

**BANCA D'ITALIA**

**Temi di discussione**

**del Servizio Studi**

**Information Spillovers and Factor Adjustment**

by L. Guiso and F. Schivardi



**Number 368 - February 2000**

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## SINTESI

**Il contenuto del presente lavoro esprime solamente le opinioni degli autori, pertanto esso non rappresenta la posizione ufficiale della Banca d'Italia**

Recenti contributi dell'economia dell'informazione sottolineano il ruolo degli *spillover* informativi. In contesti caratterizzati da elevata incertezza, le decisioni di ciascun operatore forniscono flussi informativi (*spillover*) utili per le scelte di agenti che fronteggiano un problema simile. Questo lavoro costituisce un primo tentativo di offrire evidenza empirica sulla rilevanza di tali flussi, studiando il ruolo degli *spillover* per le scelte di aggiustamento del fattore lavoro da parte delle imprese. L'ipotesi di partenza è che gli *spillover* richiedono congiuntamente la similarità nell'attività produttiva e la prossimità fisica fra le imprese, due caratteristiche definitorie dei distretti industriali, che costituiscono quindi un laboratorio ideale per verificare la validità di tali teorie.

Utilizzando un *panel* di circa 2.300 imprese distrettuali per il periodo 1982-1996, si analizza come le scelte individuali in termini di variazione dell'occupazione siano influenzate dal comportamento delle altre imprese del medesimo settore appartenenti allo stesso distretto. I principali risultati sono riassumibili nei seguenti termini:

- controllando per shock aggregati ed individuali, l'aggiustamento percentuale nel fattore lavoro a livello individuale risente sensibilmente di quello medio delle altre imprese del settore nello stesso distretto. Particolarmente importanti sono gli aggiustamenti di maggior entità, presumibilmente a causa della loro maggior visibilità rispetto a quelli modesti;

- in linea con le previsioni della teoria, l'aggiustamento delle imprese distrettuali di un settore non è influenzato né da quello delle imprese che appartengono allo stesso distretto ma a un diverso settore né da quello delle imprese del settore localizzate al di fuori del distretto;

- il processo di diffusione dell'informazione è influenzato da alcune caratteristiche del gruppo di riferimento, come il numero di imprese del settore e la presenza di imprese di grosse dimensioni;

- gli *spillover* informativi costituiscono un elemento di amplificazione degli shock aggregati e inducono una tendenza alla concentrazione temporale dei fenomeni riallocativi in quanto le imprese tendono ad aggiustare simultaneamente;

- la sensitività dell'aggiustamento individuale a quello delle altre imprese è inversamente proporzionale alla dimensione dell'impresa, una indicazione che le piccole imprese fanno maggior ricorso a fonti di informazioni esterne e quindi beneficiano maggiormente dall'essere localizzate in un distretto.

# INFORMATION SPILLOVERS AND FACTOR ADJUSTMENT

by Luigi Guiso\* and Fabiano Schivardi\*\*

## Abstract

We investigate the role of information spillovers (IS) in determining firms' labor adjustments. We test the proposition that information on relevant state variables spills over through one firm's decision to those of other firms, assuming that spillovers matter only among firms that are both similar and geographically close. From a large panel of manufacturing firms, we select those that are located in a given industrial district and produce the same goods. We propose a solution to the identification problem typical of the empirical analysis of social effects. Our results show that firms' decisions are indeed affected by those of similar, neighboring firms, while the actions of firms not satisfying either of the criteria have no impact. We test other implications of the theory and find further supporting evidence of the relevance of IS. First, measures of extreme adjustments exert a stronger influence than mean adjustments; second, smaller firms seem to rely more on external sources of information; third, the effects depend on such characteristics of the reference group as its size and the presence of large firms. Finally, given that firms exposed to IS tend to adjust simultaneously, we find that spillovers amplify the effect of aggregate shocks and constitute a powerful mechanism of amplification of the business cycle.

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## 1. Introduction<sup>1</sup>

Recent years have seen the emergence of a new literature that emphasizes the interaction between information acquisition and agents' decisions. Although there are various strands, the common feature of this literature is that agents can acquire useful information through social learning, i.e. by observing the behavior of other agents facing the same problem. The central idea is that the lack of information about some underlying state variable that is of public interest can be made up for, at least partly, by looking at what other, similar agents do. If the information that is privately available to agent *A* to form his decisions has some value for agent *B* - a neighbor of *A*'s - the observation of *A*'s actions can help *B* to make a better decision since *A*'s actions will partly reveal his information.

More generally, consider situations where a pool of agents are uncertain about some relevant common variable and can learn about it through time by direct accumulation of information. Suppose each agent has some private piece of information which if pooled with the others' would increase the information available to each. If pooling is ruled out, each agent's private information will be embedded in his decisions; thus, the other agents' choices become an alternative source of information. As a consequence, individual agents' decisions will be affected both by their private information and by other agents' decisions. In other words, private information spills over through individual actions.

This process of social learning can be seen at work in a variety of situations; for instance, a decision to enter a new market with uncertain demand is likely to be affected by the observation of other firms entering and the performance of previous entrants. Similarly, the decision to undertake an investment project or to hire or lay off workers may benefit from the observation of what neighbor firms do. On the consumer's side, the decision to try a new product is likely to be influenced by the observed popularity of the product with other consumers; the same holds for the choice of a book or a movie. During a bank run as well, the single depositor's decision to withdraw will depend not only on his own assessment but also

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<sup>1</sup> We are grateful to Giuseppe Bertola, William Brock, Ricardo Caballero, Andrew Caplin, Steve Davis, Thomas Steinberger, Federico Signorini and Joseph Zeira for discussions and suggestions. We received helpful comments from seminar participants at the Bank of Italy and at the 1999 Annual Meeting of the Society for Economic Dynamics, Alghero. We alone are responsible for all remaining errors. Luigi Guiso thanks the Italian Ministry of Universities and Scientific Research (MURST) for financial support. The views expressed here are our own and do not necessarily reflect those of the Bank of Italy. E-mail: guiso@tin.it, schivardi.fabiano@insedia.interbusiness.it

on what the other depositors do, as this may reveal valuable information on the fragility of the bank. Information spillovers have been cited, as an important factor in determining the timing and extent of the recent crisis in Asia, as investors were learning about the structural problems of those economies at the same time as the crisis was erupting.<sup>2</sup>

The theory, then, is relatively well developed but, to our knowledge, there are essentially no studies testing its empirical validity. Our intention is to fill this gap. To this end we rely on a panel of Italian industrial firms that allows us to classify them into two groups, a *study* group of firms that are more likely to be exposed to information spillovers and a *control* group for which information is unlikely to be passed on through their actions. The idea is that social learning will only take place if: *a)* firms' actions convey useful information because their problem is analogous to that faced by other firms; and *b)* these actions are readily observable. Thus, to identify exposure to information spillovers we rely on firms' *similarity*, identified with their product brand, and *proximity*, defined in terms of geographical distance. Similarity assures that other firms' actions potentially contain valuable information, proximity implies that they are easily observable.

To classify firms according to the degree of exposure to information spillovers we use location within an industrial district. One interesting feature of the Italian economy is that often firms, particularly small and medium-sized firms specialized in the production of a particular good, such as ties, chairs, shoes and leather goods, textiles, corks, etc., tend to group together in the *same area*, which becomes an industrial district. Presumably firms in a district should be more exposed to spillovers than firms in the *same industry* that are not part of a district.

Our test for the existence of information spillovers turns on the adjustment of productive factors. We relate the factor adjustment of a given firm in a given sector and located in a given district to the adjustment of the other firms in the same sector and district and to that of firms that are in the same sector but outside the district or are located in the district but produce unrelated goods. If information spillovers are present, we expect that - controlling for shocks - one firm's adjustment is affected by the adjustments of firms in the same district and sector

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<sup>2</sup> Note that nothing ensures that the information gathered by observing other agents' behavior will always be correct. Indeed, if some agents hold incorrect beliefs about the underlying state variable, they might transmit such beliefs to the other agents, thus generating negative information. This possibility is studied in models of herding behavior and information cascades, reviewed below. We will return to this point later, showing how the structure of the reference group can influence the possibility that such an event takes place.

but is unaffected by that of firms outside the district or the sector or both. Furthermore, for firms not located in a district, what other similar firms do should be irrelevant. Our findings are consistent with the idea that learning takes place not only through the direct signals that a firm receives on its market environment but also by exploiting the information contained in other firms' actions. Indeed, if each firm has just one small, independent piece of information and there are many participants, the information contained in other firms' action may be much more valuable than that directly available to the firm.

We start in Section 2 by reviewing the theoretical literature on information spillovers and firms' decisions. In Section 3 we lay out a simple analytical framework to organize our empirical strategy and derive the main implications to be tested. Section 4 addresses the identification problem that emerges in estimating models with social interactions. In Section 5 we describe the data and discuss how we measure exposure to information spillovers. Section 6 presents the results of the estimates for the adjustment of labor in our basic specification; Section 7 extends the estimates in various directions and checks their robustness to changes in specification and sample selection. Section 8 tests some implications of information spillovers for firms' response to aggregate shocks, showing that they can be a powerful mechanism of amplification of business fluctuations. Section 9 considers the effect of different reference group structures on the learning process and, through that, on the performance of firms. Section 10 concludes.

## 2. Review of the literature

The theoretical literature on information spillovers studies how social learning influences the decision-making of an agent who faces an optimization problem in an uncertain environment. The focus is on how the private information of the agents is transmitted through actions, and how information spillovers influence the timing and outcomes of the decision-making process. A useful classification is based on timing. A first group of models assumes that actions are taken sequentially and at a pre-set time, and that before taking decisions each agent can observe the actions of the previous agents. This literature is mainly concerned with the possibility of *information cascades*, which occur when agents disregard their own private information and base their action only on the history of previous actions.<sup>3</sup> A second class

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<sup>3</sup> See the seminal contributions of Banerjee (1992) and Bikhchandani et al. (1992), or Bikhchandani et al. (1998) for a recent survey. Anderson and Holt (1997) find that information cascades tend to occur frequently

of models, which is the direct reference of our empirical work, endogenizes the timing of actions, so that in each period all agents can decide their course of action, unless they have already made an irreversible decision. Chamley and Gale (1994) consider the case of a group of agents that get the option to make an investment of uncertain value (but perfectly correlated across agents); the value, in turn, is positively correlated with the unknown fraction of agents in the population that get the option. They show that the equilibrium involves inefficient delay, because each agent has an incentive to wait to see how many others exercise the option, to better assess the optimality of doing so. Caplin and Leahy (1994) study a model of a multi-stage investment project with a continuum of firms, in which at each stage each agent receives a private signal about the common value of the project, and decides whether to maintain the investment or to pull out. In their equilibrium, actions have an extremely discontinuous character, with a phase of no action followed by a period in which the actions of a fraction of agents totally resolve uncertainty, thus prompting a large mass of agents to act simultaneously in the subsequent period. Rob (1991) and Horvath et al. (1997) study the effect of the information revealed by previous entrants on subsequent entry into a market with unknown demand. Rob obtains an entry pattern that is monotonically decreasing over time, whereas Horvath gets different entry patterns according to the structure of uncertainty, including paths with a discontinuous character, in which most of the firms enter the market in a short period of time. Backing away from full rationality, Ellison and Fudenberg (1993, 1995) propose a model in which boundedly rational agents choose between two alternative technologies according to a rule that weights new information and the behavior of other agents. Their models offer an alternative way to rationalize the correlation between individual and aggregate decisions and show that even naive rules can lead to socially efficient outcomes. In an extension of the model, they introduce different locations and assume that each agent looks only at the decisions of people in the neighborhood; this idea constitutes the basis of our own empirical approach. In a similar framework, Bala and Goyal (1998) study the role of the structure of the reference group on the learning process. They show that if the group has a small subset of players with particularly high visibility, such as a few large firms in an environment of small firms, then information cascades can occur even where the timing of actions is endogenous and choices are repeated over time, with negative effects on firms' profitability. At the same

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in controlled experiments. In a recent paper, Avery and Zemsky (1998) show that they cannot arise in financial markets if there is a market maker that observes the previous pattern of transactions, because the latter will price according to such information, thus prompting the agent to resort to private information.



time, the probability of a cascade occurring decreases with the size of the reference group. We will test the validity of these predictions in the context of our empirical specification.

