Critical mass effect and restructuring in the transition towards a market economy*

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Abstract

Restructuring firms in a transition economy produces a sort of network externality, in that the profitability of restructuring depends on the number of firms that already adopted this strategy. We investigate under what conditions a "critical mass" exists, i.e. a situation in which such extemality is positive, and restructuring spurs imitation, possibly leading to the eventual transformation of the whole economy. We find a critical mass effect when the main effect of restructuring is an increase in value added (i.e., aggregate demand) rather than an increase in the firm's ability to compete against rival home firms. The critical mass case becomes the typical one when competition spurs firms' efficiency.

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1 Introduction

Recent experiences of former communist countries clearly indicate that transformation processes are far from smooth and sometimes do not follow patterns Western economies are familiar with. In some situations we observe that initial "good" examples of effective, competent management seem to drag other firms to pursue an efficiency compatible with a market economy. Other times, initial entrepreneurial successes seem to coexist in apparently stable situations with firms attached to the status quo. Finally, in some cases we observe dynamics in which restructuring firms remain isolated cases, while most firms refuse substantial changes and become the dominant group[1].

In particular, one of the main features - privatization - does not seem to produce immediate effects, also because former party bureaucrats have been turned into "managers", maintaining their previous responsibilities within a different hierarchy[2]. In this situation, we agree with Aghion *et al.* (1994) that the focus of the analysis should be on restructuring rather than on privatization[3].

While other papers[4] analyze aspects of managerial choices in isolation,

[1] Although these processes are heavily influenced by political events we shall not explicitly study, it is interesting to refer to Rodrik (1995) who, talking about "experiences ... full of surprises" raises a similar point as for political events.

[2] Several studies on Russia (Earle *et al.*, 1995; Commander *et al.*, 1995) indicate that ownership structure matters very little to firm's behavior, i.e., more precisely, that the share of different groups in the firm's ownership is a very poor explanatory variable in predicting firms' behavior. In the cases examined by these papers, workers' influence is extremely strong irrespective of the identity of the owner, and this is why we prefer to emphasize restructuring rather than privatization.

[3] A precise definition of "restructuring" depends on specific situations. Throughout the paper, we will label in this way the decision to cut the total wage bill in order to increase resources available for investments. This resembles what Aghion (1996) labels "reactive" restructuring, which seems to be the typical restructuring carried out in firms controlled by insiders.

[4] E.g., Blanchard and Aghion (1996). A result that somehow goes in the same direction is contained in Aghion *et al.* (1994), who indicate that the speed of restructuring increases with the size of the private sector.

here we take a different viewpoint, considering the interdependence among firms' decisions. Our starting point is that restructuring entails a sort of (positive or negative) network extemality[5], as the number of firms that have restructured affects other firms' incentives to restructure: in particular, two effects should be considered. First, if a firm lowers wages (and prices), the increase in competition reduces other firms' profitability. Secondly, lower wages allow the firm to produce higher output and distribute more value added in the form of (invested) profit. This demand creation effect is beneficial to aggregate demand and thus to all producers[6].

If the main effect of restructuring is this increase in value added, firms' interests coincide, so that the positive bandwagon effect seems the more natural outcome. On the other hand, if restructuring does not liberate substantial resources, but mainly affects a firm's ability to outdo rival producers, then as the number of restructuring firms increases, market competition becomes tougher. If the gains from restructuring decrease enough, the temptation for some firms to remain in the status quo is substantial. This simple intuition provides the basis for our analysis.

The idea of network externality naturally leads to the notion of critical mass[7], i.e., a situation in which the profitability of restructuring increases with the number of restructured firms if and only if the number of firms

[5]For a definition, see, for instance, Katz and Shapiro (1985), who also stress the problem of multiple equilibria that typically emerges in these cases. Another application of this notion is given by Dowd and Greenaway (1993). Notice that this literature mainly analyzes positive network externalities, while in the present context the sign of the network effect can vary.

[6]We will show later that these effects are more favorable (less harmful) for low-cost firms, which are better able to exploit demand increases and to tackle an increase in competition. Thus, if a firm decreases its wage bill this makes restructuring a relatively more appealing option for other firms, as they witness a heavier market pressure to become low-cost firms themselves.

[7]In this case the externality is positive and prevails over other forces in the economy like in Hansen (1997). Other papers which use the notion of critical mass in transition economies are Grosfeld (1994) and Kornai (1994). Roland and Verdier (1994) introduce the notion of critical mass in a politico-economic perspective.

which have already restructured is large enough. The "threshold" number of firms beyond which the bandwagon effect is sparked off is what we label "critical mass". In this paper, we do not assume its existence, showing under what conditions a critical mass effect emerges and is (or is not) relevant to the analysis of transition economies.

The existence of a network externality provides a rational basis for imitative behavior, that we introduce using evolutionary dynamics (Weibull, 1995). This also helps as a selection device, in that network externalities, generating multiple Nash equilibria, raise the issue of equilibrium selection. Specifying the (evolutionary) dynamics of choice helps us understand the conditions that lead to either equilibrium, and the evolutionary framework provides quite a natural set-up in this sense[8].

The structure of our model is as follows. At the outset, firms have different expectations about the effectiveness of restructuring and behave according to their intertemporal preferences and expectations[9]. Over time their behavior

[8]A similar viewpoint is at the basis of Berkowitz and Cooper (1997), who introduce adaptive learning in a microeconomic model of the transition process, which also display multiple equilibria.

