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Abstract
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Keywords
J54, D24, worker cooperative, capitalist firm, productivity, employee ownership, labor-managed firm

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PRODUCTIVITY, CAPITAL, AND LABOR IN LABOR-MANAGED AND CONVENTIONAL FIRMS: AN INVESTIGATION ON FRENCH DATA

FATHI FAKHFAKH, VIRGINIE PÉROTIN, AND MÓNICA GAGO*

Using two new data sets from France, the authors present the first study of the comparative productivity of labor-managed and conventional firms involving large representative samples of firms in a range of industries including services. Their study offers new stylized facts on labor-managed firms, and disentangles incentive effects from those of differences in input demand behavior on factor elasticities. Contrary to received wisdom, labor-managed firms are not smaller than conventional firms; they grow as fast or faster in all industries. The two groups of firms organize production differently. Labor-managed firms are as productive as conventional firms, or more productive, in all industries, and use their inputs efficiently; but in several industries conventional firms would produce more with their current input levels if they organized production like labor-managed firms. On average overall, firms would produce more using the labor-managed firms' industry-specific technologies. Labor-managed firms do not produce at inefficiently low scales.

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A data appendix with additional results, and copies of the computer programs used to generate the results presented in the paper, are available from the first author at fathi.fakhfakh@u-paris2.fr. The data used to construct the data sets can be obtained from the French statistical institute Insee (by applying to the Committee on Statistical Confidentiality) and from the French federation of worker cooperatives, Confédération Générale des SCOP.

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Over the last two decades, policymakers have shown a sustained interest in employee ownership. Their interest has been supported by an abundant empirical literature that consistently shows firms with some employee ownership and/or profit sharing performing as well as or better than other firms in capitalist economies. Employee ownership was unexpectedly widespread at the start of the transition away from central planning (Earle and Estrin 1998). However, employee ownership has had little effect on firm performance in transition economies (Jones 2004; Estrin et al. 2009), and the century-old debate on the performance effects of employee ownership is by no means over. In this article, we contribute to the debate by examining the productivity of conventional and labor-managed firms with two new, large, panel data sets covering some 7,000 French firms annually, about 500 of which are fully employee-owned. In the process, we offer new stylized facts on labor-managed firms in relation to conventional ones, and revisit classic theoretical hypotheses regarding factor demands in labor-managed firms. In particular, we explore differences in workforce composition between the two types of firms and the implications of the hypothesis that labor-managed firms underinvest, which has played a major role in policy debates about employee ownership but regarding which little systematic evidence is available.

A key issue in the debate on the performance effects of employee ownership is employee participation in governance. Studies on the effects of this form of participation on firm performance have produced mixed findings (see, e.g., Addison et al. 2004; FitzRoy and Kraft 2005). The more robust studies in that strand of literature present results that are more favorable to governance participation (Addison 2005). In addition, it has often been argued that there is a complementarity between participation in profit, such as profit sharing and the financial component of employee stock ownership, and participation in governance. In this case, there should be stronger positive effects on productivity if the two forms are present together in the same firm, as is the case in worker cooperatives (see Conte and Svejnar 1990; Levine and Tyson 1990; Ben-Ner and Jones 1995). Worker cooperatives practice the ultimate form of participation in governance, in that employees own the firm, vote on strategic decisions, and elect senior management, who can be voted down at any time in French cooperatives. In this way cooperative members also decide on the extent of their own day-to-day involvement in running the firm. As Pencavel (2001) notes, the performance of worker cooperatives provides a crucial test for the productivity effects of employee ownership in general.

Extensive comparative data have been used recently to investigate pay and labor demand issues in labor-managed and conventional firms (Pencavel, Pistaferri, and Schivardi 2006; Burdín and Dean 2009); however, until now only a small number of studies have been able to compare the productivity of fully employee-owned firms with that of conventional firms (Conte and Svejnar 1988; Berman and Berman 1989; Estrin 1991; Craig and Pencavel

1992, 1995; Pencavel and Craig 1994; Bayo Moriones et al. 2003; Jones 2007). With the exception of Bayo Moriones et al., who look at qualitative measures of performance, these researchers studied samples from a few dozen firms. The data we use cover a much larger sample than previous performance studies. We compare two representative samples of conventional French firms with 20 or more employees with all the worker cooperatives in existence in France in the same size band. Existing studies look at labor-managed and conventional firms from one industry only, or match firms in the two groups by industry and size. The data we have make it possible to allow systematic differences in firm size and technology to be related to ownership form as well as industry. A key purpose of the article is thus to investigate whether results obtained with samples covering a single industry or a small range of industries, and with industry-matched samples, still stand with more extensive samples.[1] Having a representative sample of conventional firms over a range of industries and years also offers us an opportunity to contribute significantly to the updating of stylized facts about labor-managed firms in relation to conventional ones that has recently begun as more extensive data have become available (see Pencavel et al. 2006; Burdín and Dean 2009).

A labor-managed firm's production function may differ in several ways from that of a conventional firm. Differences in X-efficiency associated with employee involvement may shift the whole function up- or downward. Different output elasticities may also be observed if incentive effects are embodied in the factors. However, several hypotheses on labor-managed firms' investment and labor demand behavior also imply that the two types of firms should operate at different scales and with different combinations of capital and labor, so their observed marginal productivities and elasticities may differ. Using Generalized Least Squares (GLS) and Generalized Moments Method (GMM), we estimate a production function industry by industry for the two groups of firms, and test for differences in total factor productivity and for the equality of the estimated parameters. The translog specification, which fits the data best, also makes it easier to disentangle incentive effects from issues of scale and factor proportions than do specifications using functional forms with constant output elasticities with respect to the factors, such as the Cobb-Douglas form. Thus, we examine incentive issues by testing for the equality of the estimated coefficients of the translog, which is rejected, and explore the role of differences in labor composition between the two groups of firms. We then revisit the traditional hypothesis that labor-managed firms underinvest by comparing the estimated local returns to scale for the two groups of firms in our samples using the same estimated production function parameters, so that any differences are due to systematic

[1]Unfortunately, our data sets do not lend themselves to detailed cross-industry comparisons. Numbers of observations at the industry level oblige us to remain at a level of aggregation that is too broad for meaningfully investigating substantive differences across industries.

differences in input levels between the two groups of firms. We also make univariate comparisons suggested by the literature in relation to this and other traditional hypotheses on factor demands.

The French case is useful for looking at these issues because the cooperative movement in that country has been relatively successful. French worker cooperatives (Sociétés coopératives de production—SCOPs) have not degenerated into or been sold out to conventional firms, so that the movement has had a continuous presence since the mid-nineteenth century. SCOPs also represent reasonable models of participatory or labor management for conventional firms. Because cooperatives are required by law to start up with at least 2 or 7 members (depending on the precise legal form they choose for the company), they include few micro firms and the vast majority are small and medium-sized enterprises. In this article, we look at firms with 20 or more employees, a minimum imposed by the available data on conventional firms. While SCOPs have narrower pay differentials than conventional French firms do, pay varies across jobs and most SCOPs have a fairly heterogeneous labor force. These features make SCOPs a realistic firm model for a range of businesses and allow us to examine the effect of labor management without conflating it with skill homogeneity and pay equality issues. In addition, French cooperative law makes it very difficult for a cooperative to become a conventional firm, so that even if some cooperatives are doing less well than they might as conventional firms, they effectively do not have the option of exiting the cooperative form; conversely, members of firms that are doing exceptionally well as cooperatives cannot sell their firms to conventional owners to realize the value of their assets. This characteristic removes a potential source of bias in the assessment of productivity effects. However, our data may lead us to underestimate the productivity of SCOPs relative to that of other firms, because the SCOP sample covers the whole population of SCOPs with 20 or more employees. As a result, the SCOP sample includes a substantially higher proportion of firms that have recently been created and firms that are about to close down than the conventional samples, which were not designed to be representative of young and dying firms.