One of the main implications of this strand of the literature is that, under certain informational conditions, the pattern of agents' actions will follow a distinctive path. If decisions are costly to reverse, the fact that each agent can extract useful information from the actions of others constitutes an incentive to delay actions by comparison with the case where learning is strictly individual. Once some agents act, however, the information revealed could induce further actions, triggering a self-reinforcing process that will lead a large number of agents to act within a brief period. We should therefore observe a positive correlation between the individual and the aggregate level of activity, even after controlling for exogenous causal factors. In addition, one should observe periods of low activity, in which the incentive to delay dominates, followed by periods of sharp increase in the level of activity, without large changes in the underlying state variables.<sup>4</sup> Schivardi (1998) applies this idea to explain the large increase in job destruction in cyclical troughs (Davis et al., 1996), showing how relatively small aggregate shocks can induce a burst of reallocation if they touch off information revelation.

We are not aware of any empirical study directly addressing information spillovers. Some parallel lines of research should be kept in mind, however, and may be usefully reviewed to better identify the specificity of information spillovers. One such is the literature on location choices in relation to *knowledge* spillovers. This literature has been inspired by the recent surge of interest in economic geography, which stresses that production tends to be concentrated in regions that specialize in some particular product.<sup>5</sup> The idea is that there might be substantial increasing returns from concentrating firms in a given location, due to knowledge spillovers, which occur when the expertise and the R&D of one firm benefit the neighbors. While the results are far from conclusive, a consensus has emerged that knowledge spillovers are an important factor in firms' location. For example, Ellison and Glaser (1997) construct a series of indexes to study concentration and show that, for the US economy, production is more concentrated than a random distribution of firms would predict, even controlling for the

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<sup>4</sup> Models that formalize this idea are presented, among others, by Caplin and Leahy (1994, 1996), Chamley and Gale (1994) and Horvath *et al.* (1997).

<sup>5</sup> See for example Audretsch (1998), Feldman and Audretsch (1998), Harrison et al. (1996), Jaffe et al. (1993), Wallsten (1998).

natural characteristics of the regions. Moreover, the narrower the definition of the sectors, the greater the degree of concentration. We see these results as complementary to our own. This literature focuses on knowledge spillovers, i.e. spillovers that directly affect productivity. We consider, instead, the effects of actions through the changes they induce in the information set, without necessarily inducing a change in any real variable. Moreover, our analysis is at high frequencies, considering the changes in factors in response to business cycle shocks, while economic geography takes a longer-run perspective, stressing the knowledge spillovers as factors in the long-term development of regions and in growth.

Our work is also related to the macroeconomic literature on production spillovers at business cycle frequencies,<sup>6</sup> initiated by Caballero and Lyon (1992). This literature is predicated on the observation that labor productivity is procyclical. This could be interpreted as a sign that the productivity of the single firm is positively affected by the aggregate level of activity, due to some form of thick-market externality (Diamond, 1982). External economies could then induce a positive correlation across firms in factors demand, independently of information spillovers. In recent years, a body of literature has challenged the assertion that the Solow residual is procyclical, claiming that the empirical finding disappears when one takes account of variations in effort, intermediate goods, cyclical variations in capital utilization and aggregation effects.<sup>7</sup> Moreover, even assuming that the empirical finding is correct, there are other explanations for pro-cyclical Solow residuals, such as labor hoarding (Basu and Kimball, 1997), internal increasing returns (Hall, 1988) or changes in the distribution of firms' productivity due to entry and exit (Horvath, 1999). Due also to Sbordon (1997), who considers the different dynamic implications of the alternative explanations, a consensus has emerged that external effects cannot be the main reason for the procyclical nature of productivity. Although we also offer direct evidence on the importance of information flows in inducing positive correlation in labor adjustments, we consider that the consensus view's underplaying the role of external economies contributes to ruling out an alternative explanation for our empirical findings.

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<sup>6</sup> See for example Basu and Kimball (1997), Caballero and Lyon (1992), Hall (1988), Jimenez and Marchetti (1998) and Sbordon (1997).

<sup>7</sup> See for example Basu and Fernal (1997) and Burnside, Eichenbaum and Rebelo (1995).

### 3. A simple analytical framework

To illustrate our empirical specification, we construct a simple reduced-form model that abstracts from the strategic aspects underlying information spillovers, which are discussed in the papers reviewed in Section 2. Assume that the prospects of a firm at time  $t$  are summarized by a state variable  $X(t)$ , which is a sufficient statistic for determining the optimal level of the firm's factors of production  $N_i(t)$  (employment or the stock of capital). For firm  $i$ , the evolution of the state variable is governed by the following equation:

$$(1) \quad X_i(t) = A_i X_i(t-1) E_i(t)^{\beta_0} E(t)^{\beta_1} \left( \frac{N_{-i}(t)}{N_{-i}(t-1)} \right)^{\beta_2}$$

where  $E_i(t)$  and  $E(t)$  are log-normally distributed, independent random variables. Equation (1) shows that the evolution of firm  $i$ 's prospects depends on a firm-specific characteristic,  $A_i$ , which may be thought of as long-run efficiency; an idiosyncratic shock,  $E_i(t)$ ; and a common shock  $E(t)$ . The assumption that the adjustment of other firms influences firm  $i$ 's evaluation is modeled by assuming that firm  $i$ 's prospects improves if other firms are increasing their factor of production and conversely. For example, an entrepreneur might become more pessimistic upon observing other firms in the same sector going out of business, assigning a higher weight to any negative signal.<sup>8</sup> The adjustment of other firms is denoted by  $N_{-i}(t)$ , with  $\beta_2$  parameterizing the strength of the channel. If what other firms do has no effect on firm  $i$ 's evaluation, then  $\beta_2 = 0$ . For any variable  $Y(t)$ , define  $y(t) \equiv \log Y(t) - \log Y(t-1)$ . Then, taking logs in equation (1), redefining  $\alpha = \log A$ ,  $\epsilon = \log E$  and rearranging, we get:

$$(2) \quad x_i(t) = \alpha_i + \beta_0 \epsilon_i(t) + \beta_1 \epsilon(t) + \beta_2 n_{-i}(t).$$

Finally, we assume that the percentage change in factor  $N$  depends on that in  $X$ :

$$(3) \quad n_i(t) = f(x_i(t)) + u_i(t)$$

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<sup>8</sup> Indeed, the adjustment of others could be thought of as amplifying a given realization of the aggregate shock  $E(t)$ , a point to which we return later.

where  $u_i(t)$  is an error term uncorrelated with  $\epsilon_i(t)$  and  $\epsilon(t)$ . Assuming that  $f(\cdot)$  is an affine transformation, so that  $f(x) = a + bx$ , substituting equation (2) into (3) and assuming without loss of generality  $b = 1$  we obtain our basic empirical specification:

$$(4) \quad n_i(t) = a + \alpha_i + \beta_0 \epsilon_i(t) + \beta_1 \epsilon(t) + \beta_2 n_{-i}(t) + u_i(t)$$

The absence of information spillovers implies  $\beta_2 = 0$ , and this hypothesis can be directly tested once we specify how to measure  $n_{-i}(t)$ . In our basic specification we will measure the adjustment of others as the mean adjustment of firms in  $i$ 's reference group, excluding  $i$ 's adjustment. Notice that information spillovers tend to induce co-movement among the firms that are subject to them since they add a common factor. Thus, one should find a higher degree of co-movement among firms with a high degree of exposure to information spillovers, an implication that will be discussed in future work.

The specification in equation (4) has two features: first, it implies a linear response of  $n_i(t)$  to the adjustment of others. Yet it may be that the firm's adjustment is triggered by the adjustment of others only when the latter is substantial. This would occur, for instance, if there were costs of adjusting factors as in Caplin and Leahy (1994) so that agents tend to adjust infrequently but substantially. We will account for the presence of non-linearities by replacing the mean adjustment in equation (4) with various quintiles of the distribution of the adjustment of others. Second, what matters is assumed to be the current adjustment of others; thus, one could ask who adjusts first. With high frequency data, the lagged adjustment would be more appropriate; with annual data such as ours, simultaneous adjustment is probably not too restrictive; and as Section 6 shows, this intuition is supported by our empirical evidence.

#### 4. Identification and the “reflection” problem

A potentially serious problem in estimating equation (4) is that it could be impossible to identify  $\beta_2$ , owing to what Manski (1993) calls the “reflection problem”. This arises because the actions of the individual agents in a group are related to the average action of the members of the group through an adding-up condition. Thus, without some prior restriction, the parameter characterizing the presence of information spillovers (and in general the other

parameters as well) is not identified. To illustrate the identification problem, consider a simplified version of equation (4):

$$(5) \quad n_i(t) = b_0 w_i + b_1 z + b_2 n_{-i}$$

where  $w_i$  is an individual characteristics and  $z$  is a characteristic common to all elements of the reference group, and where for simplicity we have dropped the time index  $t$  and the random component  $u_i$ .

Notice that, for all  $t$ ,  $\frac{1}{K} \sum_i n_{-i} = \frac{1}{K} \left( \frac{\sum_i n_i - n_1}{K-1} + \dots + \frac{\sum_i n_i - n_K}{K-1} \right) = \frac{1}{K} \sum_i n_i = \bar{n}$ , where  $K$  is the (known) number of firms in the reference group. Using (5), averaging over  $i$  and solving for  $\bar{n}$  we have:

$$(6) \quad \bar{n} = \frac{b_0}{1 - b_2} \bar{w} + \frac{b_1}{1 - b_2} z$$

where  $\bar{w} = \sum_i w_i / K$  is the mean of the individual variable. Noticing that  $n_{-i} = \frac{K}{K-1} \bar{n} - \frac{1}{K-1} n_i$ , substituting into (5) and using (6), we obtain the reduced form equation for firm  $i$ 's adjustment decision:

$$(7) \quad \begin{aligned} n_i &= \frac{(K-1)b_0}{K-1+b_2} w_i + \frac{b_2}{1-b_2} \frac{Kb_0}{K-1+b_2} \bar{w} + \frac{b_1}{1-b_2} z = \\ &= Aw_i + B\bar{w} + Cz. \end{aligned}$$

Suppose now that  $\bar{w} = z$ , that is the variable that enters the equation individually, is the same one that enters as average; then, we can factor equation (7) as

$$(8) \quad n_i = Aw_i + (B+C)z.$$

This is the situation analyzed in Manski (1993), and identification cannot be achieved unless we impose some additional restrictions. This is clear from (7) where only the composite parameters  $A$  and  $(B+C)$  are identified. However, as noted by Brock and Durlauf (1999), if  $z \neq \bar{w}$ , so that  $w_i$  only enters the equation individually, than the system is identified and we can retrieve the social interaction parameter.<sup>9</sup> Notice that, to make the illustration as simple

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<sup>9</sup> Dividing  $A$  by  $B$  in equation (7) and taking  $K$  as known, one recovers parameter  $b_2$ ; given  $b_2$  the other parameters are obtained.

as possible, we have assumed that  $w_i$  and  $z$  are scalars. The argument generalizes to the case in which  $w$  and  $z$  are vectors, in which case the condition for non-identification is that all the variables that enter individually also enter as averages, that is  $\bar{w} \subseteq z$ . Notice also that the identification problem only arises if the social interaction variable enters equation (5) linearly: otherwise,  $\bar{w}$  would also enter equation (7) in a nonlinear fashion, and the factorization of equation (8) would not be possible even if  $\bar{w} = z$ .<sup>10</sup> We will exploit this property in a set of regressions later.