This approach is also suggested by some empirical studies on transition economies. The behavior of firms depends on their expectations on the future of the economy and their understanding of the actual functioning of a market system. In some countries (e.g., the former Soviet Union) a large number of "managers" have little experience of a market economy, and firms have a limited endowment of human capital. Not surprisingly, their choices - probably based on a limited knowledge of how a market economy works - tend to suffer of substantial inertia as pointed out, for instance, by Commander et al. (1995) in a study on firms' decision making in Russia. Observed behavior seems to display a tendency to "follow the stream", and the assumption of evolutionary change in behavior, with its emphasis on bounded rationality and on the relevance of "local" (actual and past) experience and evidence for the decision making of economic agents, seems to fit quite well with these observations.

[9]More precisely, following the literature on evolutionary games, we assume that at the start of the transition we have a given initial distribution of firms between two types. Firms of the former type accept to reduce wages and to invest, while firms of the latter type disregard the need to compete in a market, stick to the status quo attitude and pay higher wages.

changes, following an imitative process in which more successful strategies are adopted by an increasing number of firms. This in turn affects the performance of firms and of the whole economic system, which is modeled in a very general way. The process ends when either all firms adopt the same behavior (complete transformation, or re-establishment of the status quo) or the distribution of firms is such that both strategies yield the same payoffs to the decision makers (i.e., the workers), so that nobody has an incentive to revise his behavior.

The latter case occurs when the mixed distribution is stable, i.e. is the "equilibrium" towards which the system tends. Under these circumstances, imitative behavior "naturally" pushes some firms back to old habits. In the former one, if there is a distribution of firms' strategies such that nobody has an incentive to change strategy (a mixed equilibrium), this is unstable, and thus it represents the "critical mass". The goal of the analysis is to characterize either situation, in the attempt to single out which economic conditions may help or hinder the transformation process.

We have a critical mass case when restructuring liberates substantial resources and thus has a large impact on aggregate demand, and when individual firms' profitability depends heavily on the country's performance rather than on their ability to compete against rival home firms. If these effects are large, the performance of firms depends on a major common factor, i.e., the macroeconomic impact of wage dynamics, and thus they eventually tend to behave in the same way; if for some (exogenous) reason the critical threshold is reached, all firms will eventually restructure, and vice-versa.

The paper is organized as follows. Section 2 lays down the model. Some preliminary results are obtained in Section 3. Section 4 analyzes the dynamics of the economy and discusses the conditions for the critical mass case. Sections 5 contains some concluding remarks and a sketch of some tentative policy implications of our analysis.

2 Restructuring and firms' behavior: the basic model

We model the dynamics of an industry, in which a given number of firms (N) compete. Firms' property rights have been given to insiders, so that we have a sort of labor-managed firm, in which no distinction between "workers" and "firm" is made. Wages and investments are decided by the firm.

The firms' objective function

In each instant, each firm has a utility function depending on its workers' present and future consumption. No borrowing is allowed, so that present consumption coincides with the current wage w. Future consumption depends on the ability of the firm to produce and distribute incomes in the future, and its discounted value is thus proportional to current investment[10], y. It seems therefore convenient to specify firm i's realized utility (payoff) directly as a function of current wage and investment levels[11]:

$$P_i \equiv \gamma_i y_i + \lambda w_i \tag{1}$$

with $\gamma_i, \lambda > 0$. Thus, workers care about two things: the "soundness" of their firm, and the real wage they obtain. With no loss of generality, λ will be set equal to one.

The weight γ_i is firm-specific, in that workers differ in their perception of the relationship between present investments and future incomes[12]. Some firms believe that giving up current incomes will have a high return, others expect restructuring to provide a poorer result. We label the first group type

[10]The relationship between wage reduction and investments is typically not automatic, but the crucial aspect for our purposes is that a wage cut improves the future prospects of the firm. the relationship between performance/investment and the relevant economic variables will be analyzed in the following section

[11]The linearity of the relationship between utility and investment entails no particular loss of generality. Any monotone transformation would yield similar results.

[12]This can be expressed either in terms of different degrees of "optimism" in the reform process or in a difference in the model of the economy each firm has in mind.

1 and the second one type 2, so that[13] $\gamma_1 > \gamma_2$.

This assumption seems especially plausible in an environment in which economic agents have no experience of the functioning of a market economy. Furthermore, economies in transition have so far worked under very distorted conditions, and - also given the lack of reliable data - it is extremely hard to guess how well they are going to perform in a market context. At least in the medium run identifying "the" correct model for such economies appears an extremely difficult task.

Wages and investments

In determining their wage and investment levels, workers have two options. The first one is to restructure the firm, accepting a low wage now (w_R) in exchange for a better prospect of future earnings. The second one is to have a conservative attachment to the status quo, entailing a higher current wage $w_S > w_R$ at the expense of investment and of a higher probability of future liquidation of the firm[14]. It is quite clear that the same idea might be re-formulated in several ways. The key point is that some firms aim at strengthening their long term competitive positions, while others prefer to reap short term benefits by postponing investments, stripping the firm's assets, and so on[15].

[13] In the spirit of the literature on evolutionary games, we do not try to endogenize these types.

[14] Sachs (1993) argues that an extreme "liquidatory" behavior prevailed in Poland in the second half of the Eighties. In different periods, both in Poland and in Russia wages shot up with no relation to labor productivity. A predatory behavior of almost illegal nature is reported by several authors, e.g. Frydman and Rapaczinsky (1994), Kornai (1992), Pinto *et al.* (1993). The fear that rent-seeking behavior might prevail over entrepreneurship is also expressed by Grosfeld (1994). Similar problems emerge when managers control the firm. When too many exogenous factors are at work, the measurement of a manager's future performance is unreliable, and rewarding the manager for long term decisions is highly problematic. Furthermore, Frydman and Rapaczynski (1994, p. 164) point out that very often managers are old regime figures that are likely to be sacked anyway once full privatization is achieved.