Worker Cooperatives and Conventional Firms in France

In 2011, about 2,000 worker cooperatives operated in France, employing approximately 46,500 people.[2] Although this is sizeable by many industrialized countries' standards, SCOPs still represent a minute proportion of all French firms (less than 1% of all firms with one employee or more).

[2]Figures in this section come from the CG-SCOP (http://www.scop.coop/chiffres-cles-scop.htm accessed on November 19, 2009, and http://www.les-scop.coop/sites/fr/les-chiffres-cles/ accessed on September 25, 2012) for cooperatives, and from INSEE (http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATTEF09203 accessed on November 19, 2009, and http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATTEF09203 accessed on September 25, 2012) for French firms in general.

The characteristics of SCOPs' membership shares and rights are in large part defined by French law (see CG-SCOP 2003). A few salient features are particularly relevant to our purposes. SCOPs are owned by their employees, and all employees can become members. Members have normal shareholders' rights. In particular, they elect the board and the chief executive officer, and vote in general meetings. Member workers have one vote each, regardless of the share of capital they hold.[3] In 2006, 58% of all SCOP employees were members. The other employees were either newly hired and still in their probationary period or employees who were past probation and had chosen to stay with the firm but not to join as members. Most new employees become members after their probation period (85% of employees who had been with the firm for two years or longer were members in 2006, 91% in 2007, 87% in 2008, and 80% in 2010 and 2011).

Each new member is required to buy at least one share, but members typically buy more. Individual cooperatives may require their members to purchase more shares later on (up to a maximum of 10% of the members' wages every year), often using profit-sharing bonuses. Membership shares are not tradable and are paid back at par when members leave the firm. The average individual capital stake held by worker members was approximately US$ 8,300 in 2006, equivalent to a little more than four months' pay on the median private sector wage.[4] Large conventional French companies have a small amount of employee stock ownership, though no comprehensive figure is available about average employee holdings.

Although only members vote, at least 25% of profit is distributed to all SCOP employees. Profit sharing is also widespread among conventional firms in France, but the corresponding bonuses are slightly more than half the level of those paid out in SCOPs in the years for which we have comparable information for the two groups. In 2006, the average profit-sharing bonus was about US$ 3,000 in conventional firms and US$ 5,800 in SCOPs,

[3]French law allows limited ownership of a worker cooperative's capital by nonemployees (e.g., other cooperatives and friends and relatives of employee members) who may receive higher dividends on their shares than employee members receive. In total, nonemployees may not have more than a certain percentage of voting rights, but within those limits each may be allowed to vote according to their capital stakes (see CG-SCOP 2003).

[4]Values are at the 2006 exchange rate. The average capital share was € 6,400, and the median monthly private sector take-home pay for full-time workers was € 1,555 in 2006 (net of payroll taxes and social security contributions but not of income tax; see Bessière and Depil 2008).

There are several possible explanations for members having to buy extra shares. Often they have collectively decided that each member should commit themselves to buying more shares annually as decided by the AGM, and this is written in the bylaws. These shares are often bought with profit-sharing bonuses and play the same role as Mondragon's individual capital accounts, into which part of profit is paid for members to accumulate savings for retirement (see Alzola et al. 2010). Estrin and Jones (1995) argue that individually owned capital in SCOPs is a form of commitment to the firm (conversely, the existence of the cooperative also allows members to benefit from the collectively owned capital accumulated in the firm by previous generations). It may also be viewed as a form of insurance for job security—an investment in their jobs.

or, respectively, about 1.4 and 2.8 months' median private sector pay.[5] French cooperative law requires another share of profit to be plowed back into a collectively owned portion of capital, which cannot be split among members even if the cooperative goes bankrupt, but instead devolves to another cooperative or a charity. The minimum required annual plowback is 25% of profit, though in practice SCOPs choose to retain on average about 45% of profit in this way.[6] Collective capital reserves amounted to approximately US$ 36,200 per employee on average in 2006, equivalent to about 21 months on median private sector pay.[7]

SCOPs are found in a range of industries. Manufacturing and construction still dominate but 45% of SCOPs supplied services in 2005 (compared with 71% of all French firms), and the share of that sector is growing quickly.[8] Contrary to popular belief, SCOPs are not generally smaller than conventional French firms, but the size distributions of the two groups are different. Very small firms (less than 10 employees) make up the bulk of conventional firms (83.4% of firms with at least one employee had less than 10 in 2007) but represent a significantly lower proportion of SCOPs (55.5% in 2007 and 60.7% in 2011). Cooperatives include more medium-sized firms. Firms with 10 to 499 employees constitute a considerably higher proportion of SCOPs (44.2%) than of conventional firms with at least one employee (16.4%). The proportion of firms having 500 to 1,999 employees, however, is similar in the two groups (0.2% of conventional firms and 0.3% of SCOPs), as is that of firms with 2,000 or more employees (0.04% of conventional firms and 0.05% of SCOPs in 2007).[9]

[5]Respectively, € 2,233 and € 4,305, the bulk of which is held in blocked accounts with the firm in SCOPs. (Unfortunately, the median bonus level isn't available for either group of firms.) Since SCOPs share profit among all employees, existing members have no incentive to prevent other employees from joining, and SCOPs do not degenerate into capitalist firms. See Estrin and Jones (1992) for an empirical examination of viability issues for SCOPs.

[6]Figure provided by the CG-SCOP. The figure for 2008 was 39% and that for 2010 was 41%. French law also requires conventional companies to retain at least 10% of profit in reserve. We do not know what percentage of profit conventional companies retain in practice.

[7]About € 27,900.

[8]The historically high share of construction among SCOPs is probably related to a regulation relating to government contracts that gives a preference among equivalent bids to SCOPs and to other types of cooperatives and small and medium-sized enterprises (SMEs). SCOPs are also exempted from local corporate tax, as are many types of SMEs. The tax advantages associated with profit sharing, which include exemptions from payroll taxes and social security contributions on profit-sharing bonuses and other tax concessions encouraging investment, are available to all firms but benefit those that distribute more profit to employees the most.

As a point of comparison, the large sample of Italian firms looked at by Pencavel et al. (2006) includes a greater proportion of worker cooperatives in retail and construction, and of conventional firms in manufacturing.

[9]A similar pattern in the compared size distributions of conventional and labor-managed firms is observed by Burdín and Dean (2009) in Uruguay. Pencavel et al. (2006) find that in Italy both the average and the median levels of employment of worker cooperatives are higher than those of conventional firms.

Theory

Two types of hypotheses have been put forward regarding the compared productivity of labor-managed and conventional firms. An abundant literature on the incentive and information effects of participatory schemes on productivity applies in particular to labor-managed firms. Another literature posits that both the labor demand and investment behavior of labor-managed and conventional firms may differ because they have different objectives, so that, as Estrin (1991) puts it, they organize production differently. We will summarize hypotheses drawn from each part of the literature in turn.

Incentive and Information Issues

The hypotheses concerning the effects of employee participation on X-efficiency are well known, and we will only outline the arguments here (for extensive reviews see Bonin et al. 1993; Ben-Ner and Jones 1995; Dow 2003; and Addison 2005). Employee participation is thought to increase productive efficiency by reducing agency and information costs. Participation in governance and profit, as in SCOPs, offers workers both incentives and opportunities to reveal private information to management and to one another, to work harder and "smarter," to invest in firm-specific human capital, and to monitor one another, which may be more effective than hierarchical monitoring. Governance participation may promote a sense of self-determination and dignity—factors that may increase intrinsic motivation (Frey and Jegen 2005; Ellingsen and Johanneson 2007). Decisions in which employees have a voice also internalize their interests. Employee voice may therefore improve decision quality and reduce the attractiveness of "exit" options such as quits, which are costly to the firm. The effects of all forms of participation may be embodied in either of the factors, so that output elasticities may differ between labor-managed and conventional firms. Finally, participation in profit and in governance may be complements, giving worker cooperatives, which have both, an additional advantage. Labor-managed firms may be beset with coordination failures, however, due to the collective nature of incentives and decision processes in democratic firms, and their managers' incentives to manage may be diluted. Theory thus makes ambiguous predictions concerning the comparative productive efficiency of labor-managed firms.