To achieve identification in our empirical specification, we rely on proxies for liquidity constraints. It is our contention that liquidity constraints are an impediment to adjustment, especially when it involves pecuniary costs. This is obvious in the case of upward adjustments in the quantity of factors of production, as they directly involve pecuniary outlays. But even downward adjustments, particularly in labor, might imply pecuniary costs, as is stressed by the literature on firing costs. Firing workers in Italy involves, among other things, a severance payment dependent on the worker's seniority, which can be as large as 2 or 3 times a worker's annual wage.<sup>11</sup> In these circumstances, adjustment may be blocked by liquidity constraints arising from limited access to credit.<sup>12</sup> To achieve identification we will insert in our empirical specification firm-level proxies for liquidity constraints and assume that while they affect firms directly, their group average does not directly affect firms' adjustment decisions. Our justification for this is that firms' creditworthiness - which determines access to credit - depends on firm-specific variables but not on group averages once the former are controlled for<sup>13</sup>.

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<sup>10</sup> More precisely, the model is identified if the social interaction term is a nonlinear function of the data. We refer the interested reader to Brock and Durlauf (1999), who give an excellent treatment of the issues reviewed here.

<sup>11</sup> At the time of separation each worker is entitled one month's gross wage for every year of service.

<sup>12</sup> An alternative way to achieve identification would be to use firm-level measures of adjustment costs, if available. Our approach can, in a sense, be regarded as equivalent. Although very little has been done on the interaction between financial constraints and adjustment costs, a few papers point out that they are observationally equivalent. Within the context of a business-cycle general equilibrium model, Carlstrom and Fuerst (1997) show that financial market imperfections can be regarded as endogenous costs of adjusting the capital stock. More closely related to our approach is the paper by Campbell and Fisher (1998) who claim that differences in the observed job creation and destruction rates of U.S. manufacturing plants are better explained by differences in employment adjustment costs across plants rather than in financial constraints. Implicitly, they are assuming that financial constraints affect firms' production factor adjustment in the same way as adjustment costs.

<sup>13</sup> This is not to say that firms in one district cannot all get more credit than firms in another district. For instance, if all firms in a certain district use less specific capital than firms in another district, compared to the

## 5. Data description

We estimate several variants of the model illustrated in Section 3, using a panel of Italian manufacturing firms drawn from the Company Accounts Data Service (CADS), which collects annual balance-sheet data on a sample of about 30,000 firms, over a period of 15 years (from 1982 to 1996). Besides reporting balance-sheet information the Service also reports employment and a detailed description of company characteristics.<sup>14</sup> To identify firms with high exposure to information spillovers, we merge this database with the Industrial Districts Database (IDD) constructed by the National Statistical Institute (Istat). To this purpose Italy is divided into *local labor systems* (LLS), i.e. territorial groupings of municipalities characterized by a certain degree of commuting by the resident population. If an LLS is characterized by a high concentration of small and medium-sized firms in the same two-digit sector classification, it is classified as a district. Districts are allocated to a 9-sector classification according to their product specialization. We then identify firms that are in the same district and sector and thereby divide the sample into a study group (firms in the same district and sector, i.e. those with high exposure to information spillovers) and a control group of low exposure firms (firms in the same sector but not located in districts). The geographical classification ensures that the firms that we include in the study group satisfy the observability criterion. Since they belong to the same sector, the similarity requirement is also fulfilled. In fact, this is an ideal context to test the relevance of information spillovers in shaping firms' decisions. Table 1 reports summary information sector-by-sector for the sample, using Istat's 9-sector classification. Panel A compares the sample with the population; the first two columns show the incidence of employment in specialized district firms (i.e. firms located in a district and belonging to the specified sector) on total employment in the sector for the sample and for the population, respectively. It is clear that the sample tracks the population very well. "Textiles and clothing", "leather and footwear", "wood, furniture, construction materials and glass", "machinery, computers and production tools" stand as sectors where a large portion of total output is accounted for by districts. These are also the sectors where districts are most common and they account for 167 out of the total of 199 (Column 6). For the remaining sectors

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latter they will be more creditworthy since they can offer better collateral, and thus all have greater debt capacity. However, district average creditworthiness - as measured by the district average capital specificity - will play no role once firms' capital specificity is controlled for.

<sup>14</sup> For a more detailed description of the CADS database, see the Appendix.

the share of employment accounted for by specialized district firms is minor. Columns 3 and 4 show employment in specialized district firms as a share of total employment in the district for the sample and for the entire population. Again, the structure of employment in the sample is close to that in the population, particularly in those sectors where production typically takes place in districts. Panel B reports summary statistics for the total sample by sector.

The overall sample has two problems: first, for some districts, there are only a few firms. For instance, the average number of specialized district firms in “food, beverages and tobacco” is 9.8, and in 1991 only 1 district out of 16 had more than 30 firms; the corresponding figures for “paper, printing products and publishing” are 4.3 and 0 and for “metallurgy and metal products” 3 and 0. If not all firms in the true reference group are included, then relying on a small sample may lead to noisy measures of the adjustment of others. We tackle this by excluding all the districts with fewer than 30 firms in any sample year.<sup>15</sup> Second, some sectors are characterized by a high degree of heterogeneity when a two-digit classification is used, making it hard to fulfill the similarity criterion. The last column of the table classifies the 9 sectors according to product heterogeneity. The classification was made by informally comparing the list of products in the 4-digit classification for each of the 9 sectors. Some sectors show a high degree of product heterogeneity. When relevant, we have dealt with this problem by reclassifying districts according to their specialization at the three-digit level. Sometimes, however, even at the three-digit level there remains considerable heterogeneity - as in some mechanical industries. In these cases - given that a four-digit classification was never feasible in terms of observations - we have dropped the districts. After these exclusions, we are left with 14 districts in 5 sectors for a total of 20,334 observations and 1,485 firms; non-district firms in the five sectors are 3,146 for a total of 42,022 observations.<sup>16</sup>

Table 2 reports summary statistics for each sector and district and for non-district firms, taking 1991 as the reference year. It is worth noticing that the sectors selected are those that,

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<sup>15</sup> This excludes firms producing “rubber, plastic and chemical products” and firms classified as “other manufacturing”.

<sup>16</sup> To reduce product heterogeneity we have split the “textiles & clothing” sector into its two components “textiles” on the one hand and “clothing” on the other. Since none of the “clothing” districts in the sample had the minimum number of firms, they were all dropped. We have also reclassified the mechanical sector using a three-digit classification; the only sector with a low degree of product heterogeneity that had the minimum number of firms was “production tools”, which has three districts. Finally, we have separated “wood & furniture” from “construction materials and glass” which in the 9-sector classification are lumped together. This way, we retain three districts in “wood & furniture” and one in “construction materials and glass”.



on the basis of panel A of Table 1, have the highest incidence of employment in district firms, and all of Italy's well-known industrial districts are included in the sample. Most districts are in "textiles" (6 out of 14) and are located in the North (10 out of 14); only 4 are in the Center and none in the South. This is consistent with the general under-industrialization of the South. The size of the districts measured by the number of specialized firms (observations) ranges from a minimum of 38 firms (552 observations) in the production tools district of Padua, to 329 (4,250) in the wool district of Prato. District firms are typically small, their average size ranging from a low of 26 employees (in the Prato district) to a high of 113 (Cossato). Concentration of production - measured by the ratio of the 95th percentile of employment to the median (Column 4) - is generally small, as one would expect in a network of similar firms. Yet it varies across districts, as does firm performance (return on assets, Column 6). In Section 9 we investigate the relation between firm performance and district concentration. Column 8 reports the share of firms in the modal four digit sector both within each district and for firms out of districts. As expected, the concentration is generally higher within each district, indicating a tendency to specialize in some particular production. This is stronger for the leather and the furniture sectors (which are more concentrated also out of districts), while "textiles" and "production tools" are characterized by a majority of districts where the modal four-digit sector accounts for less than fifty percent of specialized firms. The high degree of similarity among district firms could give rise to a correlation in factor adjustments not necessarily due to information spillovers, a possibility that we will explicitly take into account in our empirical analysis. Finally, the last column of Table 2 reports the number of non-specialized firms - i.e. firms located in the district but producing different goods. Comparing the average number of specialized and non-specialized firms gives a clue of the production focus of the various districts and reveals that districts differ along this dimension as well.

## 6. Results

We start estimating equation (4) for the whole sample of district firms. One can base the tests on any factor of production; we choose to rely on labor adjustments and disregard the adjustment of the stock of capital. The fact is that we have information on employment year by year, but no reliable data on capital. Balance-sheet data are reported at historical costs, and the time span covered by the data is too short to use permanent inventory methodology to estimate the capital stock. In order to implement specification (4) we still need measures

of the aggregate and specific shocks that firms face. It is now well established that firms' adjustments are characterized by considerable heterogeneity (Davis and Haltiwanger (1992), Caballero, Engel and Haltiwanger (1997), Boeri (1996)). To control for such differences, we run an auxiliary regression of the rate of growth of real sales in deviation from its mean and standardized with its standard deviation, on a full set of year dummies interacted with location and sector dummies to allow for aggregate shocks differing across area and sector. To better account for local shocks, for district firms we allow for one location dummy for each district, while for non-district firms we use provinces.<sup>17</sup> We then use the fitted values from this regression (common within a group of firms in the same region and sector) as a measure of the aggregate shocks; the residuals are taken as proxies of the idiosyncratic shocks.<sup>18</sup>

As argued in Section 4, to achieve identification we follow the idea that adjustment involves pecuniary costs that are more easily faced if no credit impediments are present. We proxy financial constraints at firm level using the ratio of cash flow to total sales.<sup>19</sup> Since both positive and negative adjustment should be dampened by financial constraints, we expect more positive and more negative adjustments by the less severely credit-constrained firms. To capture this effect we interact the proxy for financial constraints with two dummies, one for non-positive and one for non-negative adjustments. If these variables are picking up ease of adjustment we should find a positive effect on the first interaction and a negative on the second. Indeed, in all regressions the pattern of signs is as expected.<sup>20</sup>

For each firm and for each year in the sample, we measure the adjustment by other firms in the same district and sector (the reference group) as the (unweighted) average percentage

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<sup>17</sup> Italy is divided into 103 provinces, roughly comparable to US countries. This is the finest classification allowed by our dataset for non-district firms. A district is a much smaller territory than a province, often coinciding with a few suburbs of a city or town.