[15] The choice between restructuring or not is the typical binary choice, that can be usefully tackled within the present set-up; however, some agents might look for a "third

Investment is defined as the value added (V_i) that firms decide not to distribute: $y_i \equiv V_i - w_i$. This entails a trade-off: if workers decide for a high wage, their present income is higher, but at the cost of a lower expected future income. Furthermore, firm i's "performance" V_i depends on the wage decision in that a higher wage reduces the ability of the firm to generate value added, so that $dV_i/dw_i < 0$ or more precisely - given our framework - $V_R > V_S$. The reason is that a wage increase does not simply entail a redistribution of surplus to workers, but also a lesser ability to compete in the market; as costs are higher, output is reduced and so is value added[16].

As for the aggregate consequences of restructuring, we have to consider two effects. The direct effect is the one just pointed out, i.e. a firm that restructures can distribute a higher value added. On the other hand, because of competition the restructuring of one firm can have a negative impact on other firms' situation (in equilibrium, other firms' output levels decrease). Here we assume that the former, direct effect dominates, while in Appendix 2 we show in a Cournot framework under which conditions this assumption holds[17].

As the performance of the whole economy depends on the wage setting convention that prevails in the system, i.e., on whether restructuring firms prevail on "conservative" ones, it will be crucial to investigate the dynamics

way", an intermediate option with lower short run costs and long-run benefits. Although this could represent an interesting extension of the present analysis, a satisfactory study in this direction would require a technically demanding and lengthy analysis, and is thus outside the scope of this paper.

[16]Indeed, one might think of "R-firms" as close to long-term profit maximizers, and of "S-firms" as more standard labor managed firms. A standard comparison between profit maximizing firms and labor managed firms produces this result (Delbono and Rossini, 1992). As shown in Appendix 1, this assumption holds even if restructuring does not affect the firm's objective function.

[17]Notice that this means that we are assuming that an increase in average wage decreases total value added (i.e., aggregate demand); this is simply a formalization of the traditional argument in favor of restructuring firms in transition economies (unless this condition is met, why should restructuring be desirable to transition economies?).

of these two behavioral types, trying to understand which factors might help R-type firms to prevail. In each instant, there are n R-type firms and $N-n$ S-type firms. Therefore, if we define $\mu \equiv n/N$, average wage is $\widetilde{w} \equiv \mu w_R + (1-\mu)w_S$ and $\widetilde{V} \equiv nV_R + (N-n)V_S$ is total value added.

2.1 Restructuring and interaction among firms

The decision of a firm to restructure entails different effects on other firms, that operate through two logically distinct channels.

l. By increasing value added, restructuring fuels aggregate demand, and this increases the incentive for other firms to exploit such market opportunity As restructuring renders a firm better able to compete and gain, this represents a *positive* (network) externality, such that the payoff of restructuring increases with the number of firms that have already adopted such strategy.

2. Restructuring reduces costs and allows a firm to change its competitive behavior. Without modeling competition in detail, we only assume that some minimal conditions are satisfied:

a) there is a positive relationship between a firm's cost and the price it charges (or a negative relationship between cost and market share) ;

b) if a firm sets a lower price, its rivals' profits are negatively affected, so that a firm facing tougher competition is induced to respond to it.

These assumptions imply that restructuring brings about a better ability to compete in the market, and that it produces a profit-stealing effect on other firms. Therefore, on the one hand, an increase in the number of restructuring firms makes it more difficult for inefficient firms to survive, providing an incentive for other firms to restructure (*positive* network externality). On the other hand, when the number of restructuring firms is high, market competition might drive profit to a very low level; at this point, giving up higher wages might become no longer worthwhile, because the low profitability entails anyway a limited ability to invest (*negative* network externality).

Therefore, the final effect can be either positive or negative, depending on which of these effects prevails. To investigate these relationships, we specify

firm i's investment as follows:

$$y_i = f[w_i, \widetilde{w}, p^*, D(p^*, \widetilde{w})] \tag{2}$$

where p^* denotes the price of imported goods, and D denotes aggregate demand. Demand is defined as the sum of incomes produced in the sector we focus on, $\widetilde{V}$, and of incomes produced elsewhere in the economy (d): $D \equiv \widetilde{V} + d$. We formalize previous assumptions as follows

$$\frac{\partial f}{\partial w_i} < 0, \ \frac{\partial f}{\partial \widetilde{w}} > 0, \ \frac{\partial f}{\partial p^*} > 0 \text{ and } \frac{\partial f}{\partial D} > 0 \tag{3}$$

Thus, firm's profitability depends on several factors. First of all, we have the wage paid to workers, which has a negative effect on the resources available for investment. As for the prices chosen by other firms, that depend on $\widetilde{w}$ as regards home firms, an increase in any of them reduces the competitive pressure on firm i and increases its profitability[18]. In the same way, an increase in aggregate demand increases firm's profits. As previously argued, we assume $\partial D/\partial \widetilde{w} < 0$: total value added increases when more firms decide to restructure.

Notice that this elementary structure is extremely standard, apart from the non-negligible feature that - following an extensive empirical evidence on Eastern European economies - wages are not explicitly linked to labor productivity.

3 The dynamics of firms' decision-making

We have thus seen that the interaction we consider generates network externalities, and we know from the existing literature[19] that we typically have

[18] Obviously, this requires the firm's efficiency not to be affected by competition. We will see in the conclusions to what extent considering this possibility can enrich our result.

[19] The literature is fairly rich, but mainly concentrates on the adoption of new technologies. Katz and Shapiro (1985) synthesize some of the more relevant issues.

multiple equilibria. In general, as we will see, if no other firm has restructured, it might not be optimal for a firm to restructure, because the necessary "critical mass" is not yet there. Depending on the relative strength of previous effects, several cases are here possible, e.g.:

- if many other firms have restructured it might be advantageous to do the same thing, either because aggregate demand is so high, that there is the possibility to obtain substantial advantages, or to avoid the penalties that market competition imposes on inefficient firms;
- in other cases, if a large enough number of firms have restructured, competition may reduce current profits so much, that the incentive to do the same thing might vanish, and in equilibrium firms behave in different ways.