The empirical literature on participatory schemes confirms that participation in profit is often associated with an increase in total factor productivity.[10] The mixed findings regarding governance participation may be due

[10]For worker cooperatives, see Dow (2003). Studies on participation in profit in conventional firms are also reviewed in Pérotin and Robinson (2003). More recent evidence that surplus participation is associated with peer monitoring can be found in Kruse et al. (2004) and Kruse, Blasi, and Park (2008).

to the insufficient attention paid to the endogeneity of participation in many early studies, as the results of more robust recent studies are generally more supportive of a positive and significant effect on firm performance (see Addison 2005 for a review).[11] As can be expected if forms of participation in governance and surplus are complementary to each other, there is evidence that employee share ownership and profit sharing have greater positive effects when associated with governance participation, both on firm performance (e.g., Black and Lynch 2001; Kato and Morishima 2002; Pendleton and Robinson 2010) and on employee attitudes (Kruse and Blasi 1997; Ros 2003). Doucouliagos's (1995) finding that participatory practices had greater positive effects on productivity in worker cooperatives has been interpreted as evidence that worker cooperatives must be more productive than conventional firms, whether due to complementarity or simply, as Doucouliagos argues, because levels of participation of all types are higher in labor-managed firms. The latter interpretation is supported by the findings of Bayo Moriones et al. (2003) in which the same forms of participation in decisions have the same positive effects on productive efficiency in conventional and labor-managed firms.

It should be noted that even in the presence of positive incentive effects from participatory practices, worker cooperatives may not be more productive overall than less participatory conventional firms. If the labor-managed firm maximizes a member's utility function (whether a representative or median member's utility) in which both income and leisure are arguments and worker owners have a normal income–leisure tradeoff, the firm may choose a lower level of effort than a conventional firm would (Jensen and Meckling 1976). This effort may be more effective than in the conventional firm due to the incentives and information effects we have just reviewed, so that the net effect on total factor productivity of having a cooperative structure may be positive, negative, or neutral at the same level of employment.

Interestingly, three of the four studies of comparative productivity estimating production functions for matched samples of employee-owned and capitalist firms (Berman and Berman 1989; Estrin 1991; Craig and Pencavel 1995) find no significant difference in total factor productivity between the two groups when they are constrained to have the same production function.[12] The fourth (Jones 2007) finds differences that are not consistent across specifications and estimation methods. Using qualitative measures of performance, Bayo Moriones et al. (2003) do not find that worker cooperatives perform better or worse than conventional firms that have the same levels of shop-floor participation.

[11]See also FitzRoy and Kraft (2005) for governance participation in conventional firms, and Estrin and Jones (1995) for French cooperatives. Other studies of participation in cooperatives include, e.g., Estrin, Jones, and Svejnar (1987). For reviews of studies of French participatory firms, see Fakhfakh and Pérotin (2002) and Fakhfakh (2004).

[12]Looking at dynamic adjustments to financial constraints, Maietta and Sena (2004) find cooperatives adjust their productivity more efficiently than conventional firms.

However, the three production–function studies that test for differences in the estimated functions between the two groups find them to be significantly different, and the other study (Jones 2007) finds there are significant firm-specific fixed effects, which may capture technological differences between the two groups. Craig and Pencavel (1995) compute output differentials using the estimated functions at each subsample mean point and find predicted output is higher with the cooperative elasticity estimates at both points.

Differences in the estimated technologies can reflect embodied incentive and information effects, but may also be due to differences in the equilibrium factor demands of the two groups of firms.

Factor Demand Issues

Both the investment behavior and the labor demand of labor-managed firms may differ from those of conventional firms. A classic hypothesis, with variants by Furubotn and Pejovich (1970) and Vanek (1977), proposes that labor-managed firms that rely on collectively owned self-finance will underinvest. The key point here is that collective ownership (and/or the absence of a market for individual membership shares) truncates cooperative members' property rights by limiting their rights to the returns on investments to the period in which they work with the firm. As a result the firm may not invest; alternatively, it may require inefficiently high rates of return on investment and short payback periods so that it will underinvest. If the production function common to the cooperative firm and its capitalist "twin" exhibits increasing then decreasing returns to scale, the cooperative will find its long-run equilibrium in the increasing returns range rather than at constant returns like the conventional firm. If returns to scale are constant along the whole relevant output range, the labor-managed firm will consume its capital and "self-extinguish" (Vanek 1977). SCOPs cannot consume their capital and are constrained by law to plow a portion of all profit back into the cooperative. This may be why there is no evidence that they underinvest or self-extinguish (Estrin and Jones 1992, 1998). The underinvestment hypothesis more generally has been much disputed.[13] It nonetheless remains important because it has been repeatedly invoked as a reason for the small number of labor-managed firms in capitalist economies, and the small scale of many worker cooperatives or their low capitalization are still often seen as evidence in support of the hypothesis.

Together with a slower capital growth and a smaller size for cooperatives, increasing returns to scale among cooperatives and constant returns among conventional firms would be consistent with underinvestment. A smaller scale could also be evidence of capital starvation, which is commonly thought to characterize labor-managed firms, especially at foundation, due to difficulties in accessing external finance and to members' limited wealth.

[13]See Uvalić (1992) and Dow (2003) for detailed reviews of the underinvestment debate.

Berman and Berman (1989) show that in the capital starvation case a smaller scale should be associated with lower capital intensity for cooperatives and a higher marginal product of capital, together with the same or a faster rate of capital growth. Berman and Berman do observe lower capital intensity among the cooperatives in the plywood industry in Washington and Oregon, as do some studies of other groups of worker cooperatives, though this may have been due to sampling.[14] Capital constraints at foundation are consistent with the life cycle observed by Estrin and Jones (1992) who argue that SCOPs may overaccumulate collective assets. Overaccumulation could result from the obligation to retain part of profit together with the tax incentives encouraging investment in firms that have profit-sharing plans in France, and may compensate for early capital starvation. SCOPs' choice to plow back more than the required minimum share of profit may also stem from a concern to preserve employment. Zevi (2005) argues that members actually pursue job security and view capital accumulation and the growth of the cooperative as a way to ensure that security. The evidence provided by Navarra (2008) on Italian worker cooperatives, which retain the bulk of their profit, supports the hypothesis that cooperative members view collective capital accumulation as a form of insurance to preserve employment and to maintain pay stability during downturns.

Labor-managed firms may use less capital intensive technologies than conventional firms because of a preference for employment. Alternatively, they may simply have a less volatile labor demand than conventional firms, at least downwards, if the firm maximizes profit per member subject to a labor supply constraint, and this may affect their productivity relative to conventional firms' in recessions. As Pencavel et al. (2006) observe, pay is endogenous in a labor-managed firm, so that labor demand should be determined differently from conventional firms'.[15] Their findings on Italy, as well as those of Craig and Pencavel (1992) and Pencavel and Craig (1994) on the United States, and Burdín and Dean (2009) for Uruguay, confirm that worker cooperatives tend to adjust pay more than employment in response to demand shocks while conventional firms adjust employment rather than pay. Bartlett et al. (1992) also find Italian cooperatives to have less variable employment levels than their conventional counterparts. Bartlett (1994), however, finds Italian cooperatives' employment responds to wages as well as to demand changes. Both he and Estrin (1991) observe that Italian cooperatives increase employment faster than conventional firms at certain stages of the firm's life.

[14]For example, Bartlett et al. (1992) and Jones (2007), using industry-matched samples, find worker cooperatives to be less capital intensive than conventional firms in Italy, but Bartlett (1994) finds Italian worker cooperatives to be more capital intensive than other firms. Using an extensive data set on Italian firms from banking sources, Pencavel et al. (2006) observe that the capital-labor ratios of cooperatives are more dispersed than those of other firms, with greater proportions of cooperatives with very low and with very high capital intensity.