<sup>18</sup> Given that the regressions include a measure of firm-specific shocks to sales one could argue that identification of social effects could be reached this way; however, since they average out to zero within districts they cannot help achieving identification.

<sup>19</sup> We have also experimented with alternative measures of credit constraints, such as the share of intangible assets on total assets - a measure of the firm's ability to pledge collateral - and the share of liquid assets on total assets, an indicator of the ability to face liquidity needs. Our results are essentially invariant to the measure used, and thus we only report those based on cash flow.

<sup>20</sup> To save on space we do not report the coefficients of the proxies for liquidity constraints; in all regressions they turn out to be statistically significant and to have the expected signs. In general, the positive adjustment interaction carries a larger coefficient, suggesting that liquidity constraints matter most when factors are adjusted upwards.

change in employment by the firms in the group, excluding the adjustment of the firm in question. If the signals received by each firm in a given district and sector are all equally informative, then the unweighted average adjustment is adequate to summarize the information contained in the decisions of others; if the information content of the signals differs across firms (increasing with size, say), then weighted averages may be preferable. Given that one of the defining characteristics of industrial districts is the predominance of small firms, and that the choice of weights contains a degree of arbitrariness, for the time being we use unweighted averages.

To account for unobserved variables that may be relevant to factor adjustment, we estimate a fixed-effects model. Obviously, the fixed effects will also pick up any unobservable variable that is common to all firms in a given district-sector and does not vary over time. Table 3, Column 1 shows the results of parameter estimates for the simplest specification, which only includes controls for aggregate and idiosyncratic shocks and the adjustment of similar and observable firms, i.e. those located in the same district and sector.<sup>21</sup> Both aggregate and firm-specific shocks have a positive and highly significant impact on factor adjustment, though idiosyncratic shocks are economically twice as important as aggregate shocks (the estimated coefficients are 0.056 and 0.026 respectively). The estimates show that each firm's factor adjustment is positively and significantly affected by the adjustment of the other firms in the same district and sector (coefficient = 0.308;  $t$  statistic = 5.61): an average increase in employment of one percent by the firms in the reference group leads to a response of approximately a third of a point by each other firm in the group. This is a remarkable effect and is clearly consistent with the idea that firms rely heavily on the information contained in the actions of other, similar firms.

Other interpretations are possible, however. In particular, it may be that our proxy for common shocks is imperfect and that the average adjustment is picking up unexplained time-varying sector-district shocks rather than true information spillovers. To address this problem we add to the regression two explanatory variables: first, for each firm  $j$  and year

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<sup>21</sup> The number of workers employed is a piece of information not required for the balance sheet, but supplied in addition to it. As a consequence, the records may not always be accurate and outliers may be present. To take care of outliers we have excluded observations with a tenfold increase in employment or with a decrease in real sales accompanied by a twofold increase in employment. This led us to exclude 372 observations on the total of district and nondistrict firms. Since we use the change in employment as our left-hand side variable, we lose some observations with respect to those reported in Table 2; adding those lost due to missing values, we are left with the sample of 17,456 observations, for district firms and 34,795 for non-district firms.

$t$  in the sample we compute the average (unweighted) adjustment of firms located in *other districts* but in the *same sector* as firm  $j$ .<sup>22</sup> Second, for the same firm  $j$  and all years, we compute the average adjustment of firms located in the *same district* as firm  $j$  but belonging to sectors *other* than that of  $j$ . If our measure of adjustment by firms in reference group is picking up unaccounted sector shocks or district-specific shocks, these two variables should absorb part of the effect and the estimate of the reference group adjustment should diminish in both magnitude and significance. On the other hand, if our controls are correctly picking up aggregate sector-district shocks and the reference group adjustment reflects information spillovers, the two additional regressors should have no explanatory power. In the case of the first indicator this is so because, since it refers to firms located in other districts, it does not fulfill the observability requirement; for the second, non-sector firms, because it does not fulfill the similarity requirement. Finally, we include as an additional regressor the average adjustment of non-district firms in the same sector as firm  $j$ : if actions by others only affect one's decision through information spillovers, this variable should not be statistically significant. The results of the estimates are shown in Column 2 of Table 3. The parameters of the aggregate and specific shocks are essentially unaffected, as is that of the adjustment by firms in the reference group, which is only slightly smaller (0.287 compared to 0.308) and equally significant. None of the other measures of adjustment included in the regression (by firms in other districts, those in other sectors, or non-district firms in the same sector) has explanatory value. They all have small and statistically insignificant coefficients whether taken alone or as a group (the group test for the hypothesis that they are jointly equal to zero has a group-value of 0.578).

There is yet another explanation for these results. As shown in Table 2, district firms tend to have a relatively high degree of sectoral concentration when measured at four-digit levels. If a shock hits the particular class of goods in which the district is specialized, then one should expect that the adjustment of firms out of district has little explanatory power, because such firms are not as specialized in the same goods. To account for this possibility, we further restrict the definition of sector when selecting the control group. For each district, we retain the firms in the modal four-digit sector and, if this has less than 50 percent of the

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<sup>22</sup> To calculate the adjustment of firms in other districts, for sectors with multiple districts we confine ourselves to the districts already included in the sample; for the two sectors with only one district, we must resort to the districts that are not in the sample, given that the "same sector, other districts" set within sample is empty.

firms, all firms in any other four-digit sector with at least 25 percent of firms. For firms in these sectors, we then construct the adjustment of non-reference firms (in other districts or out of districts) within the narrower sector definition. For reference group firms, we maintain the same measure of adjustment as before, based on the coarser sector definition. From a sectoral classification viewpoint, there is now more heterogeneity in the reference group firms than in the non-reference group ones, which implies that, if our previous results are driven by a shock to a particular class of goods, then the adjustment of the non-reference group should be at least as important as that of the reference group. The results are reported in Column 3 of Table 3. The coefficient of the adjustment of the reference group drops slightly, arguably for the higher heterogeneity; however, the adjustment of non-reference group firms still fail to have any impact, suggesting that our results are not driven by the higher similarity among district firms, and that proximity is indeed a necessary condition for the effects that we find.

So far we have assumed that what matters for firm  $j$  decisions is current actions of the firms in the reference group. Some papers assume an information (or observation) lag. It may thus be argued that the relevant actions are those of the past actions. This is obviously an empirical problem, and we address it in Column (4) where we include the one-year lagged adjustment by reference group firms as well as current adjustment. The estimates show that lagged adjustment has no explanatory value when current adjustment is included, perhaps because we are using low-frequency data.

Finally, Column 5 of Table 3 reports the basic regression for non-district firms. We take as the reference group for these firms all other non-district firms in the same sector. Since no restriction is put on location, firm  $j$  and the firms in its reference group will on average be located far apart and the observability requirement will not be fulfilled. Consequently, if information spillovers are the reason why other firms' actions affect firm  $j$ 's decisions, the adjustment of others should have no effect when equation (4) is estimated on the sample of non-district firms. And this is what we find: while the measures of aggregate and idiosyncratic shocks are both significant and with coefficients comparable to those found for district firms, the adjustment by other non-district firms in the same sector as firm  $j$  has a small coefficient, with the wrong sign and not statistically different from zero. Taken together, these results are remarkably consistent with the idea that firms' actions reveal valuable information to other firms in their district and industry.

## 7. Robustness and extensions

### 7.1 *Reaction to large adjustments*

If the revelation of information is what drives the results in Table 3, then one should expect the entire distribution of adjustments by others, not only its mean, to matter. Moreover, as is argued in Section 3, in the presence of adjustment costs extreme adjustments are likely to convey more information. While small changes in the labor force may reflect “business as usual”, the observation of a firm undergoing a dramatic change in manning levels could have a stronger influence on the information set of the competitors and thus prompt emulation. To allow for this possibility, we calculate the 10<sup>th</sup> and 90<sup>th</sup> percentiles of the distribution of the adjustments by firms in the reference group and in other control groups and estimate equation (4) using these variables as proxies for other firms’ adjustment. Table 4 shows the results.<sup>23</sup> Column 1 gives the estimates for the simplest specification: both the 10<sup>th</sup> and the 90<sup>th</sup> percentiles have a positive impact on firms’ decisions. Although the parameters are likely to be imprecisely estimated given the high collinearity of the regressors (expected when the distribution of adjustments moves symmetrically), an  $F$ -test rejects the hypothesis that the two variables are jointly equal to zero even at the 1 percent level of confidence. Notice also that the upper tail carries a larger coefficient and is more significant than the lower tail. This could be because our dataset does not record exits, potentially a fundamental source of information, whereas start-ups with their strong increase in employment, are in the sample.

The use of quintiles also allows us to perform an indirect comparative test of the information-based versus the “real” effects-based explanation of the significance of the adjustment of others. If the adjustment of other firms is reflecting “real” spillovers, due for example to technological externalities that increase all firms’ productivity, then one should expect that what matters is the average adjustment; if on the contrary it is mainly due to information spillovers, and if the most extreme adjustments convey the most information, then one should expect the extreme quintiles to be more important for the size of the adjustment. We accordingly run a regression that includes both the mean and the top and bottom quintiles of the distribution of the adjustment of others. The results, shown in Column 2 of Table 4, are clear-cut: adding a measure of central tendency, such as the average adjustment, has no

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<sup>23</sup> As is argued in Section 4, with nonlinear measures of adjustments the identification problem does not arise. For comparability, and given that they are significant, we include the proxies for liquidity constraints also in this set of regressions.

explanatory value once the two extreme quintiles are present. This is strong evidence that the phenomenon cannot be explained by real factors.

Column 3 shows the estimates including adjustment by non-reference groups, measured by the 10<sup>th</sup> and 90<sup>th</sup> percentiles. The inclusion of the corresponding measures of adjustment in these other groups makes the estimate of the effect of the lower tail in the reference group smaller and less precise but does not affect that of the upper tail. Three out of six coefficients of the added regressors have the wrong (negative) sign and only the 10<sup>th</sup> percentile of firms outside districts is significantly different from zero at 10 percent (but not at 5 percent). In addition the hypothesis that they are jointly equal to zero cannot be rejected by an  $F$ -test ( $p$ -value = 0.246).

Finally, Column 4 runs the regression for non-district firms with the 10<sup>th</sup> and 90<sup>th</sup> percentiles in the adjustment of other non-district firms. In this case, the 10<sup>th</sup> percentile has a large and significant coefficient but the 90<sup>th</sup> percentile is not significant and has the wrong sign.

The results using the adjustment in the tails of the distribution confirm those using average adjustment; however, they also strengthen the interpretation of the results in terms of information spillovers.

## 7.2 *Fraction of firms adjusting*

To further assess the robustness of our results we estimate our basic regressions using a third measure of other firms' actions, namely the share that change employment by more than a given threshold amount. As is shown by Chamley and Gale (1996), in certain circumstances the share of firms that adjust can be taken as a sufficient statistic of other firms' actions: the higher the share that raises or lowers the factor of production above or below a certain threshold, the stronger the signal. To test this implication we replace the adjustment of others by the share of firms that increase or decrease staff by 25 percent or more. When these shares refer to the reference group, we expect the former variable to exert a positive effect on the adjustment of the firm, the latter a negative effect. When the shares refer to non-reference groups, there should be no statistically significant effect. The results, shown in Table 5, are fully consistent with these predictions: the share of reference group firms that lower employment by more than 25 percent affects the adjustment of a given firm negatively and

significantly: the effect of the share of firms that raise employment by more than 25 percent is positive (and more pronounced, Column 1). Adding the mean adjustment in the group provides no increment in explanatory power (Column 2). However, when the adjustments of all the other non-reference groups are inserted, we fail to formally reject the assumption that, taken together, their coefficients are equal to zero ( $p$ -value for the test = 0.033). But notice that some coefficients have the wrong sign and that four out of the six coefficients are not statistically different from zero. Finally, running the regression among non-district firms, we obtain results very similar to those of the previous table, with the lower measure of adjustment significantly different from zero and the higher measure showing the wrong sign (Column 4). Thus, overall, these results are not qualitatively different from those reported in Table 3 and Table 4.