As argued in the introduction, it seems useful to use the logic of evolutionary games to select among the above possibilities, characterizing under what conditions each equilibrium will be reached and whether or not "critical mass" effects really exist. These ideas can be developed along the following lines.

We assume that at time 0 type 1 firms (which are n_0) set a wage equal to w_R, while the others set a wage equal to w_S. This means that the beliefs of the workers determine the initial distribution of choices as regards wages[20], so that at the beginning type 1 firms are ready to bet on the future and invest more than type 2 firms. Thus payoffs for the two groups at time 0 are, respectively:

$$P_1^0 \equiv \gamma_1 y + w_R \tag{4}$$

and

$$P_2^0 \equiv \gamma_2 y + w_S \tag{5}$$

[20]Technically, this simply provides the initial conditions for the dynamics.

Each firm observes the behavior of other firms and behaves adaptively. Firms change their behavior if they realize that - given their own preferences, i.e. their own γ_i - they could obtain a higher payoff imitating the other strategy, while they maintain their previous behavior otherwise[21]. In an environment where decision makers are unable to single out the optimal strategy, the assumption that other firms' performance is an important guideline is probably a sensible starting point for an analysis of behavioral change[22].

Type 1 firms change their behavior if and only if $\gamma_1 y_R + w_R < \gamma_1 y_S + w_S$, i.e. iff

$$\Delta w > \gamma_1 \Delta y \tag{6}$$

where $\Delta w \equiv w_S - w_R > 0$ and $\Delta y \equiv y_R - y_S > 0$: restructuring will be abandoned if the short term gains the firm can get are higher than long term perceived benefits. An analogous condition for type 2 firms to change their behavior after the initial choice is

$$\Delta w > \gamma_2 \Delta y \tag{7}$$

The above conditions can be interpreted as follows. Δw represents the opportunity cost of restructuring in terms of foregone current income, and it is the same for all firms. $\gamma_i \Delta y$ is instead the benefit from restructuring as *perceived* by type i firms, and depends on the firm's expectation on the

[21] This change in behavior only requires a different perception of what the best strategy is, and not an actual change in preferences. The issue of endogenous changes in preferences is probably a relevant one in contexts of radical cultural changes, but its consideration is beyond the scope of the present analysis. A recent step in this direction is provided by Bisin and Verdier (1996).

[22] In a market economy, where a large amount of information circulates quite freely, this assumption would be extremely restrictive. In an economy where (bad) statistics are produced quite randomly, the assumption that firms can observe their rivals' performance might - on the contrary - be considered too "generous". The complaints of OECD and the World Bank about the production of data, for instance, in Russia are quite well known.

future viability of the economy. Notice that conditions (6) and (7) cannot be simultaneously met, so that we can only have one-direction shifts. However, it is possible that no type of firm revises its initial choice, when

$$\gamma_2 < \frac{\Delta w}{\Delta y} < \gamma_1 \tag{8}$$

Therefore, starting from the initial conditions (4) and (5), the number of R-firms evolves according to the following dynamics.

$$n_{t+1} = n_t + g(n) \tag{9}$$

where

$$g(n) \equiv \begin{cases} 1 & \text{iff} \quad \Delta w < \gamma_2 \Delta y, \ n_t < N \\ -1 & \text{iff} \quad \Delta w > \gamma_1 \Delta y, \ n_t > 0 \\ 0 & \text{iff} \quad \gamma_2 \leq \frac{\Delta w}{\Delta y} \leq \gamma_1 \end{cases} \tag{10}$$

The term $g(n)$ expresses the change in n, and it is defined so that its value can be either 1 or -1 in case the payoff differentials are large enough, or else 0. Moreover $g(n) = 0$ under the following complementary slackness conditions:

$$\begin{cases} \Delta w < \gamma_2 \Delta y & \text{with} \quad n_t = N \\ \Delta w > \gamma_1 \Delta y & \text{with} \quad n_t = 0 \end{cases} \tag{11}$$

In other words, the timing of the model is chosen in such a way that at each "tick" of the clock (at most) one firm decides to switch to the other type if this turns out to be rewarding. Given the assumptions of the model, the direction of adjustment is always unambiguous.

As γ_i and Δw are exogenous, the endogenous factors affecting behavioral dynamics operate via Δy, and in particular we have to understand how Δy varies with the number of firms that prefer to restructure. Let us first establish two preliminary results.

Denote by n^* the number of R-type firms to which the dynamics (9) converges eventually. We moreover define two crucial values of $\mu \equiv n/N$ as

$$\overline{\mu}_1 : \ \gamma_1 \Delta y(\overline{\mu}_1) = \Delta w \tag{12}$$

and

$$\overline{\mu}_2 : \ \gamma_2 \Delta y(\overline{\mu}_2) = \Delta w \tag{13}$$

Given the integer constraint, we then have to define the set $E \equiv [\min(\overline{\mu}_1, \overline{\mu}_2), \max(\overline{\mu}_1, \overline{\mu}_2)] \cap \left\{\frac{n}{N}\right\}_{n=1}^{N}$, i.e. the set of possible values of μ lying between the two critical values $\overline{\mu}_1$ and $\overline{\mu}_2$; the generic element of E is denoted by e. Let us consider for the moment the case in which E is non-empty, so that the interval between $\overline{\mu}_1$ and $\overline{\mu}_2$ contains at least one value of n/N . Then define $\overline{n}_1 \equiv N \min_{e \in E}[d(e, \overline{\mu}_1)]$ and $\overline{n}_2 \equiv N \min_{e \in E}[d(e, \overline{\mu}_2)]$, where d stands for Euclidean distance. In other words, $\overline{n}_1/N$ is the possible fraction of R-firms lying between the two critical values $\overline{\mu}_1$ and $\overline{\mu}_2$which is closest to $\overline{\mu}_1$, and accordingly for $\overline{n}_1/N$ and $\overline{\mu}_2$; notice that if E is a singleton, then $\overline{n}_1 = \overline{n}_2$. In other words, $\overline{n}_1$and $\overline{n}_2$ are the closest integers to the cut-off values $\overline{\mu}_1$ and $\overline{\mu}_2$, at which the marginal benefit of restructuring equals its marginal cost.