[15]See also Basu, Estrin, and Svejnar (2005) for an analysis of labor demand in conventional and employee-owned firms.

More stable employment levels in response to downturns, at least for some occupational groups, would also be consistent with a collective choice model in which the cooperative maximizes the median member's utility. Testing such a model for Italy, Estrin (1991) suggests that the median voter in Italian cooperatives is a blue-collar worker whose employment is favored by the firm. A correspondingly lower proportion of managerial staff in cooperatives than in conventional firms could also follow from superior incentives and lower agency costs in the labor-managed firm.

Empirical Strategy, Data, and Estimation

Empirical Strategy

To test the main hypotheses outlined above, we estimate production functions on panel data for large samples of worker cooperatives and conventional firms, industry by industry. We first test for an overall difference in total factor productivity by inserting a dummy variable for the cooperative form while constraining the parameters of the production function other than the intercept to be the same for the two groups. In all industries, significance tests lead to preferring the Transcendental Logarithmic form ("translog") to the Cobb-Douglas,[16] so that we estimate a function of the form:

$$(1)\, Log(Q_{it}) = a + \sum_{j=1}^{k} \alpha_j . Log(I_{it}^j) + 0.5 \sum_{j=1}^{k} \alpha_{jj} . (Log(I_{it}^j))^2 + \sum_{j \neq h} \alpha_{jh} . Log(I_{it}^j) . Log(I_{it}^h) + \lambda . Control_{it} + \beta . Scop_i + \mu_i + e_{it}$$

where Q_{it} is a measure of the value-added of firm i at time t, I_{it}^j is the amount of the jth input for firm i at time t, and *Scop* is a dummy variable equal to 1 if the firm is a worker cooperative (and 0 otherwise). *Control* is a set of control variables including an estimate of the firm's share of its product market in order to proxy for output price differences that might otherwise be confused with productivity differences.[17] Other variables in the *Control* vector represent human capital and occupational mix differences that may result from labor demand differences in the two groups, including the share of managers in the workforce, share of supervisory staff, and the gender composition of the workforce. Differences in labor composition may result from incentive effects, such as a lesser need for supervision, and should arguably

[16]The translog specification is well suited to large heterogeneous samples of firms as we have here but may result in implausible marginal product estimates with small samples. We have verified that our estimated elasticities and implied marginal products take positive values in ranges that are consistent with economic theory (tables presenting estimated elasticities and marginal products are available from the authors). This is true both on average and for the overwhelming majority of observations among both groups of firms.

[17]Because our measure of output is value-added, it will be higher if the output price is higher, but we do not have prices for each firm. Variable definitions are given in Appendix A.

not be controlled for to measure productivity differences between the two types of firms. However, if one dominant group imposes a pattern of skill mix at the expense of productivity, as in the public choice model, controlling for labor composition may increase the estimated productivity effect. We explore the effect of this set of controls on the estimated SCOP effect on total factor productivity, $\hat{\beta}$.[18]

We then allow for the possibility that incentive effects are embodied in the factors and the two groups have different production functions by testing for differences in all estimated parameters. The sets of parameters estimated for the cooperative and conventional firms turn out to be significantly different for all industries. Following Craig and Pencavel's (1995) approach, we therefore look at total factor productivity by comparing, for each group of firms, the predicted outputs obtained using the two estimated sets of parameters. Thus, we compare the outputs predicted for SCOPs (i.e., using their input levels) in each industry when using the parameters estimated for cooperatives in that industry and when using the parameters estimated for conventional firms in the industry. Any difference is due to differences in the technologies used by the two groups of firms (i.e., the set of estimated parameters of the production function). We repeat the exercise using conventional firms' input levels. Rather than doing this at the mean point of each sample, we compute predicted outputs for each firm, which allows us to test for the statistical significance of the observed mean difference between the two predicted outputs in each group.

Next, we investigate one of the key predictions of the underinvestment hypothesis, which concerns returns to scale. Observed differences in returns to scale could be consistent with incentive effects embodied in the factors (since the estimated technologies are different for the two groups of firms) and/or with different investment behavior in the labor-managed firms. The translog specification makes it possible to disentangle these two types of effects, because it allows marginal products, elasticities, and returns to scale to vary with input levels.

To examine differences in returns to scale that might be due to systematic differences in input levels possibly associated with differing investment behavior, we hold technology constant. We compare the two estimates of local returns to scale obtained using one set of estimated production function parameters but the different input levels of the two types of firm, so that any difference reflects input differences only. Local returns to scale with each technology are again computed for each firm, so that differences between estimates using conventional firms' and cooperatives' inputs with a given technology can be tested for. We also test for constant returns to scale (by

[18]Conte and Svejnar (1988) and Bayo Moriones et al. (2003) also investigate the role of different forms of participation in the two types of firm, an analysis for which the data are not available for conventional firms here. Such an approach might in any case raise other issues in the French case, where individual capital ownership, for example, is of a different nature in the two types of firms due to both voting rights and tradability differences.

comparing each estimate to 1). While we do not estimate investment or labor demand functions in this article, these estimated returns to scale, together with descriptive statistics concerning capital and labor in the two types of firms, provide stylized facts against which to check the patterns implied by the underinvestment, capital starvation, and labor demand hypotheses reviewed in the theory section (under Factor Demand Issues).

The Data

We have assembled two new data sets from several sources. For cooperatives we use the annual data collected by the SCOP federation, CG-SCOP, on all French worker cooperatives from 1987 to 2004 (about 1,500 firms per year). For conventional firms we use different subsets of two surveys conducted annually by the French statistical office INSEE on firms with 20 or more employees: the Annual Enterprise Survey, which provides economic information on a stratified representative sample of about 12,000 firms, and the Structure of Employment Survey, an annual survey that provides information on the occupational and gender distributions of the workforce of some 22,000 firms. For some years, we also have balance sheets and selected accounts for 10,000 of the firms included in the Annual Enterprise Survey. A number of SCOPs appear in both the INSEE and the CG-SCOP data sets, so we were able to check in detail the consistency of the variable definitions and measurements across sources.[19]

We had to remove cooperatives with less than 20 employees at any time over the sampling period for consistency with the data on conventional firms. In addition, we decided to remove the industries in which SCOPs were absent or were present but constituted less than 2% of the firms in that industry in the data set. This was done in order to perform the analysis industry by industry, so as not to confuse scale and factor demand issues with mean characteristics that might stem from the different industry distributions of conventional and labor-managed firms. This approach is supported by statistical tests, which reject the hypothesis that the production function parameters are the same across industries—so that a single estimation per data set, pooling all industries together, would provide inconsistent estimates. However, we had to remain at a fairly high level of aggregation due to observation numbers, especially in Data Set 1 (which covers Construction and Services as well as Manufacturing). At that level, the industry groupings defined by the French industrial classification system are still quite broad. For this reason, it is difficult to comment meaningfully on industry differences, and we will focus instead on the consistency of results across industries when we present our findings. The resulting data comprise two data sets.

The first data set is an unbalanced panel covering seven industries in 1987 to 1990 (Capital Goods, Consumer Durables, Consumer Goods, Construction, Transport, Business Services, and Consumer Services) and has

[19]See Appendix B for the details of data set construction.

about 17,700 observations in total. The representativeness of the conventional firm sample is achieved with weights attached to each firm-size stratum that are proportional to inverse sampling probabilities. We use the weights for descriptive statistics but not for the estimations.[20] The second data set is an unbalanced panel covering four manufacturing industries in 1989 to 1996 (Mechanical Engineering, Printing and Publishing, Paper and Wood, and Metals) with about 15,300 observations in total. In this data set, the conventional firm sample is exhaustive for manufacturing firms with 30 or more employees and includes a random sample of firms with 20 to 29 employees, but we do not have the sampling probabilities. One industry (Consumer Durables) was originally present in both data sets. We were not able to obtain safe estimates with Data Set 2 for the Consumer Durables industry because of the small number of usable observations on cooperatives with 20 or more employees, and this industry was dropped from Data Set 2. We still used this industry to carry out further consistency checks between the two data sets since the sample periods overlap by two years (1989 and 1990). While there are differences—for example, conventional firms are larger and cooperatives smaller on average in the second data set—estimation results for the same years are very similar with the two data sets. For some estimations, we extended the second data set to include worker cooperatives with less than 20 employees (see below). In all our data sets (Data Set 1, Data Set 2, and the extended version of Data Set 2), markedly more entry and exit occurs among the cooperative sample, which is exhaustive, than among the conventional firm sample, despite comparable entry and exit rates in the two populations (see Pérotin 2006).[21] The implication of this difference is that the cooperative sample is likely to appear less productive, all else being equal, than the conventional sample, as newly created and dying firms tend to be less productive than sound continuing firms.