### 7.3 *Evidence from individual sectors*

The estimates reported so far restrict the effect of the adjustment of firms in the reference group to be the same across the five sectors in the sample. Yet it could be that information spillovers are relevant only in some sectors, such as those producing virtually the same goods or those where goods, even if not similar, are highly complementary in demand so that firms are subject to the same aggregate shocks. If this were the case, firms could learn even by observing the decisions of other firms producing different but related goods. Though we have been careful to select sectors that group similar or related goods, our procedure is judgmental and potentially arbitrary. It could be that the results for the whole sample are driven by particularly strong informational interactions among the firms of just one sector. We check this possibility in Table 6, which reports the estimate of the basic specification for each of the five sectors. In each case we report the specification with only the adjustment of the firms in the reference group and also that with the other groups, using the mean to capture the adjustment of others. When only the reference group is included, its coefficient is always positive; the point estimate in the “textile”, “leather & footwear” and “production tools” sectors is comparable to that of the entire sample (0.406, 0.461, and 0.260 respectively compared to 0.308) and always statistically significant. It is smaller (0.087) but significant for “construction materials and glass” and not statistically significant for the firms producing “wood & furniture”. Adding the adjustment of other firms not in the reference group adds no explanatory value to the regression except for “wood & furniture” where we cannot reject the hypothesis that the adjustment of



non-reference group firms matters ( $p$ -value for the test = 0.0033). If we take these results at face value, spillovers seem to be stronger in the “light industry” sectors, probably because they produce a more homogeneous set of goods.

### **8. Firm size and sensitivity to social learning**

Presumably, different firms will react in different ways to the information contained in the actions of others. Some firms may not rely, or need rely less, on the observation of others’ actions to extract information because they already receive enough signals; thus, they may attach little weight to the information conveyed by the decisions of others. These are presumably the larger firms, which are likely to have both more private information and a better capacity to process it. Furthermore, if there are fixed costs of gathering and processing signals, larger firms have more incentive to incur them, because any advantage coming from new information would apply to a larger output. Finally, larger firms probably have access to a larger network than smaller firms to gather information, which makes them less sensitive to local information spillovers. It is thus conceivable that the degree of reliance on neighboring firms’ actions decreases as firm size increases. To test this hypothesis we split the sample of district firms by size and run our basic specification for each quartile. The results, reported in Table 7, are supportive of the foregoing: the effect of reference group adjustment, while positive and significant for all size groups, declines monotonically with the size of the firm. Taking the first and the last quartile, the difference in impact is substantial: among firms in the first quartile the impact of the adjustment of others is more than three times as great as among firms in the fourth quartile (0.679 compared to 0.177). For the middle two quartiles the coefficient is in between these two extremes, around 0.3, close to that for the sample as a whole.

### **9. Amplification of aggregate shocks**

We argued in Section 2 that information spillovers offer a natural mechanism of amplification of aggregate shocks. The endogenous pace of information revelation can in fact be speeded up in nonlinear fashion by shocks that break the inertial behavior induced by social learning. Schivardi (1998) applies this idea to explain the surge in job destruction that we observe at the troughs (Davis et al. 1996), showing how relatively small aggregate shocks can induce a burst of reallocation if they set in motion the process of information-revealing

actions. The implication in terms of the two groups of firms considered - i.e. district and non-district firms - is that firms that are subject to information spillovers should tend to concentrate adjustments in certain periods while the control group should follow a smoother pattern of labor adjustment. To test the validity of this implication we identify a series of periods, which we call “adjustment years”, in which adjustment intensity is particularly strong. If the predictions of the model are correct, we should find that district firms have lower sensitivity to aggregate shocks in non-adjustment years and higher in adjustment years, because those should be the years in which the response to shocks is amplified by information flows. Non-district firms should show no substantial differences, since for them all that matters is presumably the observation of the shocks.

We identify adjustment years relying on out-of-sample information. We use the data from ISDB, a database constructed by the OECD that contains information on factors of production and output value at the sector level for a set of OECD countries. We select payroll employment for Italy from 1970 to 1996 for four sectors: “textiles, apparel and leather”<sup>24</sup>; “wood”; “production tools and metal products excluding machinery”; “non-metallic mineral products”. For each, we calculate the average annual percentage changes in employment, classifying as “adjustment years” those in which the sector recorded an employment increase or decrease larger than the period mean plus one standard deviation. By this definition, the adjustment years are 1983-84, 1988, and 1992-93 for “textiles and leather”; 1983-85 and 1993 for “wood”; 1984-87 and 1992-93 for “metal products”; 1983-89 and 1991 for “non-metallic mineral products”<sup>25</sup>. All the adjustments except “wood” in 1985, textiles in 1988 and “non-metallic mineral products” in 1986-89 were downward, in line with the downtrend of employment in manufacturing over the period.<sup>26</sup> We then construct a dummy that, for each firm-year observation, is equal to one if the observation falls in an adjustment year for the relevant sector and zero otherwise. Finally, we interact this dummy with the aggregate shock,

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<sup>24</sup> The dataset does not distinguish between textiles and leather, so we have to aggregate these two sectors.

<sup>25</sup> The more volatile and less correlated behavior of “non-metallic mineral products” is in line with the greater cyclical sensitivity and the cyclical misalignment of the construction sector, to which it is closely linked.

<sup>26</sup> We have experimented with stricter definitions of adjustment years, broadening the band outside which the change in employment must lie (and therefore reducing the number of adjustment years) up to the mean plus or minus 1.5 times the standard deviation. Our results are robust to such changes.

distinguishing between district and non-district firms and estimate the following equation:

$$(9) \quad n_{it} = b_1\epsilon(t)d_{na,d} + b_2\epsilon(t)d_{a,d} + b_3\epsilon(t)d_{na,nd} + b_4\epsilon(t)d_{a,nd} + b_5\epsilon_i(t) + u_i(t)$$

where  $d_{x,y}$  is a dummy taking value 1 if the observation is in year  $x$  ( $x = [a$  (adjustment);  $na$  (non-adjustment)]) and location  $y$  ( $y = [d$  (district);  $nd$  (non-district)]) and zero otherwise.

The theory implies that  $b_1 < b_2$  (firms exposed to information spillovers respond more to aggregate shocks in adjustment years),  $b_1 < b_3$  (firms exposed to information spillovers are less responsive to aggregate shocks in non-adjustment years),  $b_2 > b_4$  (exposed firms respond more than non-exposed firms in adjustment years), and  $b_3 = b_4$  (no difference in responsiveness to aggregate shocks among non-exposed firms). The estimation results are reported in Table 8. The point estimates (Column 1) support the predictions. The response of district firms to aggregate shocks is three times as great in adjustment than non-adjustment years (0.072 vs 0.023), implying that the effects of the shocks are greatly amplified. The coefficient for district firms in non-adjustment years (0.023) is smaller than that of non-district firms (0.059). The latter, in turn, is smaller than that of district firms in adjustment years (0.072). Tests of equality of the coefficients reported at the bottom of the table at least partly confirm this conclusion, with only the test of the null hypothesis that district firms have a higher response than non-district in adjustment years being rejected. Furthermore, we cannot reject the hypothesis that the response to aggregate shocks for non-district firms is the same in adjustment and non-adjustment years (i.e. that  $b_3 = b_4$ ), as theory suggests.

Since the definition of adjustment years is somewhat arbitrary both in sample period and in threshold, we have checked our results defining only 1993 as an adjustment year. In 1993 the Italian economy recorded the sharpest rate of job destruction since the Second World War and a record contraction in manufacturing employment, common to all industries; as we have seen, the previous procedure indicates 1993 as an adjustment year for all sectors except “non-metallic mineral products”. The estimates, reported in Column 4 of Table 8, are very similar to those obtained when all adjustment years are used; however, in this case we fail to reject the hypothesis that, for exposed firms, the response in 1993 is the same as in the other years (i.e. that  $b_1 = b_2$ ).<sup>27</sup>

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<sup>27</sup> This is probably because in this case the parameter of the adjustment year is estimated with fewer observations (and therefore less precisely); moreover, while restricting the definition of adjustment years to 1993

Our test of the implications of information spillovers for the sensitivity of factor adjustment to aggregate shocks can be honed still more finely. If the extra response to shocks that we observe in adjustment years for district firms is indeed due to social learning, then when we control for the adjustment of others this effect should decrease or disappear (implying that  $b_1 = b_2$ ). We accordingly estimate equation (8) on the subgroup of district firms; we then run the same regressions including the average adjustment of other firms in the same district and sector. The results are reported in Columns 2 and 3 using all adjustment years and in Columns 5 and 6 using only 1993. Whatever the adjustment year, we find a sizable decline in the difference between the coefficients when the adjustment of others is included in the regression. Formal tests of equality of the coefficients, however, do not give qualitatively different results, although the test statistics do change in the expected direction. This lends support to the idea that the adjustment of others is responsible for the extra response of firms to aggregate shocks in adjustment years, and that information spillovers constitute a relevant channel of amplification of shocks.

## 10. Reference group structure and learning

In this section we extend the analysis to inquire how the structure of the reference group affects learning. It is intuitive that if a group of firms tends to behave similarly because they learn from one another, then they should end up performing similarly. It is also plausible that the structure and amount of learning that takes place may depend on the structure of the group. Bala and Goyal (1998) formalize these intuitions using a framework where firms (agents) learn from their neighbors' actions and outcomes as well as from the past records of their choices. They study how the social structure affects the long-run performance of a group of connected firms<sup>28</sup> and the nature of the learning process. They show that similar, informationally connected firms end up undertaking the same actions and, at the limit, performing similarly. Obviously, this does not imply that the action chosen by all members of the connected group is the optimal action; it only implies that it is chosen by all. Yet, depending on the structure

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guarantees that we are selecting a true adjustment year, it also implies that the other years might include both adjustment and non-adjustment years. This will tend to bias the test towards finding no difference in sensitivity to aggregate shocks.

<sup>28</sup> According to Bala and Goyal (1998), firms in a group are connected if for every pair of firms  $i$  and  $j$ , either  $i$  directly observes  $j$  or there exist firms  $i_1, \dots, i_m$  such that  $i$  directly observes  $i_1$ , which directly observes  $i_2, \dots, i_m$ , which directly observes  $j$ .

of the group, firms may end up choosing the profit-maximizing action. Bala and Goyal (1998) show that this is more likely to happen if the reference group is large and if there are no informationally dominant firms, i.e. firms whose actions are observed by all other firms in the group. On one side, more firms in a group simply means that more information can be gathered by observing the behavior of others; on the other, if the group contains one or a few dominant players, firms may end up being trapped into a sub-optimal action. The intuition behind this result is that, since a dominant player is observed by all other members of the group, each member will tend to emulate him, disregarding his own private information, in the spirit of an information cascade. As a consequence, the process of information revelation and diffusion is impaired, and the private information of agents is not revealed efficiently.