Therefore, when the proportion of firms opting for restructuring is equal to $\overline{n}_1/N$, optimistic firms are indifferent between maintaining low wages and going back to the status quo, as the two strategies yield the same payoff. Analogously, when the proportion is $\overline{n}_1/N$, type 2 firms are indifferent between the two strategies[23]. Now we have to try and understand the relationship between these two values, which in turn will allow us to determine the properties of (9) and to analyze the dynamic stability of this economy.

Combining (12) and (13), one can see that $\Delta y(\overline{\mu}_2) > \Delta y(\overline{\mu}_1)$. This implies that $\overline{\mu}_1 < \overline{\mu}_2$ if and only if $\Delta y(\mu)$ is an increasing function of μ. Considering (9), this establishes our preliminary results:

Lemma 1 *If* $\frac{\partial(\Delta y)}{\partial \mu} < 0$, *then: a)* $\overline{n}_1 > \overline{n}_2$; *b) if* $n_0 > \overline{n}_1$, *then* $n^* = \overline{n}_1$; *if* $n_0 < \overline{n}_2$ *then* $n^* = \overline{n}_2$ *if* $\overline{n}_2 \leq n_0 \leq \overline{n}_1$, *then* $n^* = n_0$.

[23] Of course, there might be cases in which adopting a certain behavior is a dominant strategy, but these cases are fairly straightforward and will not be analyzed explicitly.

Lemma 2 *If* $\frac{\partial(\Delta y)}{\partial \mu} > 0$, *then: a)* $\overline{n}_1 < \overline{n}_2$; *b) if* $n_0 < \overline{n}_1$, *then* n^*=0; *if* $n_0 > \overline{n}_2$, *then* $n^* = N$; *if* $\overline{n}_1 \leq n_0 \leq \overline{n}_2$, *then* $n^* = n_0$.

The interpretation of these apparently cumbersome results is indeed extremely simple and intuitive. In the first case, when the difference in the investment levels that restructuring firms are able to undertake decreases with the number of firms that adopt such strategy, Lemma 1 tells us that we eventually converge towards a "mixed" equilibrium, where not all firms are going to be restructured (see Figure 1a). Unless the initial number of "optimists" is between the two crucial levels (in which case, nobody has an incentive to move) we will converge towards one of the extremes. If the number of "optimists" is large enough, we converge towards $\overline{n}_1$, otherwise $\overline{n}_2$ will be eventually reached. When the economy is in one of the two extremes, no group has an incentive to change its strategy, and the dynamics comes to an end.

In the second case, unless the starting point is between the two critical levels defined by (12) and (13), we have an "all or nothing" situation, i.e., one in which if the initial number of type 1 firms is large enough, all will follow the example; otherwise, the economy tends to recede to the status quo (see Figure 1b).

[Figures 1a, 1b about here]

If the initial proportion of R-firms lies within the "zone of inertia" between the two critical values, then the current state will be preserved and all firms will stick to their original choices[24].

[24]A purely technical remark is in order. All previous conclusions rely upon the assumption that the set E is nonempty, which amounts to require that N be large enough to permeate the interval $[0,1]$ with a dense enough pattern of values of n/N as n runs from 0 to N, thus hitting the critical interval $[\min(\overline{\mu}_1, \overline{\mu}_2), \max(\overline{\mu}_1, \overline{\mu}_2)]$. If E is indeed empty, then it is never the case that a possible proportion of R-firms lies within the "zone of inertia", and both $\overline{n}_1$ and $\overline{n}_2$ fail to exist. In this case, it is easily checked that the dynamics will never stop upon a stationary value but will permanently oscillate between the

4 Characterization of equilibrium and emergence of critical mass effects

The next step in the analysis is now to try and understand the economic conditions that lead to the two situations identified in Lemmas 1 and 2. From (2)-(3) above, we can see that

$$\begin{aligned} \frac{dy_i}{d\mu} &= \frac{\partial f}{\partial \widetilde{w}}\frac{d\widetilde{w}}{d\mu} + \frac{\partial f}{\partial D}\frac{\partial D}{\partial \widetilde{w}}\frac{d\widetilde{w}}{d\mu} = \\ &= \frac{d\widetilde{w}}{d\mu}\left[\frac{\partial f}{\partial \widetilde{w}} + \frac{\partial f}{\partial D}\frac{\partial D}{\partial \widetilde{w}}\right] \end{aligned} \tag{14}$$

Therefore, given that $d\widetilde{w}/d\mu = -\Delta w < 0$ is the same for all firms (i.e., it does not depend on w_i), we have

$$\begin{aligned} \frac{d(\Delta y)}{d\mu} \propto & -\left[\frac{\partial f}{\partial \widetilde{w}}(w_R) - \frac{\partial f}{\partial \widetilde{w}}(w_S) + \frac{\partial f}{\partial D}\frac{\partial D}{\partial \widetilde{w}}(w_R) - \frac{\partial f}{\partial D}\frac{\partial D}{\partial \widetilde{w}}(w_S)\right] = \\ & -\left[\frac{\partial f}{\partial \widetilde{w}}(w_R) - \frac{\partial f}{\partial \widetilde{w}}(w_S)\right] - \frac{\partial D}{\partial \widetilde{w}}\left[\frac{\partial f}{\partial D}(w_R) - \frac{\partial f}{\partial D}(w_S)\right] \end{aligned} \tag{15}$$