Our measure of output is value added; capital and labor are measured by fixed assets and the total number of employees, including both members and nonmembers, respectively.[22] All financial variables are deflated by the consumer price index.

Estimation

To estimate our production function, we have used OLS and random effects (GLS).[23] Our panels are short (especially in Data Set 1) and unbalanced, so

[20]Since firm size (employment level) is an argument of the estimated function, and the translog functional form allows the technology to vary with firm size, unweighted estimation is preferable (see Reiter, Zanutto, and Hunter 2005).

[21]This difference is due to the sampling for the official surveys, which isn't designed to capture entry and exit accurately but rather to replace dying firms and to provide an annually representative sample of the firm population.

[22]We use the terms "workers" and "employees" interchangeably. Worker cooperative members are employees as well as entrepreneurs in French law.

[23]OLS will be biased here and our OLS results did not show any fundamental problem. We are not reporting them here in order not to add to our already complex tables.

that numbers of observations per firm vary in each group of firms. For this reason, along with the presence of the SCOP dummy variable, GLS is preferable to Fixed Effects, and we present GLS estimation results. We also present System-GMM estimations carried out on the extended version of the second data set. Input levels, in particular employment, are likely to be determined simultaneously with output levels, so that both the OLS and GLS estimators may be biased. In addition, some unobserved firm characteristics could be correlated with the ownership form and affect output (for example, if cooperatives were found in sub-industries for which the cooperative form was better suited).[24] GMM handles not only unobservable firm effects but also the possible endogeneity of the inputs (see Arellano and Bond 1991; Arellano and Bover 1995).

For the standard GMM estimators, variables are used in first differences to eliminate unobservable individual effects, and lagged values in levels are used as instruments to correct for endogeneity. However, as suggested by Griliches and Mairesse (1997), fixed effects and GMM estimators produce rather unsatisfactory results with production functions (low, insignificant, and often negative capital elasticity and very low estimates of returns to scale). Blundell and Bond (1998, 2000) show that the lagged levels of a series provide weak instruments for first differences, whereas results in levels are still reliable. They suggest stacking equations in differences with the lagged variables in levels as instruments and equations in levels with lagged variables in differences as instruments (Ahn and Schmidt 1995; Arrellano and Bover 1995). This System-GMM estimator yields elasticity and returns to scale estimates that are more consistent with economic theory. Our estimation results lead us to a similar interpretation of the merits of the various estimators. By estimating simultaneously equations in differences and in levels, this estimator also allows us to control for persistent unobserved heterogeneity while estimating the effect of a time-invariant SCOP variable. We instrument both inputs as well as the variables controlling for workforce composition for this System-GMM estimation, and use Sargan tests for the validity of the instruments. All the GMM estimations we present have valid instruments. We could not use this strategy with the first data set, which has a very short time dimension (four years at most for a given firm). With this data set, we present only GLS estimation results, which may be more

[24]Numbers of observations do not allow us to test for differences in SCOPs' and conventional firms' distributions across sub-industries at a lower level of aggregation, which would be useful with Data Set 1, as it covers services and construction as well as manufacturing. However, SCOPs are present in most sub-industries in that data set, with, for the most part, peaks and troughs in the same sub-industries as conventional firms. The exceptions are printing and publishing, and construction—where there is a markedly larger share of SCOPs than of other firms—and, to a lesser extent, the textile and chemical industries, where a larger share of conventional firms than cooperatives can be found. Historical factors explain the strong SCOP presence in printing and publishing, and access to government contracts the place of construction.

Cooperative creations are more countercyclical than conventional firm creations (Pérotin 2006). This could affect the productivity of recently created SCOPs but may not weaken the productivity of continuing firms, the vast majority of the sample. Aggregate exit rates are about the same among SCOPs and conventional firms over the period (ibid.).

vulnerable to endogeneity issues. The second data set in its original form had too few observations on cooperatives; to get around this problem, we constructed an extended version of this data set, which includes cooperatives with less than 20 employees. We therefore present three sets of results for the second data set—GLS estimations using only firms with 20 or more employees in both groups; System-GMM estimations using the extended version of the data set; and GLS estimations performed on this extended data set, in order to check whether any differences between the GLS and System-GMM estimates result from the different sample or estimation method.

Empirical Results

Descriptive Statistics and Stylized Facts

Tables 1 and 2 present the mean values of the main variables and ratios for each of the data sets, with *t*-tests of the mean differences between cooperative and conventional firms. The representativeness of the conventional firm sample and availability of the appropriate weights for the first data set, together with the exhaustive cooperative sample (for firms with 20 or more employees), imply that comparisons using this data set should provide more reliable stylized facts than the comparisons presented in many earlier studies. Table 1 confirms that the size of worker cooperatives, as measured by their employment level, is not consistently smaller than conventional firms', even when the smallest firms, which are more common among conventional firms, are removed from the sample. While conventional firms are significantly larger in three industries, there is no significant difference between the two groups in two industries, and cooperatives are actually larger on average than conventional firms in the remaining two industries. In Data Set 2 (Table 2) conventional firms are consistently larger than labor-managed ones, but this may be due to the undersampling of conventional firms with 20 to 29 employees. When size is measured by the level of capital, conventional firms are significantly larger in most industries in both data sets (Tables 1 and 2)—although in two industries in Data Set 1, no significant difference is found between the two groups of firms. Capital intensity shows no significant difference between the two groups of firms in the majority of industries in both data sets (conventional firms are more capital intensive in all other industries). These findings are consistent with recent evidence on Italy (Pencavel et al. 2006), and suggest that labor-managed firms are not necessarily undercapitalized, whether because of capital starvation or underinvestment. Average labor productivity is higher in conventional firms in most, though not all, of the industries in both data sets. Our estimates of the firms' average market shares are below 1% in all industries and for both types of firms, which suggests neither type occupies niche markets at the level of aggregation at which we were able to compute this variable. In most industries in Data Set 1, there is no difference between the two groups' average market shares.

