of the firms, as well as the interest rate behavior. Therefore, we analyze the business cycle as a persistent change in *aggregate production* and *financial fragility*. For the sake of convenience, we put forward a classification of the business cycle into four phases (see also Minsky, 1982):

- robust expansion,
- fragile expansion,
- fragile recession and
- robust recession.

Figure 1 shows a simulation of the aggregate output and the debt ratio.

In order to analyze the dynamics of the firms' distribution we make two different elaborations. On one hand we divide the series in subperiods. For each of this we compute the average skewness index of the size distribution and of the financial position distribution. The results are shown in figure 2. On the other hand we compute the following tables, which present the joint probability distribution matrix of firms according to their 9 possible states during the 4 business cycle phases (the last column report the average size distribution and the last row the average financial position distribution).

[8]They are classified as small if $K_{it} \leq 110$, medium if $110 < K_{it} \leq 120$, large if $K_{it} > 120$, safe if $\beta_{it} \leq 0.45$, speculative if $0.45 < \beta_{it} \leq 0.65$ and "Ponzi" if $\beta_{it} > 0.65$.

[9]It is worth noting that idiosyncratic shocks have very different effects. A positive shock causes the improvement of the financial position and consequently of investment and production. A negative shock can determine the bankruptcy of a firm. Consequently the latter causes a first order loss while the former has an advantage of the second order.

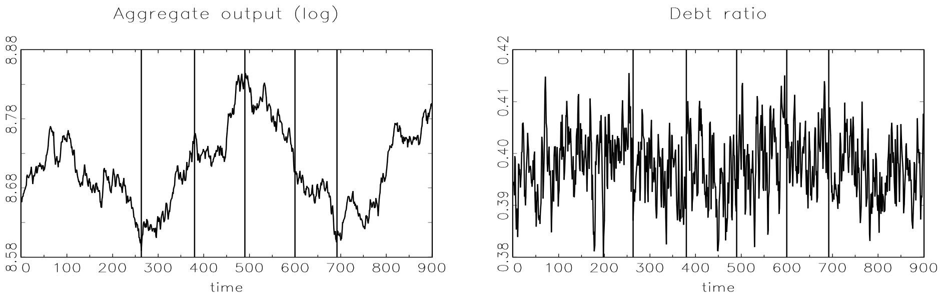

Figure 1: Aggregate output and debt ratio. The vertical lines mark the switch points of the business cycle phases.

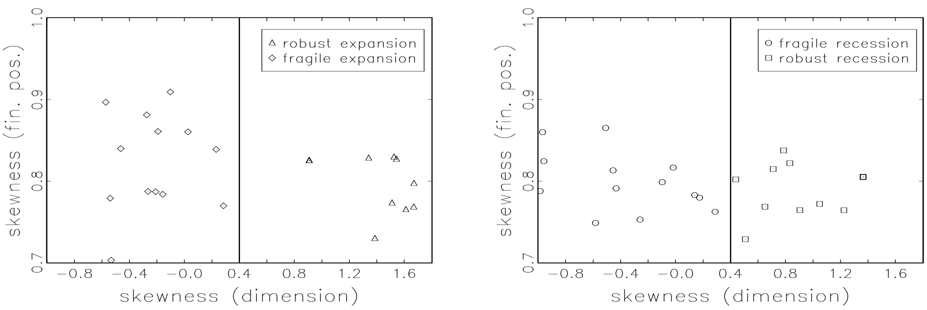

Figure 2: skewness index (it increases when the share of small or safe firms increases).

robust expansion

	safe	spec.	Ponzi	distribution
small	0.56302048	0.24499035	0.19198918	0.74928484
medium	0.61283949	0.18732958	0.19983093	0.08819254
large	0.59122877	0.22715073	0.18162050	0.16252263
distribution	0.57531478	0.23604033	0.18864490	

fragile expansion

	safe	spec.	Ponzi	distribution
small	0.47722784	0.30455673	0.21821543	0.31071179
medium	0.59813864	0.21675006	0.18511130	0.27630822
large	0.64172507	0.20242629	0.15584865	0.41297999
distribution	0.58128602	0.23658826	0.18212572	

fragile recession

	safe	spec.	Ponzi	distribution
small	0.49685226	0.28527737	0.21787036	0.35733995
medium	0.60639807	0.21638873	0.17721320	0.11833228
large	0.61788292	0.21152501	0.17059208	0.52432777
distribution	0.57641511	0.23571368	0.18787121	

robust recession

	safe	spec.	Ponzi	distribution
small	0.54593344	0.25302771	0.20103885	0.66190087
medium	0.57973787	0.27892747	0.14133466	0.06085650
large	0.63563507	0.18416143	0.18020350	0.27724263
distribution	0.57486618	0.23460989	0.19052393	