The sign of expression (15) depends on the signs of the expressions in square brackets, i.e., on the answers to two crucial questions:

- does a (marginal) increase in other firms' costs help low cost firms more than high cost firms?
- does a (marginal) increase in demand help low cost firms more than high cost firms?

two consecutive values of n/N boxing the critical interval $[\min(\overline{\mu}_1, \overline{\mu}_2), \max(\overline{\mu}_1, \overline{\mu}_2)]$. This implies that there will always be a "marginal" firm perpetually switching between the R- and the S-strategy: given the choices of all other firms, any choice whatsoever will cause the alternative strategy to become more rewarding, to bring about the opposite situation as the latter is adopted in the subsequent period, and so on. This is, however, a special case of limited interest: it is sufficient to assume that the switching entails a suitable amount of adjustment costs to rule it out. It will therefore be ignored in the following analysis.

In general, these answers depend on the model of market behavior one has in mind; it is plausible to think that different models might yield different answers, especially because in situations like the one we want to describe market "games" can be extremely different from the ones we are used to analyze. However, we believe that in most cases both answers are positive, as long as prices move "somehow" in line with costs (i.e., wages). Our argument - supported by a Cournot example in the Appendix - runs as follows.

An increase in $\tilde{w}$ has two effects on the profit of a firm of a given wage level. On the one hand, the average output level of firms in the market decreases, forcing a price increase (Δp); at the same time the distribution of output levels changes, so that the firm can exploit its improved competitiveness, increasing its output level by Δx_i. This entails an increase in profit, which depends on that firm's cost in the following way:

- given Δp, the profit increase is larger, the higher the level of output, i.e. the lower the firm's cost;
- given Δx_i, the profit increase is larger, the larger the price-cost margin, .i.e. - again - the lower the cost.

Therefore, both effects favor low wage firms[25] [see Appendix 1], and we can thus assume that

$$\frac{\partial(\Delta y)}{\partial \tilde{w}} \equiv \frac{\partial f}{\partial \tilde{w}}(w_R) - \frac{\partial f}{\partial \tilde{w}}(w_S) > 0 \tag{16}$$

An analogous argument applies to increases in demand. A market expansion allows both price and output increases, and the profit increase is larger for the firm which is better able to exploit market dynamics, i.e. for the low wage firm. Therefore:

$$\frac{\partial(\Delta y)}{\partial D} \equiv \frac{\partial f}{\partial D}(w_R) - \frac{\partial f}{\partial D}(w_S) > 0 \tag{17}$$

[25]Notice tha, although we concentrate on monotonic dynamics, we could have non-monotonic cases, in which the signs of the conditions below change over time as n changes.

Thus, both terms in square brackets in expression (15) are positive, and we have two conflicting effects. It is convenient to re-write (15) as follows:

$$\frac{d(\Delta y)}{d\mu} \propto \frac{\partial(\Delta y)}{\partial \widetilde{w}} - \frac{\partial(\Delta y)}{\partial D}\frac{\partial D}{\partial \widetilde{w}} \tag{18}$$

where the first term on the RHS is negative, while the second, given $\partial D/\partial \widetilde{w} < 0$, is positive. Expression (18) summarizes the findings of this section, that can be organized distinguishing two cases.

Proposition 3 *If* $\frac{\partial(\Delta y)}{\partial D}\frac{\partial D}{\partial \widetilde{w}}$ *is small enough, then the economy will eventually tend to a mixed equilibrium, i.e., a mixed stationary state is stable.*

In this case, the sign of (18) is negative, so that we are in the case of Lemma I.

When $n < \overline{n}_1$, the payoff of firms that are restructuring is higher than the one of the others, so that more firms decide to restructure their business. However, when $n > \overline{n}_2$ the reverse is observed: the number of restructuring firms is "too large" and hence some of them shift to a high wage policy.

The economic intuition for this result can run as follows. Here the dominating effect in (18) is the first one, which depends on the relative competitiveness of firms inside the country. This effect is important when μ is small, i.e. when the average wage of the country is high: in this case, R-type firms are "rare" and if a S-type firm decides to restructure its profit increase is large because market competition is not fierce. On the other hand, if μ takes on a higher value, competition is already quite tight so that profit increases accruing to firms that moderate their wage claims cannot be substantial. This is why when "too many" firms restructure, the payoff of the firms which refuse to do so can be greater: as the gains from being more efficient are small, it might be preferable to reap short term gains.

In the opposite case, we have the following

Proposition 4 *If* $\frac{\partial(\Delta y)}{\partial D}\frac{\partial D}{\partial \widetilde{w}}$ *is large enough and the initial distribution of firms is not in the interval* $[\overline{n}_2, \overline{n}_1]$*, we have a critical mass effect, so that*

the economy either goes back to the status quo (when $\mu_0 < \overline{n}_2$) or achieves a complete restructuring. In other terms, mixed stationary states are unstable.

In this case, (18) is positive and, if mixed stationary distributions of firms exists, they tend to be unstable, at least for large enough perturbations (see Lemma 2). This means that now the adaptive dynamics tends to move away from that specific distribution of firms: when $\mu < \overline{\mu}_2$, the payoff of restructuring firms is lower than the one of those who stick to the status quo, so that the number of the firms in the latter group tends to increase. When $\mu > \overline{\mu}_1$, the number of restructuring firms tends to increase further. In this case the dynamics tends to make one type prevail on the other: if the initial number of firms opting for restructuring is sufficiently large, the others will follow. If that number is too low, then a conservative behavior will appear to be more rewarding, and will attract all firms. This is what we usually mean by "critical mass" effect.