Table 1. Weighted Variable Means,[a] Data Set 1: 1987–1990

Industry (maximum n*)*	*Capital Goods (SCOPs 157; Conventional firms 3,217)*			*Consumer Durables (SCOPs 128; Conventional firms 2,588)*			*Consumer Goods (SCOPs 272; Conventional firms 3,678)*			*Construction (SCOPs 645; Conventional firms 925)*		
	SCOPs	*Conv.*	t-*test*	*SCOPs*	*Conv.*	t-*test*	*SCOPs*	*Conv.*	t-*test*	*SCOPs*	*Conv.*	t-*test*
L	64	61	NS	79	63	NS	71	51	***	61	93	***
K	1668	2718	***	4401	1649	NS	1600	1319	NS	958	1220	***
K /L	20.8	31.3	***	20.2	19.0	NS	20.5	20.2	NS	14.1	14.1	NS
VA/L	31.4	36.4	***	30.3	34.2	***	30.8	31.3	NS	29.3	30.2	***
% Women	22.8	22.6	NS	19.8	22.3	NS	40.5	48.3	***	6.2	7	***
% Managerial	16.4	18.6	***	20.4	23.9	***	15.8	17.4	**	19.3	18.6	NS
% Supervisory	6.6	7.2	NS	7.6	8.4	NS	6.6	8.6	***	4.7	5.1	***
% Marketshare	0.08	0.11	***	0.08	0.11	NS	0.44	0.13	NS	0.19	0.04	NS
ΔL (%)	3.3	3.4	NS	2.9	4.8	*	0.6	2	*	2.3	0.9	**
ΔK (%)	10.0	7.2	*	13.5	7.3	**	5.1	5.2	NS	8.8	6.2	***
Δ(K/L) (%)	12.3	5.3	**	11.4	5.6	*	6.7	6.1	NS	7.9	6.1	NS

Industry (maximum n*)*	*Transport (SCOPs 71; Conventional firms 1,702)*			*Business Services (SCOPs 71; Conventional firms 2,788)*			*Consumer Services (SCOPs 47; Conventional firms 1,412)*		
	SCOPs	*Conv.*	t-*test*	*SCOPs*	*Conv.*	t-*test*	*SCOPs*	*Conv.*	t-*test*
L	40	66	***	47	56	*	108	66	*
K	1113	1933	***	561	1891	***	539	1538	***
K /L	25.7	32.7	**	17.1	16.7	NS	9.8	18.7	***
VA/L	35.9	32.6	NS	37.1	40.3	**	21.6	26.4	***
% Women	10.6	15.2	***	20.9	44.4	***	32.0	66.3	***
% Managerial	8.3	12.9	***	9.3	27.8	***	7.4	16.6	***
% Supervisory	7.1	11.3	**	6.9	18.0	***	12.4	18.0	*
% Marketshare	0.63	0.1	***	0.10	0.08	NS	0.31	0.20	**
Δ L (%)	1.1	3.7	**	5.1	5.9	NS	8.9	3.9	NS
Δ K (%)	8.6	5.9	NS	18.6	9.7	***	11.0	7.7	NS
Δ(K/L) (%)	10.3	4.6	NS	14.1	8.7	NS	5.2	8.3	NS

[a]Observations on conventional firms weighted by inverse strata sampling probabilities; financial variables in € 1,000s.

***, **, and *: the means are significantly different at the 1%, 5%, and 10% levels, respectively; NS: difference is not significantly different from zero.

The percentage of women is lower in the SCOP workforce in the majority of industries in both data sets, although three industries show no difference between cooperative and other firms. Worker cooperatives have already been observed to employ a higher proportion of men in France in the past, as well as in Spain (Elio 2006). In France at least this was traditionally attributed to the industry composition of the sector, which is not the issue here, so other factors must be at play. Finally, although the percentage of managerial and supervisory staff is lower in cooperatives in the majority of industries, as expected, several industries show insignificant differences, especially in the proportion of supervisors.

The bottom three lines of Tables 1 and 2 show the average annual percentage growth of fixed assets, capital intensity, and employment for each group of firms in the two data sets, respectively. In both data sets and in all

Table 2. Variable Means,[a] Data Set 2: Firms with 20 or More Employees, 1989–1996

	Mechanical Engineering (SCOPs 303; Conventional firms 4,447)			*Printing and Publishing (SCOPs 503; Conventional firms 1,219)*			*Paper and Wood (SCOPs 92; Conventional firms 2,095)*			*Metals (SCOPs 218; Conventional firms 4,041)*		
Industry (maximum n*)*	*SCOPs*	*Conv.*	t-*test*	*SCOPs*	*Conv.*	t-*test*	*SCOPs*	*Conv.*	t-*test*	*SCOPs*	*Conv.*	t-*test*
L	57	329	***	70	305	***	87	310	***	50	365	***
K	1973	12456	***	3558	13071	***	3180	29460	***	2280	24934	***
K/L	31.12	29.71	NS	40.99	38.94	NS	30.26	58.73	***	39.83	43.85	NS
VA/L	33.08	39.80	***	39.70	42.85	***	33.00	42.07	***	34.60	37.34	NS
% Women	9.3	17.7	***	32.1	43.7	***	26.3	32.2	NS	17.2	24.2	***
% Managerial	7.7	31.9	***	11.7	21.2	***	9.6	19.0	***	7.5	22.1	***
% Supervisory	10.1	9.4	NS	6.8	12.8	***	3.7	8.2	***	6.0	6.9	NS
% Marketshare	0.04	0.35	***	0.01	0.28	***	0.04	0.32	***	0.01	0.17	***
ΔL (%)	–1.6	–1.3	NS	–0.4	–1.9	*	–2.2	–1.0	NS	0.9	–1.0	*
ΔK (%)	6.6	4.6	NS	4.8	4.8	NS	10.4	5.9	*	7.8	5.7	NS
Δ(K/L) (%)	9.9	8.2	NS	9	8.7	NS	13.6	9.2	NS	8.5	8.8	NS

[a]Financial variables in € 1,000s.
***, **, and *: Means are significantly different at the 1%, 5%, and 10% levels, respectively; NS: difference is not significantly different from zero.

industries, the growth of capital in SCOPs is the same as or higher than in conventional firms. Capital intensity grows faster among cooperatives in two industries in the first data set, but the differences are only weakly significant, and only one of these two industries shows significantly lower capital intensity in SCOPs, a possible sign of capital starvation. In the other industries in Data Set 1, and in all industries in Data Set 2, there is no significant difference between the rates of growth of capital intensity in the two groups. This evidence is not consistent with underinvestment, nor does it really fit a capital starvation hypothesis.

Differences in employment growth rates are weakly significant or insignificant in both data sets (Tables 1 and 2). When they are significant, they show conventional firms growing faster in three industries (cooperatives grow faster in one industry) in the first data set, which covers a period of moderate growth. In the second period, a time of recession or slow growth, conventional firms cut jobs while cooperative firms cut jobs less fast or even grow.

Total Factor Productivity

The GLS estimates of total factor productivity differentials (i.e., the estimated coefficient of the cooperative dummy) for each industry with our two data sets are presented in Tables 3 (for 1987–1990) and 4 (1989–1996); GLS and GMM estimates for the extended version of Data Set 2 also appear in Table 4. Once all controls are included in the equation, the GLS estimates concerning the industry that is common to the two data sets are consistent

Table 3. Productivity Differential: GLS Estimates, Data Set 1: 1987–1990
Dependent Variable: Log (Value Added)

Industry	*No controls*	*Controls: Labor composition*	*Controls: Labor composition and market share*
Capital Goods	–0.043	–0.062	–0.062
(1,091,[a] 3,163[b])	(–0.88)	(–1.18)	(–1.17)
Consumer Durables	–0.100*	–0.086	–0.081
(921,[a] 2,545[b])	(–1.73)	(–1.48)	(–1.37)
Consumer Goods	–0.012	0.072	0.079
(1,291,[a] 2,632[b])	(–0.24)	(1.33)	(1.44)
Construction	–0.047*	–0.006	–0.006
(479,[a] 1,489[b])	(–1.66)	(–0.23)	(–0.25)
Transport	0.047	–0.107	–0.101
(604,[a] 1,633[b])	(0.56)	(–1.02)	(–0.91)
Business Services	–0.145	–0.079	–0.083
(1,035,[a] 2,385[b])	(–1.16)	(–0.19)	(–0.20)
Consumer Services	0.019	0.005	–0.042
(505,[a] 1,352[b])	(0.15)	(0.04)	(–0.30)

[a] Maximum number of firms.
[b] Maximum number of observations.
Asymptotic *t*-ratios in parentheses.
***, **, and *: significant at the 1%, 5%, and 10% levels, respectively.

across data sets with the same estimation method, despite the difference in time periods.