The simulation of the model shows some stylized facts emphasized by the literature. In particular,

- Entry and Exit flows are highly correlated and are present both in expansions and in recessions (Cable and Schwalbach, 1991);

- Newly born firms present a high rate of infant mortality (Baldwin, 1995);

- Young firms have high growth rate (Baldwin, 1995, Dumme *et al.*, 1988);

- The growth rate decreases both with the dimension and age of the firm (Evans, 1987): consequently big and mature firms are usually financially solid because they recur less to external financial sources;

- There is persistent heterogeneity among firms regarding both dimension and financial position. This means that distributions always have a positive standard deviation. The distribution with respect to dimension is asymmetric (Sutton, 1997, Dosi *et al*, 1995, Hashemi, 2000). The moments of distribution by financial position varies with the business cycle (Gallegati and Stanca, 1999).

Moreover, the simulations show that there is not tendency of the series to converge to a singular distribution. Both the distribution by dimension and by financial position keeps a positive dispersion. There is however a modification of the distribution with the different phases of the cycle. In the expansive phases there is a decrease in the share of small firms in pro of the larger ones, while the medium ones grow moderately. The firms' dimension thus varies pro-cyclically. Although the distribution of the financial position doesn't change much, the change affects mainly the joint distribution. The percentage of the safe firms rises at the beginning of expansion and reaches a maximum around the middle of the expansive phase. During the end of the expansion and the beginning of the recession, the share of hedge firms declines and rises again in the following periods. This phenomenon mainly involves small firms. Large firms for instance are again in a good financial position in the fragile expansion and are affected with a delay by the worsening of the credit conditions: the shares of large firms that are speculative and "Ponzi" increase only in the fragile recession. As expected, the financial solidity of firms rises with their dimension. Among the small firms the percentage of hedge is low with respect to larger ones, being mostly speculative and "Ponzi". On the contrary, medium and large firms have a comparable share of speculative firms, while larger (medium) firms have a share smaller than the average of speculative-"Ponzi" (hedge) units.

4 Conclusions

This paper analyzed the emergence of economic fluctuations using a model in which a population of interacting heterogeneous agents seek for profits in an asymmetric information setting. Small idiosyncratic shocks continuously hit the economy, while the financial fragility modifies the propagation mechanism during time. Consequently, individual shocks have very different effects on the aggregate depending on whatever the system is financially fragile, and the size of the feedbacks. Nevertheless, thanks to the entry-exit mechanism, it is possible to identify some systemic aspects of the financial fragility and its relation with output fluctuations. We have shown that output fluctuations can be asymmetric and their amplitude and duration change from cycle to cycle.[10] Moreover, firms differ in dimension and financial position and this heterogeneity is persistent and asymmetric. As regards the firms' turnover process, the number of entries and exits are heavily correlated and present in each stage of the cycle. Life expectancy of the newly born firms is rather low, while the growth rates decrease both with the dimension and age of the firm: consequently big and mature firms are usually financial solid. Since we have shown that the moments of distribution by financial position varies

[10]The asymmetry is quite evident if one thinks of a single firm. When it has a safe financial position, the production varies in a continuous way, while if it is "Ponzi", it can go bankrupt, determining a discontinuous jump in the production.

with the business cycle, it can be pointed out that credit conditions have real asymmetric and long lasting effects on the industrial dynamics. This model suggests that there are significant interactions between the distribution of firms' financial positions and aggregate economic activity, but also that these interactions are not simply a reflection of endogenous movements of firms' balance sheet positions in response to business cycle fluctuations. The simulations we performed suggest a predictive causal direction going from the evolving distribution of firms' net worth to aggregate performance.

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