The economic intuition runs as follows. In this second case, a greater demand is severely hampered by wage increases, which decrease competitiveness and investments, and the main factor contributing to a firm's performance is aggregate demand, which depends on $\widetilde{w}$. If the number of restructuring firms is large enough, the average wage is low, and therefore demand will be large enough to make a "myopic" behavior less rewarding. Now it pays off to follow the mass, because the driving force of the process is linked to the performance of the economy as a whole, and not so much to the relative competitiveness of a firm vis à vis the others. Notice that this case is likely to be relevant when $\partial(\Delta y)/\partial D$ is large, i.e., when the firms' dependence on the internal market is substantial.

In conclusion, restructuring increases the competitive pressure exerted on other firms. This hurts high-cost (S-type) rival firms more than low-cost ones, and thus makes restructuring more appealing.

5 Concluding remarks.

Our analysis has shown how the transition process may depend on the number of firms already restructured. We have a critical mass effect when wage determination affects the country's competitiveness substantially, and has a relatively small effect on a firm's competitive position vis à vis other firms. The model we have used so far can be extended in several ways. Two possibilities are the following.

The role of international trade.

The performance of firms depends on international trade and on international competitiveness through at least two channels: - an increase in p^* improves the firms' competitiveness; - as a consequence, an increase in p^* allows firms to increase investment, as it affects aggregate demand positively.

Given the previous analysis, it is easy to see that the crucial thing is to understand what kind of firm will benefit more from protectionism, i.e. the sign of $d(\Delta y)/dp^*$. Following the argument already illustrated, it seems reasonable to think that more efficient firms are better equipped to exploit market opportunities, so that $d(\Delta y)/dp^* > 0$.

This means the following. If the mixed equilibrium is stable, an increase in p^* increases the number of firms that restructure in equilibrium. In the case of critical mass, it can be shown that some protectionism decreases the mass, so that the likelihood that the economy converges to the "good" equilibrium increases. Thus, in both cases, some protectionism seems to be favorable to restructuring.

The role of slack.

Another possible extension would be to consider that firms do not necessarily choose inputs to attain cost minimization, or that output is not maximized for any given combination of the inputs, and that this inefficiency depends on the competitive pressure perceived by the firm[26]. If the efficiency

[26]In other terms, we accept here the so called Hicks' conjecture, that has recently been investigated by a number of papers (e.g., Hermalin, 1992) pointing out some of its weaknesses. Given the starting point of Eastern European economies, however, we feel that

of each firm depends negatively on a slack parameter, that increases with the prices of other firms, and if this effect is strong enough, it might reverse a few of our results.

First of all, $\partial f/\partial \tilde{w}$ might be negative, i.e., an increase in the costs of rival firms might induce a producer to relax the spur to efficiency, reducing its ability to invest and its future prospects. If this effect is still stronger for low cost firms than for high cost firms - as seems likely in the context already analyzed - then we might have that $d(\Delta y)/d\mu$ is always positive. This implies that in the presence of managerial slack the critical mass effect should be considered a typical feature of these processes, and that we would never have a stable mixed equilibrium[27].

The critical mass case thus emerges when restructuring is very beneficial for total income, and when competition affects a firm's internal efficiency, which is probably the most general case. With the caution that a stylized model like the one we have used renders necessary, we should stress that in this situation an initial boost to the economy in the "right" direction (in the sense of the so called "big-bang" approach[28]) makes sense, as it appears necessary to complete the transition process.

This can be achieved in different ways, such as subsidizing firms that restructure, or penalizing firms whose behavior is inconsistent with a good long-term performance: any way to amplify the difference in performance between "good" and "bad" firms will do. In particular, given the known difficulty of labor-managed firms in raising outside capital, helping them to raise the capital necessary for restructuring might be crucial. This stresses the relevance of hard budget constraints, which in this setup become ways to

efficiency gains are of such magnitude that this conjecture should be considered a good working hypothesis.

[27]Notice that in this case protectionism may no longer be a sensible policy prescription: on the contrary, trade liberalization would become preferable, as it fosters efficiency. This conclusion holds unless the pressure coming from foreign products is such that even restructuring firms are forced out of the market.

[28]On this point, see e.g. Lipton and Sachs (1991) and Murphy, Shleifer and Vishny (1992).

punish firms which tend to disregard the firm's financial soundness; however, as costs may come both from higher wages and from higher investments, a closer control to investments per se and a different treatment of different parts of a firm's budget would be in order.

As the main and most natural reward to firms comes from their market performance, a proper functioning of competition is extremely important. In our set-up, competition is necessary to introduce a difference between low-cost and high-cost firms. An obviously essential feature of competition is price liberalization, that should therefore precede privatization. In sectors where spontaneous privatization is expected to be the driving force, the correct policy sequence should see liberalization first, as this is a precondition for the functioning of the incentive mechanism represented by market rivalry.

6 Appendix 1

We consider here a linear Cournot model with asymmetric costs. In a market for a homogeneous product, N firms compete in a quantity-setting game. If x_i denotes firm i's output and p is the price, the demand function is:

$$p = a - bX \tag{A1}$$

where $X = \sum x_i$, with a, $b > 0$. Labor is the only input, and its marginal productivity is constant. Therefore, firm i's cost function is

$$C_i = c_i x_i \tag{A2}$$

We can thus distinguish firms depending on their wage levels. In line with the model in the text, we have two types of firms. As type R firms pay a lower wage than type S firms, we have $c_S > c_R$. We have n type R firms, so that $X = nx_R + (N - n)x_S$.

Firms maximize profit, taking the output levels of other firms as given.