We can use our data to test this hypothesis. It implies that each firm's performance should be positively correlated with the number of other firms in the district and negatively with the weight of informationally dominant actors (large firms). We use the sample of district firms. For each district we compute the number of specialized firms in each year and construct an indicator of information leadership as the share of the three largest firms' sales in those of the reference group (i.e. the total sales of the firms in that district that are present in our sample). As an alternative measure, we use the 95th percentile of sales divided by median sales in the district. We measure performance as gross profits over total assets. We then regress this measure of profitability on the number of specialized firms, the proxy for information leadership, and a full set of year dummies, sector dummies and regional dummies as controls for performance shocks. If the theoretical prediction is correct, a higher concentration of sales should have a negative effect on profitability and a higher number of firms a positive one. Since profitability can change systematically with the size of the firm, we also insert a set of size dummies, one for each quartile of sales. Results are shown in Table 9. The first two columns report estimates using a fixed-effects estimator to account for firms' heterogeneity in performance. The first column shows the estimates when the information leadership proxy is the sales of the largest three firms; the second, when it is the ratio between the 95th percentile and the median. In both cases the results are as expected: the coefficient of the number of firms in the district is positive and significant and that of the proxy for information leadership is negative and significant, implying that the performance of firms in districts with dominant players is systematically worse than that of firms in districts without dominant players, in line with Bala and Goyal (1998). Furthermore, the effect of dominant players is economically

meaningful: increasing the ratio between the 95th percentile of sales and the median by 10 percent starting from its sample mean lowers profitability by 1.2 percentage points, almost 10 percent of its mean value<sup>29</sup>. Since our measure of performance is characterized by the presence of several extreme observations on both tails, we have also run our estimates using a least absolute deviations estimator omitting fixed effects. The results, shown in the third and fourth columns of Table 9, are very similar to those of the first two columns, reassuring us that the foregoing conclusions are robust to the presence of outliers.

## 11. Conclusions

We have exploited a rich dataset on a sample of Italian manufacturing firms to assess whether information spillovers are an important factor in determining labor adjustment decisions. Using the concepts of product similarity and geographical proximity to identify a set of firms that are more likely to be exposed to information spillovers, we have shown that, after controlling for aggregate and individual shocks, firms' adjustments in labor are strongly influenced by various measures of aggregate adjustment within the reference group. In addition, we find that large adjustments tend to induce a proportionally stronger response, arguably because they are more visible. We have also shown that the adjustments of firms that fail to satisfy either of the criteria have no impact on individual adjustments.

In accordance with the predictions of the theory on strategic learning, we have found that information spillovers tend to induce concentration of adjustments in some periods, which we have defined as adjustment years, suggesting that they actually constitute a powerful mechanism of amplification of aggregate shocks. Finally, we have investigated the impact of the structure of the reference group on the learning process, showing that an increase in the number of firms in the reference group has a positive impact on profitability, while the presence of large firms might be a barrier to the efficient dissemination of information and therefore reduce average profitability.

The analysis can be extended in many different directions. We plan to study the implication of IS in terms of co-movements of factor demands more directly, by considering how the individual hazard functions for factor adjustments are influenced by social learning. A second extension we plan to pursue relates to the estimation of the rate at which such effects

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<sup>29</sup> For this computation we are using the estimates in column 2 of Table 9.

fade with distance, to assess how “local” spillovers actually are. This would imply relating the adjustment of firms in a district to that of firms in other districts, controlling for the distance between them. Finally, it would be important to further investigate the effects of social learning on firms’ performance. This would help to better assess the implications of spillovers for industrial policy, particularly for phenomena in which information plays an important role, such as the diffusion of technological innovation, the entry into a new market, or the early phase of development of a new industry in a region.

Table 1

## SUMMARY STATISTICS FOR THE WHOLE SAMPLE

<u>PANEL A</u>						
<u>SAMPLE-POPULATION COMPARISONS:1991</u>						
Sector	Employment in specialized district firms/ Employment in the sector		Employment in specialized district firms/ Employment in district firms		Number of districts	
	Sample	Population	Sample	Population	Sample	Population
	1) Food, beverage & tobacco	7.2	5.5	27.8	24.9	16
2) Textile & clothing	36.3	38.1	36.7	40.3	65	69
3) Leather & footwear	41.9	39.4	40.7	41.3	26	27
4) Timber, construction materials and glass	24.6	20.8	37.6	35.2	39	39
5)Metallurgy and metal products except machines	0.4	0.3	62.5	17.6	1	1
6)Machinery, computers & tools	13.3	14.4	47.7	49.9	30	32
7) Rubber, plastic & chemical products	2.1	3.1	26.8	19.2	4	4
8) Paper, printing & publishing	1.4	1.6	43.5	23.4	6	6
9) Other manufacturing	34.7	52.2	13.5	20.8	4	4
Total	14.3	17.6	38.5	41.3	191	199

  

<u>PANEL B</u>					
<u>SAMPLE INFORMATION</u>					
Sector	Average N. of specialized district firms: 1991	N. of districts with at least 30 specialized firms: 1991	Total n. of observations, 1982-1996		Product Heterogeneity
			District	Non-district	
			1) Food, beverage & tobacco	9.8	
2) Textile & clothing	23.0	9	19,102	21,911	Medium
3) Leather & footwear	21.6	4	6,605	6,974	Low
4) Wood, construction materials and glass	12.7	5	5,751	13,330	Medium
5)Metallurgy and metal products except machines	3	0	50	8,664	High
6)Machinery, computers & tools	45.3	13	19,977	76,646	High
7) Rubber, plastic & chemical products	18.2	1	1,125	34,235	Medium
8) Paper, printing & publishing	4.3	0	343	16,134	High
9) Other manufacturing	21.5	1	1,154	1,908	High
Total	22.7	34	56,318	205,878	

Specialized district firms are those located in the district and belonging to the sector.



Table 2

## SUMMARY STATISTICS FOR THE SELECTED SAMPLE: 1991

<u>DISTRICTS FIRMS</u>									
District (product)	Area of location	N. of Specialized firms	Aver. empl.	Ratio of 95 <sup>th</sup> to 50 <sup>th</sup> percentile of employment	Total Number of obs. (1982-1996)	Median ROA	SD of ROA	Share of firms in the modal 4 digit sector and sector n.	N. of district firms in other sectors
	1	2	3	4	5	6	7	8	9
<i>Textile</i>									
Biella (wool)	North	76	79.00	7.73	1,198	0.089	0.11	60.5 (1710)	28
Cossato (wool)	North	59	112.86	8.74	951	0.094	0.18	55.9 (1710)	13
B.Arsizio	North	97	87.49	5.79	1,498	0.090	0.13	28.9 (1730)	226
Gallarate	North	60	73.38	6.76	836	0.094	0.09	31.7 (1770)	99
Como (silk)	North	187	61.95	3.73	2,657	0.108	0.06	32.6 (1724)	218
Prato (wool)	Center	329	25.78	4.81	4,250	0.119	0.08	54.4 (1710)	38
Total		808	56.46	6.29	11,390	0.107	0.11	35.9 (1710)	622
<i>Leather &amp; footwear</i>									
S. Croce Arno (tannery)	Center	220	20.76	3.36	2,550	0.111	0.38	77.3 (1910)	37
<i>Wood &amp; furniture</i>									
Desio	North	99	59.24	4.25	1,225	0.102	0.09	79.6 (3610)	262
Udine (chairs)	North	53	72.75	6.75	889	0.096	0.07	73.6 (3610)	132
Pesaro (furniture)	Center	41	55.27	3.1	577	0.087	0.16	95.1 (3610)	36
Total		193	62.11	4.38	2,691	0.096	0.11	80.8 (3610)	430
<i>Construcion materials</i>									
Sassuolo (tiles)	Center	96	142.77	10.17	1,388	0.094	0.08	53.1 (2620)	190
<i>Tools</i>									
Lecco	North	82	61.41	5.31	1,162	0.137	0.08	40.2 (2870)	157
Bergamo	North	48	55.17	3.36	651	0.156	0.11	37.5 (2850)	226
Padova	North	38	55.76	3.19	552	0.104	0.11	34.2 (2870)	154
Total		168	58.35	3.64	2,365	0.132	0.10	31.6 (2870)	537
<u>NON-DISTRICT FIRMS</u>									
Textile		538	99.34	8.70	7,592	0.095	0.09	21.2 (1710)	
Leather & foot.		234	71.99	6.31	3,371	0.091	0.11	52.6 (1930)	
Timber & furn.		533	54.16	5.84	7,180	0.094	0.09	51.2 (3610)	
Constr.		836	80.97	9.84	11,048	0.110	0.11	32.3 (2660)	
Materials									
Tools		1,005	61.95	5.80	12,831	0.100	0.13	30.8 (2810)	
Total		3,146			42,022				

**EMPLOYMENT ADJUSTMENT AND INFORMATION SPILLOVERS: FULL SAMPLE ESTIMATES**

Explanatory variables	District firms			Non-district firms	
	(1)	(2)	(3)	(4)	(5)
Aggregate shocks	0.026 (0.007)	0.025 (0.007)	0.024 (0.008)	0.022 (0.007)	0.058 (0.004)
Specific shocks	0.056 (0.002)	0.056 (0.002)	0.059 (0.003)	0.053 (0.002)	0.068 (0.002)
<i>Average adjustment by other firms in:</i>					
- the same distr. and sect.	0.308 (0.055)	0.287 (0.057)	0.249 (0.068)	0.300 (0.060)	
- the same distr. and sect. ( $t-1$ )				-0.019 (0.057)	
- other distr. but same sect.		-0.005 (0.031)	-0.049 (0.072)	-0.002 (0.111)	
- the same distr. but other sect.		-0.080 (0.100)	0.006 (0.040)	0.001 (0.031)	
Average adjustment by other non-distr. firms in the same sect.		0.171 (0.124)	-0.013 (0.072)	0.102 (0.132)	0.061 (0.083)
Number of observations	17,456	17,456	10,914	16,407	34,795
Number of firms	2,308	2,308	1,477	2,295	4,896
$F$ test for fixed effects ( $p$ -value)	1.84 (0.000)	1.84 (0.000)	1.65 (0.000)	1.85 (0.000)	1.57 (0.000)
$p$ -value for the $F$ test for adjustment by non-reference group firms = 0		0.578	0.912	0.852	

The left-hand side variable is the firm's percentage change in employment. Standard errors are reported in parentheses. All regressions include firm fixed effects. Aggregate shocks are the coefficients of the year-dummies in a regressions of the standardized rate of growth of real sales among district firms (respectively non-district for the estimates reported in column (5)) belonging to the same sector on a set of year-region dummies; specific shocks are the residuals from this regression. The adjustment by other firms is the unweighted average of the percentage change in employment among the firms in the reference group; when the reference group is the same as the firm in the left-hand side, the adjustment of the latter is excluded when computing the average adjustment. Column (3) reports the results for a subgroup of firms for which the adjustment for the non-reference group has been calculated using a finer (4-digit) definition of "same sector", while maintaining the same measure of adjustment as before for the reference group. All regressions include two controls for liquidity constraints measured by the firm's cash flow as a share of total sales and interacting this measure with two dummies, one for non-positive and the other for non-negative adjustments.