Some difference appears between the estimates controlling for labor composition and not controlling for it on Data Set 1 (Table 3), suggesting that in two industries the difference in labor composition may put the SCOPs at a slight productivity disadvantage, but the estimate is only weakly significant. The productivity disadvantage of cooperatives when labor composition is not controlled for is clearer in GLS estimates for two of the industries covered by Data Set 2 (Table 4). However, in the GMM estimates, which are more robust to input endogeneity problems, not controlling for labor composition does not make a difference in two of the industries covered by Data Set 2 (Mechanical Engineering and Metals); results in an insignificant difference in productivity between the two groups of firms (as opposed to a cooperative advantage when labor composition is controlled for) in Printing and Publishing; and gives cooperatives an advantage in Paper and Wood. In other words, we find no real evidence that a different labor composition hampers the productivity of cooperatives.

Overall, the GLS estimates suggest that in most industries there is no significant productivity difference between labor-managed and conventional firms. This result is in keeping with existing studies. In only one industry, Paper and Wood, is there a significant difference—one that is in favor of worker cooperatives. More significant differences appear in the GMM estimates performed on the version of Data Set 2 in which small cooperatives have been included. By comparing these estimates with GLS estimates for the same extended data set, we can infer, to a certain extent, whether the

Table 4. Productivity Differential, Data Set 2: 1989–1996
Dependent Variable: Log (Value Added)

	GLS, firms w/ 20 or more employees			*GLS w/ small SCOPs*			*System-GMM w/ small SCOPs*		
Industry	*No controls*	*Controls: Labor composition*	*Controls: Labor composition and market share*	*No controls*	*Controls: Labor composition*	*Controls: Labor composition and market share*	*No controls*	*Controls: Labor composition*	*Controls: Labor composition and market share*
Mechanical Engineering	–0.374***	–0.151***	–0.071	–0.378***	–0.149***	–0.089*	0.044	0.107	0.088
(781,[a] 3,998[b])	(–6.42)	(–2.83)	(–0.53)	(–7.42)	(–3.00)	(–1.81)	(0.34)	(1.30)	(1.17)
Printing and Publishing	–0.394***	0.042	0.086	–0.567***	–0.058	–0.104*	–0.069	0.088**	0.074**
(288,[a] 1,706[b])	(–4.13)	(0.65)	(1.36)	(–7.27)	(–0.92)	(–1.67)	(–0.50)	(2.22)	(2.18)
Paper and Wood	0.010	0.004	0.360***	–0.056	–0.062	0.162	0.348***	0.217***	0.183***
(253,[a] 2,181[b])	(0.08)	(0.03)	(3.04)	(–0.48)	(–0.54)	(1.44)	(3.18)	(3.72)	(5.67)
Metals	–0.126	–0.116	0.004	–0.182***	–0.139**	0.004	0.123	0.031	0.028
(691,[a] 4,249[b])	(–1.61)	(–1.51)	(0.05)	(–2.77)	(–2.10)	(0.06)	(1.51)	(0.40)	(0.35)

[a] Maximum number of firms.
[b] Maximum number of observations.
Asymptotic *t*-ratios in parentheses.
***, **, and *: significant at the 1%, 5%, or 10% levels, respectively.

differences with the GLS estimates for the non-extended data set are due to the inclusion of small cooperatives, to the estimation method, or to both. The advantage of cooperatives in the Paper and Wood industry remains; its magnitude is cut in half by the instrumentation but remains high at 18.3%. The more robust GMM method also is the source of the 7.4% differential now estimated in favor of cooperatives in the printing and publishing industry (the inclusion of small cooperatives results in a mildly significant negative GLS estimate). No significant difference in total factor productivity is observed in the other two industries.

We find it difficult to conclude from these tests that overall the total factor productivity of labor-managed firms is markedly different from that of conventional firms in France. If there is a difference, our results suggest it may be in favor of worker cooperatives. However, we test for differences in all the estimated parameters and in all cases the technologies of the two groups of firms are significantly different—the two types of firms organize production differently, presumably because incentive and information effects are embodied in the factors.

To compare the two groups' productivities, we therefore compare the outputs each group of firms would produce with each of the two technologies, using their current inputs. These comparisons are presented in Tables 5 and 6 using the GLS estimates on Data Sets 1 and 2, respectively, and in Table 6 using GLS and GMM estimates obtained with the extended version of Data Set 2. In several cases, no significant difference appears between the outputs a given type of firm would produce with the technology used by the cooperatives and with the conventional firms' technology. In almost all cases in which a significant difference occurs, the SCOPs would produce more with their own technology, regardless of the data set or estimation method. The exception is the GLS estimate for the Mechanical Engineering industry with Data Set 2, but the GMM estimate indicates that SCOPs would produce more with their own technology in that industry as well. In contrast, in a number of industries conventional firms would produce more using the cooperatives' technology with their current input levels.

Overall, these results suggest that SCOPs are as productive as conventional firms, or more productive, and use their inputs better. Differences occur across industries, but it seems that in several industries conventional firms would be better off if they behaved like labor-managed firms. We find no evidence that worker cooperatives are less productive than conventional firms. To gauge how the two sets of technologies compare overall, we computed the output that would be produced by French firms, on average, if all firms of each group used the SCOP technology estimated for their respective industries at their current input levels, and if all firms used the conventional technologies estimated for their industries. With Data Set 1 (Table 5), which covers a broader range of industries, the predicted outputs presented in the last column unambiguously show the SCOP technologies producing higher output on average for both groups of firms' input levels. For Data Set 2 (Table 6), which covers a small number of manufacturing industries (and

Table 5. Predicted Output Using the Two Different Estimated Technologies, in Logs
Data Set 1: 1987–1990, GLS

Firm group and technology	*Capital Goods*	*Consumer Durables*	*Consumer Goods*	*Construction*	*Transport*	*Business Services*	*Consumer Services*	*All industries (using industry-specific technologies)*
SCOPs								
SCOP technology	7.02	8.55	8.48	8.80	11.51	10.14	7.07	8.76
Conventional technology	7.06	7.53	8.56	7.30	7.54	6.96	6.96	7.44
t-test	NS	***	NS	***	***	***	NS	***
Conventional firms								
SCOP technology	7.48	8.71	8.66	10.01	13.05	10.76	7.08	8.39
Conventional technology	7.65	7.76	8.78	8.00	8.00	7.14	7.04	7.99
t-test	***	***	**	***	***	***	NS	***

***, **, and *: means are significantly different at the 1%, 5%, and 10% levels, respectively; NS: difference is not significantly different from zero.

Table 6. Predicted Output Using the Two Different Estimated Technologies, in Logs
Data Set 2: 1989–1996

	Mechanical Engineering			*Printing and Publishing*			*Paper and Wood*			*Metals*			*All industries (using industry-specific technologies)*	
	GLS firms with	*with small SCOPs*		*GLS firms with*	*with small SCOPs*		*GLS firms with*	*with small SCOPs*		*GLS firms with*	*with small SCOPs*		*GLS firms with*	*Sys-GMM with small SCOPs*
Firm group and technology	*L ≥ 20*	*GLS*	*Sys-GMM*	*L ≥ 20*	*GLS*	*Sys-GMM*	*L ≥ 20*	*GLS*	*Sys-GMM*	*L ≥ 20*	*GLS*	*Sys-GMM*	*L ≥ 20*	
SCOPs														
SCOP technology	7.21	6.49	6.51	7.84	6.26	6.13	7.42	6.31	6.20	7.50	6.29	6.28	6.33	6.27
Conventional technology	7.34	6.64	6.05	7.50	5.95	5.95	7.44	6.33	5.19	7.40	6.55	6.20	6.27	5.94
t-test	*	**	***	***	***	**	NS	NS	***	NS	***	NS	NS	***
Conventional firms														
SCOP technology	8.45	8.59	10.25	9.35	9.33	9.97	8.96	9.17	7.79	8.72	8.38	7.91	8.73	8.98
Conventional technology	8.84	8.84	9.07	9.02	9.02	9.06	9.11	9.11	8.99	9.03	9.02	9.05	8.96	9.04
t-test	***	***	***	***	***	***	***	**	***	***	***	***	***	NS

***, **, and *: means are significantly different at the 1%, 5%, and 10% levels, respectively; NS: difference is not significantly different from zero.