The reaction functions of type 1 firms are:

$$x_R = \frac{a - (N-n)bx_S - c_R}{(n+1)b}$$

and analogously for firm 2 we have

$$x_S = \frac{a - nbx_R - c_S}{(N-n+1)}$$

Equilibrium output levels then are:

$$x_R = \frac{a - (N-n+1)c_R + (N-n)c_S}{(N+1)b} \tag{A3}$$

and

$$x_S = \frac{a + nc_R - (n+1)c_S}{(N+1)b} \tag{A3'}$$

Total output is

$$X = \frac{Na - nc_R - (N-n)c_S}{(N+1)b} \tag{A4}$$

whereas equilibrium price is

$$p = \frac{a + nc_R + (N-n)c_S}{N+1} \tag{A5}$$

In conclusion, profit levels of firms for the two types are

$$y_R = \frac{(a - \widetilde{c}_R)^2}{b(N+1)^2} \tag{A6}$$

and

$$y_S = \frac{(a - \widetilde{c}_S)^2}{b(N+1)^2} \tag{A7}$$

where $\widetilde{c}_R \equiv (N-n+1)c_R - (N-n)c_S$ and $\widetilde{c}_S \equiv (n+1)c_S - nc_R$. These formulas are straightforward extensions of the symmetric case, and it is easy to see that $\widetilde{c}_S - \widetilde{c}_R = (N+1)(c_S - c_R) > 0$, so that $y_R > y_S$ (low wage firms have a larger profit). Moreover, $\partial\widetilde{c}_S/\partial n = \partial\widetilde{c}_R/\partial n = c_S - c_R > 0$.

We can now define $\Delta y \equiv y_R - y_S$, whose expression is

$$\Delta y \equiv \frac{(a-\widetilde{c}_R)^2-(a-\widetilde{c}_S)^2}{b(N+1)^2} = \frac{(\widetilde{c}_S-\widetilde{c}_R)(2a-\widetilde{c}_S-\widetilde{c}_R)}{b(N+1)^2} > 0 \qquad \text{(A8)}$$

Taking first derivatives of (A8) with respect to the relevant variables, it is easy to see the following:

$$\frac{\partial \Delta y}{\partial n} = -\frac{2(\widetilde{c}_S-\widetilde{c}_R)(c_S-c_R)}{b(N+1)^2} < 0 \qquad \text{(A9)}$$

An increase in the number of low-cost firms decreases all profits as this entails an increase in competition. The effect of an increase in n is larger for more efficient firms (for which the term $a-\widetilde{c}_i$ is larger). The interpretation is easy, in that it states that an increase in average wage (decrease in n) especially benefits more efficient firms.

Analogously, interpreting a as an index of the level of (aggregate) demand, we can see that

$$\frac{\partial \Delta y}{\partial a} = \frac{2(\widetilde{c}_S-\widetilde{c}_R)}{b(N+1)^2} > 0 \qquad \text{(A10)}$$

An increase in demand benefits all firms in proportion to the price-cost margin they are able to achieve. Therefore, their benefit is inversely proportional to their cost levels: an increase in market size (a) increases profits of more efficient firms more than those of less efficient ones.

7 Appendix 2

Here we show under what conditions, within the standard set-up already employed in Appendix 1, total value added increases when the number of firms which restructure increases. Notice first that all costs are labor costs. Therefore, value added of firm i, the sum of profit and the wage bill, is

$$V_i \equiv y_i + C_i = px_i \qquad \text{(A11)}$$

This already proves that, given $x_R > x_S$, $V_R > V_S$. This is the direct effect of restructuring mentioned in the paper. As for *total* value added produced in this industry, we have to consider the sum of firms' revenues:

$$\widetilde{V} = nV_R + (N-n)V_S = p(nx_R + (N-n)x_S) \tag{A12}$$

Restructuring entails an increase in output and a decrease in prices. With an iso-elastic demand function, industry revenues increase with restructuring as long as the elasticity of demand is larger than one.

In the present formulation, using expressions (A4) and (A5) we can see that

$$\widetilde{V} = \frac{(a+K)(Na-K)}{(N+1)^2 b} \tag{A13}$$

where $K \equiv nc_R + (N-n)c_S$ and $\partial K/\partial n = c_R - c_S < 0$. If more firms restructure, X increases, while obviously p decreases. value added increases with n if and only if $\partial \widetilde{V}/\partial K < 0$, i.e.

$$-2K + a(N-1) < 0 \tag{A14}$$

Expression (A14) is negative when K is large enough relative to a, i.e. if the industry's total cost is large enough relative to market size (i.e., when equilibrium output lies in the region of demand where elasticity is greater than 1). Under this assumption, total value added increases when firms restructure.

Remark I.

As already indicated, our condition is *always* met as long as demand elasticity is greater than 1.

With linear demand, as indicated by condition (A14) the stability properties may change. Indeed, an increase in n decreases K so that there is the possibility (but only the possibility) that this condition holds for certain values of n but may be violated "later on", if n increases. For instance, assume that at the outset of the process (A14) is met and that we are in the critical mass case. If the dynamics of the system leads to an increase in wages, this condition will a fortiori be met later on, and the economy will converge to a "bad" equilibrium. If, on the contrary, restructuring is the prevailing strategy at the beginning, n tends to increase, and it is possible

that at some point we would move from the critical mass case to the case in which mixed equilibria are stable. In other words, convergence towards the "good" equilibrium could be braked by the wage drop, thereby stabilizing the economy upon a socially inefficient outcome.

Remark 2

In this example, we have assumed that the wage change is not associated to a change in the firm's objective function, i.e., profit maximization. If restructuring does not simply entail a different wage level but an actual shift in the objective function, the result may be even more clear-cut. For instance, if high wage firms behave like workers' cooperatives and low wage firms maximize profit, then value added certainly increases with restructuring [a straightforward application of the model of Delbono and Rossini (1992) yields precisely this result].

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