**EMPLOYMENT ADJUSTMENT AND INFORMATION SPILLOVERS: ESTIMATES WITH  
PERCENTILES OF ADJUSTMENT. WHOLE SAMPLE OF DISTRICT FIRMS**

Explanatory variables	District firms			Non-district firms
	(1)	(2)	(3)	(4)
Aggregate shocks	0.023 (0.007)	0.022 (0.007)	0.026 (0.007)	0.059 (0.004)
Specific shocks	0.056 (0.002)	0.056 (0.002)	0.056 (0.002)	0.068 (0.002)
<i>Adjustment measures by other firms :</i>				
<b>A: <u>Firms in the same district and sector</u></b>				
- 10 <sup>th</sup> percentile	0.042 (0.039)	0.028 (0.045)	0.007 (0.042)	
- 90 <sup>th</sup> percentile	0.172 (0.025)	0.155 (0.039)	0.168 (0.026)	
- Mean adjustment: same district and sector		0.053 (0.092)		
<b>B: <u>Firms in other districts, same sector</u></b>				
- 10th percentile			-0.040 (0.070)	
- 90th percentile			-0.061 (0.056)	
<b>C: <u>Firms in same districts, other sector</u></b>				
- 10th percentile			0.050 (0.026)	
- 90th percentile			-0.007 (0.017)	
<b>D: <u>Non-districts firms, same sector</u></b>				
- 10th percentile			0.126 (0.072)	0.145 (0.053)
- 90th percentile			0.018 (0.059)	-0.027 (0.044)
Number of observations	17,456	17,456	17,456	34,795
Number of firms	2,308	2,308	2,308	4,896
<i>F</i> test for fixed effects	1.84	1.83	1.83	1.57
( <i>p</i> -value)	(0.000)	(0.000)	(0.000)	(0.000)
<i>p</i> -value for the <i>F</i> test for adjustment by non-reference group firms = 0			0.246	

The left-hand side variable is the firm's percentage change in employment. Standard errors are reported in parentheses. All regressions include firm fixed effects. Aggregate shocks are the coefficients of the year-dummies in a regressions of the standardized rate of growth of real sales among district firms belonging to the same sector on a set of year-region dummies; specific shocks are the residuals from this regression. The adjustment by other firms is measured by various moments of the distribution of the percentage change in employment in each sample year among the firms in the reference group; when the reference group is the same as the firm in the left-hand side, the adjustment of the latter is excluded when computing the adjustment by other firms. All regressions include two controls for liquidity constraints measured by the firm's cash flow as a share of total sales and interacting this measure with two dummies, one for positive and the other for negative adjustments.

**EMPLOYMENT ADJUSTMENT AND INFORMATION SPILLOVERS: ESTIMATES WITH  
FRACTION OF FIRMS ADJUSTING. WHOLE SAMPLE OF DISTRICT FIRMS**

Explanatory variables	District firms		Non-district firms	
	(1)	(2)	(3)	(4)
Aggregate shocks	0.024 (0.007)	0.023 (0.007)	0.027 (0.008)	0.060 (0.004)
Specific shocks	0.056 (0.002)	0.056 (0.002)	0.056 (0.002)	0.068 (0.002)
<i>Adjustment by other firms :</i>				
-25%, same district and sector	-0.137 (0.078)	-0.065 (0.093)	-0.082 (0.084)	
+25%, same district and sector	0.404 (0.069)	0.291 (0.105)	0.388 (0.071)	
mean adjustment: same district and sector		0.129 (0.091)		
-25%, other district and same sector			0.170 (0.137)	
+25%, other district and same sector			-0.172 (0.120)	
-25%, same district and other sector			-0.064 (0.058)	
+25%, same district and other sector			0.082 (0.046)	
-25%, non district and same sector			-0.390 (0.156)	-0.373 (0.123)
+25%, non district and same sector			0.029 (0.163)	-0.149 (0.118)
Number of observations	17,456	17,456	17,456	34,795
Number of firms	2,308	2,308	2,308	4,896
<i>F</i> test for fixed effects ( <i>p</i> -value)	1.84 (0.000)	1.83 (0.000)	1.84 (0.000)	1.58 (0.000)
<i>p</i> -value for the <i>F</i> test for adjustment by non-reference group firms = 0			0.033	

The left-hand side variable is the firm's percentage change in employment. Standard errors are reported in parentheses. All regressions include firm fixed effects. Aggregate shocks are the coefficients of the year-dummies in a regressions of the standardized rate of growth of real sales among district firms belonging to the same sector on a set of year-region dummies; specific shocks are the residuals from this regression. The adjustment by other firms is measured by the share of firms in the reference group that in each sample year adjust employment by more than 25 percent and by less than 25 percent respectively; when the reference group is the same as the firm in the left-hand side, the adjustment of the latter is excluded when computing the share of firms that adjust in excess of |25| percent. All regressions include two controls for liquidity constraints measured by the firm's cash flow as a share of total sales and interacting this measure with two dummies, one for positive and the other for negative adjustments.

**EMPLOYMENT ADJUSTMENT AND INFORMATION SPILLOVERS: ESTIMATES BY  
SECTOR FOR DISTRICT FIRMS**

Explanatory variable	Sector									
	Textile		Leather & footwear		Wood & furniture		Construction materials		Tools	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Aggregate shocks	0.028 (0.008)	0.029 (0.009)	0.002 (0.020)	0.004 (0.023)	0.023 (0.020)	0.028 (0.020)	0.018 (0.036)	0.052 (0.049)	0.019 (0.015)	0.020 (0.017)
Specific shocks	0.049 (0.003)	0.049 (0.003)	0.086 (0.008)	0.086 (0.008)	0.054 (0.006)	0.054 (0.006)	0.083 (0.011)	0.083 (0.011)	0.027 (0.006)	0.027 (0.006)
<i>Average adjustment by other firms in:</i>										
- the same district and sector	0.406 (0.079)	0.387 (0.081)	0.462 (0.190)	0.397 (0.226)	0.021 (0.126)	-0.218 (0.152)	0.087 (0.202)	0.071 (0.212)	0.260 (0.110)	0.231 (0.123)
- other districts but same sector		-0.199 (0.162)		0.238 (0.323)		-1.093 (0.386)		-0.441 (0.407)		0.065 (0.176)
- the same district but other sectors		-0.020 (0.036)		0.015 (0.115)		0.514 (0.157)		0.015 (0.138)		0.232 (0.234)
Average adjustment by other non-district firms in the same sector		0.176 (0.187)		0.052 (0.318)		0.756 (0.498)		0.687 (0.533)		-0.221 (0.305)
Number of observations	9,731	9,731	2,164	2,164	2,336	2,336	1,200	1,200	2,025	2,025
Number of firms	1,270	1,270	301	301	296	296	148	148	293	293
<i>F</i> test for fixed effects ( <i>p</i> -value)	1.98 (0.000)	1.97 (0.000)	1.32 (0.001)	1.31 (0.001)	1.50 (0.000)	1.46 (0.000)	2.71 (0.000)	2.72 (0.000)	1.49 (0.000)	1.48 (0.000)
<i>p</i> value for the <i>F</i> test for the adjustment of other non-reference group firms = 0		0.576		0.849		0.003		0.549		0.676

The left-hand side variable is the firm's percentage change in employment. Standard errors are reported in parentheses. All regressions include firm fixed effects. Aggregate shocks are the coefficients of the year-dummies in a regression of the standardized rate of growth of real sales among district firms belonging to the same sector on a set of year-region dummies; specific shocks are the residuals from this regression. The adjustment by other firms is the unweighted average of the percentage change in employment among the firms in the reference group; when the reference group is the same as that of the firm in the left-hand side, the adjustment of the latter is excluded when computing the average adjustment. All regressions include two controls for liquidity constraints measured by the firm's cash flow as a share of total sales and interacting this measure with two dummies, one for positive and the other for negative adjustments.

## FIRMS SIZE AND THE INTENSITY OF SOCIAL LEARNING

Explanatory variables	Firm size quartile (sample of district firms)			
	1 <sup>th</sup>	2 <sup>th</sup>	3 <sup>th</sup>	4 <sup>th</sup>
Aggregate shocks	0.022 (0.021)	0.013 (0.009)	- 0.008 (0.007)	0.001 (0.007)
Specific shocks	0.073 (0.007)	0.029 (0.003)	0.027 (0.003)	0.035 (0.003)
<i>Average adjustment by other firms in:</i>				
- the same district and sector	0.679 (0.182)	0.338 (0.076)	0.224 (0.059)	0.177 (0.052)
Number of observations	4,522	4,332	4,235	4,367
Number of firms	949	929	835	637
<i>F</i> test for fixed effects =0 ( <i>p</i> -value)	3.16 (0.000)	3.48 (0.000)	2.10 (0.000)	1.77 (0.000)

The left-hand side variable is the firm's percentage change in employment. Standard errors are reported in parentheses. All regressions include firm fixed effects. Aggregate shocks are the coefficients of the year-dummies in a regressions of the standardized rate of growth of real sales among district firms (respectively non-district for the estimates reported in column (4)) belonging to the same sector on a set of year-region dummies; specific shocks are the residuals from this regression. The adjustment by other firms is the unweighted average of the percentage change in employment among the firms in the reference group; when the reference group is the same as the firm in the left-hand side, the adjustment of the latter is excluded when computing the average adjustment.

**EMPLOYMENT ADJUSTMENT AND INFORMATION SPILLOVERS: ESTIMATES OF EXTRA  
RESPONSE IN ADJUSTMENT YEARS. WHOLE SAMPLE**

Explanatory variables	Adjustment years: all			Adjustment year:1993		
	All firms	District firms		All firms	District firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Aggregate shocks, district firms in non adjustment years - $b_1$	0.023 (0.009)	0.023 (0.008)	0.019 (0.008)	0.037 (0.007)	0.037 (0.007)	0.029 (0.007)
Aggregate shocks, district firms in adjustment years - $b_2$	0.072 (0.013)	0.072 (0.018)	0.055 (0.012)	0.071 (0.036)	0.072 (0.033)	0.048 (0.033)
Aggregate shocks, non-district firms in non adjustment years - $b_3$	0.059 (0.005)			0.061 (0.004)		
Aggregate shocks, non-district firms in adjustment years - $b_4$	0.067 (0.006)			0.073 (0.013)		
Average adjustment by other firms in the same district and sector			0.291 (0.056)			0.314 (0.056)
Specific shock	0.067 (0.001)	0.059 (0.002)	0.060 (0.002)	0.067 (0.002)	0.059 (0.002)	0.060 (0.002)
Number of observations	52,308	17,471	17,471	52,308	17,471	17,471
Number of firms	7,204	2,308	2,308	7,204	2,308	2,308
$F$ -test for fixed effects=0 ( $p$ -value)	1.68 (0.000)	1.87 (0.000)	1.85 (0.000)	1.68 (0.000)	1.87 (0.000)	1.85 (0.000)

TESTS OF HYPOTHESES:  $p$ -values for the  $F$  test of the specified null hypotheses

*Regression (1):*  $H_0: b_1 = b_2$ ;  $p$ -value = 0.001;  $H_0: b_1 = b_3$ ;  $p$ -value = 0.002;  
 $H_0: b_2 = b_3$ ;  $p$ -value = 0.364;  $H_0: b_3 = b_4$ ;  $p$ -value = 0.357.

*Regression (2):*  $H_0: b_1 = b_2$ ;  $p$ -value = 0.006.

*Regression (3):*  $H_0: b_1 = b_2$ ;  $p$ -value = 0.014.

*Regression (4):*  $H_0: b_1 = b_2$ ;  $p$ -value = 0.339;  $H_0: b_1 = b_3$ ;  $p$ -value = 0.003;  
 $H_0: b_2 = b_3$ ;  $p$ -value = 0.773;  $H_0: b_3 = b_4$ ;  $p$ -value = 0.376.

*Regression (5):*  $H_0: b_1 = b_2$ ;  $p$ -value = 0.296.

*Regression (6):*  $H_0: b_1 = b_2$ ;  $p$ -value = 0.571.

The left-hand side variable is the firm's percentage change in employment. Standard errors are reported in parentheses. All regressions include firm fixed effects. Estimates are obtained by constructing interaction dummies that let the coefficients of the aggregate shocks differ according to district-non district and adjustment year-non adjustment year. Adjustment years are defined as years in which the percentage variation in dependent employment at the sectoral level exceeds the average sectoral variation over the period 1971-1995 by one standard deviation. Sectoral employment data source: International Sectoral Data Base 1997, OECD. For the description of the variables see the note to Table 3.

## SOCIAL LEARNING AND FIRMS PERFORMANCE

Explanatory variable	Fixed effects estimates		LAD estimates	
	1	2	3	4
Average size of largest three firms in the district/average firm size in the district	-0.0042 (0.0008)	-	-0.0040 (0.0006)	-
95 <sup>th</sup> percentile of firms size in the district / median firm size in the district	-	-0.1029 (0.0180)	-	-0.0850 (0.0151)
N. of firms in district	0.0000893 (0.000030)	0.0000676 (0.0000301)	0.0001499 (0.0000196)	0.0001067 (.0000187)
Number of observations	20,380	20,380	20,380	20,380
Number of firms	2,688	2,688	2,688	2,688
F test for fixed effects =0 (p-value)	5.62 (0.000)	5.63 (0.000)	-	-

The left hand side is firm's gross profits as a share of firm's total assets. Size is measured by firm sales. Only specialized firms are considered. Each regression includes a full set of year dummies, regional dummies, sector dummies and 4 dummies for firms size (one for each sales quartile); all regression except the LAD estimates include firm fixed effects.



**POPULATION AND SAMPLE MARGINAL FREQUENCY DISTRIBUTION BY FIRM SIZE, SECTOR  
OF ACTIVITY AND GEOGRAPHICAL LOCATION IN 1990**

Marginal frequency distribution		
	Population (1990 census)	Sample
Firms size (number of employees)		
50 – 99	22.7	15.0
100-199	20.2	16.9
200-499	21.3	19.7
500-999	17.5	12.0
>999	18.3	36.4
Geographical location (regions)		
	12.7	14.9
Piemonte and Valle d'Aosta		
Lombardia	33.8	36.6
Liguria	2.5	3.9
Trentino Alto Adige	1.1	1.1
Veneto	8.9	9.3
Friuli Venezia Giulia	2.4	3.5
Emilia Romagna	10.1	9.1
Toscana	6.3	4.5
Umbria	1.6	1.1
Marche	2.4	2.1
Lazio	3.4	4.8
Abruzzi	2.1	1.4
Molise	0.6	0.1
Campania	3.9	3.7
Puglia	2.0	1.3
Basilicata	0.4	0.3
Calabria	0.6	0.2
Sicilia	1.9	1.3
Sardegna	3.2	0.7

Population and sample refer to firms with more than 50 employees.

## **Appendix: the Company Accounts Data Service (CADS)**

Our data are drawn from Italy's Company Accounts Data Service, a large database with information on a sample of over 30,000 Italian firms. The data, available since 1982 and up to 1996, are collected by Centrale dei Bilanci, an organization established in the early 1980s jointly by the Bank of Italy, the Italian Banking Association (ABI) and a pool of leading banks with the intent of building up and sharing information on borrowers. In addition to company accounts the database contains detailed information on firms' demographics (year of foundation, location, type of organization, ownership status, structure of control, group membership etc.), on employment, and on flows of funds. Balance sheets are reclassified to reduce the dependence of the data on the accounting conventions used by each firm to record income figures and asset values. Balance sheets for the banks' major clients (defined by level of borrowing) are collected by the banks. The focus on the level of borrowing skews the sample towards larger firms. Furthermore, because most of the leading banks are in the northern part of the country, the sample has more firms headquartered in the North than in the South. Finally, since banks are most interested in firms that are creditworthy, defaulting firms are not in the data set, so that the sample is also tilted towards high-quality borrowers. Despite these potential biases the comparison between sample and population moments in Table 1 suggests that the CADS is fairly representative of the whole population. This is confirmed by the data in Table A1, which compares the marginal frequency distribution by size and geographical location in the sample and in the population in 1990. While the geographical distribution of firms in the sample is not too far from that in the population, it is biased towards larger firms, especially those with 1,000 or more employees.

## References

- Anderson L. and C. Holt (1997), "Information Cascades in the Laboratory," *American Economic Review*, Vol. 87, pp. 847-62.
- Audtresch D. (1998), "Agglomeration and the Location of Innovative Activity," CEPR, Discussion Paper, No. 1974.
- Avery C. and P. Zemsky (1998), "Multidimensional Uncertainty and Herd Behavior in Financial Markets," *American Economic Review*, Vol. 88, pp. 724-48.
- Bala V. and S. Goyal (1998), "Learning from Neighbors", *Review of Economic Studies*, Vol. 65, pp. 595-621.
- Banerjee A. (1992), "A Simple Model of Herd Behavior", *Quarterly Journal of Economics*, Vol. 107, pp. 797-817.
- Basu S. And J. Fernald (1997), "Returns to Scale in U.S. Production: Estimates and Implications", *Journal of Political Economy*, Vol. 105, pp. 249-83.
- Basu S. and M. Kimball (1997), "Cyclical Productivity with Unobserved Input Variations", NBER Working Paper, No. 5915.
- Bikhchandani S., D. Hirshleifer and I. Welch (1998), "Learning from the Behavior of Others: Conformity, Fads, and Informational Cascades", *Journal of Economic Perspectives*, Vol. 12, pp. 151-70.
- Bikhchandani S., D. Hirshleifer and I. Welch (1992), "A Theory of Fads, Fashion, Custom and Cultural Change as Informational Cascades", *Journal of Political Economy*, Vol. 100, pp. 992-1026.
- Boeri T. (1996), "Is Job Turnover Countercyclical?", *Journal of Labor Economics*, Vol. 14, pp. 603-25.
- Brock, W. and S. Durlauf (1999), "Interactions-Based Models", forthcoming in Heckman, J. and E. Leamer (eds.), *Handbook of Econometrics 5*, Amsterdam, North-Holland.
- Burnside, C., M. Eichenbaum and S. Rebelo (1995), "Capital Utilization and Returns to Scale", in Bernanke, B. and J. Rotemberg (eds.), *NBER Macroeconomics Annual 1995*, Cambridge: MIT Press.
- Caballero R., E. Engel and J. Haltiwanger (1997), "Aggregate Employment Dynamics: Building from Microeconomic Evidence", *American Economic Review*, Vol. 87, pp. 115-37.
- Caballero R. and R. Lyons (1992), "External Effects in US Procyclical Productivity", *Journal of Monetary Economics*, Vol. 29, pp. 209-25.

- Campbell, J. R. and J. D.M. Fisher (1998), "Organizational Flexibility and Employment Dynamics at Young and Old Plants", NBER Working Paper, No. 6809.
- Caplin A. and J. Leahy (1993), "Sectoral Shocks, Learning and Aggregate Fluctuations", *Review of Economics Studies*, Vol. 60, pp. 777-94.
- Caplin A. and J. Leahy (1994), "Business as Usual, Market Crashes and Wisdom after the Fact", *American Economic Review*, Vol. 84, pp. 548-65.
- Carlstrom C. T. and T. S. Fuerst (1997), "Agency Costs, Net Worth and Business Fluctuations: A Computable General Equilibrium Analysis", *American Economic Review*, Vol. 87, pp. 893-910.
- Chamley C. and G. Douglas (1994), "Information Revelation and Strategic Delay in a Model of Investment", *Econometrica*, Vol. 62, pp. 1065-85.
- Davis S., J. Haltiwanger and S. Schu (1996), *Job Creation and Destruction*, Cambridge Ma, MIT Press.
- Davis S. and J. Haltiwanger (1992), "Gross Job Creation, Gross Job Destruction and Employment Reallocation", *Quarterly Journal of Economics*, Vol. 107, pp. 819-63.
- Diamond P. (1982), "Aggregate Demand Management in Search Equilibrium", *Journal of Political Economy*, Vol. 90, pp. 881-94.
- Ellison G. and D. Fudenberg (1995), "Word-of-mouth Communication and Social Learning", *Quarterly Journal of Economics*, Vol. 100, pp. 93-125.
- Ellison G. and D. Fudenberg (1993), "Rules of Thumb for Social Learning", *Journal of Political Economy*, Vol. 101, pp. 612-43.
- Ellison G. and E. Glaser (1997), "Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach", *Journal of Political Economy*, Vol. 105, pp. 889-927.
- Feldman M. and D. Audresch (1998), "Innovation in Cities: Science-based Diversity, Specialization and Localized Competition", CEPR Discussion Paper, No. 1980.
- Hall R. (1988), "The Relation between Price and Marginal Cost in US Industry", *Journal of Political Economy*, Vol. 96, pp. 921-47.
- Harrison B., M. Kelley and J. Gant (1996), "Innovative Firm Behavior and Local Milieu: Exploring the Intersection of Agglomeration, Firm Effects, and Technological Change", *Economic Geography*, Vol. 72, pp. 233-58.
- Horvath, M. (1999), "Business Cycles and the Failure of Marginal Firms", mimeo, Stanford University.
- Horvath M., F. Schivardi and M. Woywode (1997), "Delay, Entry and Shakeout in Beer Brewing", mimeo, Stanford University.

- Jaffe A., M. Trajtenberg and R. Henderson (1993), "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations", *Quarterly Journal of Economics*, Vol. 108, pp. 577-98.
- Jiménez, M. and D. Marchetti (1998), "Interpreting the Procyclical Productivity of Manufacturing Sectors: Can We Really Rule Out External Effects?", mimeo, Bank of Italy.
- Manski, C. (1993), "Identification of Endogenous Social Effects: the Reflection Problem", *Review of Economic Studies*, Vol. 60, pp. 531-42.
- Rob, R. (1991), "Learning and Capacity Expansion under Demand Uncertainty", *Review of Economic Studies*, Vol. 58, pp. 655-75.
- Sbordone, A. (1997), "Interpreting the Procyclical Productivity of Manufacturing Sectors External Effects or Labor Hoarding?", *Journal of Money, Credit and Banking*, Vol. 29, pp. 26-45.
- Schivardi F. (1998), "Reallocation and Learning over the Business Cycle", Banca d'Italia, Temi di discussione, No. 345.
- Wallsten S. (1998), "Geographic Clustering and Spillovers: An Empirical Approach Using Geographic Information Systems and Firm-Level Data", mimeo, Stanford University.
- Zeira J. (1987), "Investment as a Process of Search", *Journal of Political Economy*, Vol. 95, pp. 204-10.

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