Table 7. Average Observed Returns to Scale, GLS

Data Set 1: 1987–1990

Firm group	*Capital Goods*	*Consumer Durables*	*Consumer Goods*	*Construction*	*Transport*	*Business Services*	*Consumer Services*
SCOPs	0.865°°°	0.870°°°	0.955	0.952	0.931	0.633°	0.786
Conventional firms	0.777°°°	0.955°°°	0.993°°°	1.035°°°	0.878°°°	0.863°°	0.921°°
t-test	***	***	***	***	***	***	***

Data Set 2: 1989–1996, firms with 20 employees or more

Firm group	*Mechanical Engineering*	*Printing and Publishing*	*Paper and Wood*	*Metals*
SCOPs	0.957	1.063	1.061	0.896
Conventional firms	0.722°°°	1.104°	0.813°°	0.574°°
t-test	***	NS	***	***

***, **, and *: difference significant at the 1%, 5%, and 10% levels, respectively; NS: difference is not significantly different from zero.
°°°, °°, and °: returns to scale are significantly different from 1 at the 1%, 5%, and 10% levels, respectively.

a recession), we present the GLS estimates for comparison with Table 5, as well as the more robust GMM estimates. The GMM estimates show the SCOP technologies being more productive at SCOP input levels, and both types of technologies producing the same outputs at conventional input levels. Overall, therefore, our estimates indicate that the SCOP technology is more productive, though there clearly are differences across industries and possibly over the business cycle.

Input Level Effects: Returns to Scale

Before examining returns to scale while holding technology constant, we present the average local returns to scale estimated with Data Sets 1 and 2 for the two groups of firms in Table 7. The variety of industries, including services, present in our data sets and the representative samples offer us a rare opportunity to present new stylized facts regarding this aspect of the technologies of the two groups of firms.[25]

[25]We present only the GLS estimates, and do not use the version of Data Set 2 that includes small cooperatives, given the obvious sensitivity of returns to scale to firm size. The estimates for SCOPs in Transport (Data Set 1) and Paper and Wood, and Metals (Data Set 2) may be less reliable than in other industries, as the translog performs less well in these two cases, with a slightly lower proportion of observations for which the estimated elasticities and returns to scale have values consistent with economic theory. It should be noted that less good elasticities estimates are not necessarily due to small sample sizes—here 100% of the elasticities estimated on the smallest sample, that of SCOPs in Consumer Services, are consistent with theory.

We also tested for differences in the marginal products and elasticities for the two types of firms. In most cases elasticities and marginal products for SCOPs and conventional firms are not significantly different with Data Set 1; for the remaining parameters in Data Set 1, and those estimated with Data Set 2, differences between the two types of firms show no consistent pattern. No consistent pattern was ob-

According to the underinvestment hypothesis, conventional firms that maximize profit should operate at constant returns to scale in the long run, while underinvesting labor-managed firms would at best operate in the increasing returns portion of the production function. Average returns to scale estimated for conventional firms mostly indicate decreasing returns (with increasing returns in construction) whereas those of SCOPs are for the most part consistent with constant returns (with decreasing returns in Capital Goods and Consumer Goods in Data Set 1). Arguably, this may reflect the fact that we are estimating local returns to scale over a short period, so that we are capturing short-term returns to scale—in this case price-taking profit-maximizing firms, at least, should exhibit decreasing returns. In all industries but one (Printing and Publishing) the returns to scale parameters estimated for the two groups are significantly different. In the first period (Data Set 1) the parameters are higher for conventional firms in all industries except for Capital Goods and Transport. In these two industries, the SCOPs' parameter is higher but indicates decreasing or constant returns. The parameters estimated for the second period (Data Set 2) are higher for the cooperatives (except in Printing and Publishing, where there is no difference with conventional firms) but again indicate constant returns. Overall, the differences between the two periods suggest there may have been some adjustment to the business cycle, at least among SCOPs, from decreasing returns to scale in the first data set, which covers a period of moderate growth, to constant returns in the second one, which covers a recession. If there is underinvestment in labor-managed firms relative to conventional ones, these observed returns to scale do not show it. This issue is taken up more rigorously next, with comparisons that keep technology constant.

We have computed the local returns to scale for both groups of firms under the same technology, so that the only differences should stem from systematic differences in input levels rather than the use of different technologies. These estimates are presented in Tables 8 (Data Set 1) and 9 (Data Set 2). In both tables, under a given technology the constant returns to scale tests give the same result for the two types of firms, with the single exception of the Paper and Wood industry under the conventional firms' technology. In other words, given the same technology, the different input levels chosen by SCOPs and their conventional counterparts do not result in differences in returns to scale. Table 8 shows both types of firms having decreasing returns under both technologies in Capital Goods, and constant returns under both technologies in Consumer Goods, whereas in the remaining industries both types of firms have constant returns under the SCOP technology and decreasing returns under conventional technology. Tests of differences between the parameters estimated at the two firm groups' input levels show

served either when we compared elasticities and marginal products estimated at given input points but using the two different technologies in order to abstract from input demand differences—embodied effects did not always operate in the same direction.

Table 8. Returns to Scale, Keeping Technology Constant, at SCOP and Conventional Input Levels
Data Set 1: 1987–1990, GLS

Technology and group of firms	*Capital Goods*	*Consumer Durables*	*Consumer Goods*	*Construction*	*Transport*	*Business Services*	*Consumer Services*
SCOP technology							
SCOPs	0.865$^{\circ\circ\circ}$	0.870$^{\circ\circ}$	0.955	0.952	0.931	0.633°	0.786
Conventional firms	0.874$^{\circ\circ\circ}$	0.860$^{\circ\circ\circ}$	0.959	1.012	1.082	0.733	0.827
t-test	**	***	NS	***	***	***	NS
Conventional technology							
SCOPs	0.791$^{\circ\circ\circ}$	0.951$^{\circ\circ\circ}$	0.989	1.052$^{\circ\circ\circ}$	0.862$^{\circ\circ\circ}$	0.848$^{\circ\circ}$	0.902$^{\circ\circ\circ}$
Conventional firms	0.777$^{\circ\circ\circ}$	0.955$^{\circ\circ\circ}$	0.993	1.035$^{\circ\circ}$	0.878$^{\circ\circ\circ}$	0.863$^{\circ\circ}$	0.921$^{\circ\circ}$
t-test	***	*	NS	***	NS	NS	***

***, **, and *: means are significantly different at the 1%, 5%, and 10% levels, respectively; NS: difference is not significantly different from zero.
$^{\circ\circ\circ}$, $^{\circ\circ}$, and $^{\circ}$: returns to scale are significantly different from 1 at the 1%, 5%, and 10% levels, respectively.

several significant differences, but going both ways. Only in the Construction industry, under conventional technology, is the SCOP parameter significantly higher than the conventional one and consistent with increasing returns, but returns are also increasing for conventional firms under that technology. Table 9 shows both types of firms having constant returns in all industries under SCOP technology, and both constant and decreasing returns estimated under conventional technology. Again differences between the parameters estimated with the two levels of inputs go in both directions, with that of conventional firms equal to SCOPs' or higher under SCOP technology, and SCOPs' higher in all industries except Printing under conventional technology, but here again in the context of constant or decreasing returns. As we keep technology constant it is clear that differences in input levels do not result in the differences in returns to scale predicted by theory, nor in SCOPs producing at an inefficiently small scale or even at a scale departing significantly more from efficient scale than conventional firms.

Conclusions

With two new, large, comparative data sets on France, we set out to compare the productivity and technologies used by worker cooperatives and conventional firms, revisiting in the process hypotheses concerning the investment and labor demand behavior of labor-managed firms. We estimated production functions industry by industry, and our data on representative samples of French firms allowed us to derive updated stylized facts about the compared features of labor-managed and conventional firms. Our use of a translog specification for the production function has made it possible to disentangle incentive and information effects embodied in the factors of

Table 9. Returns to Scale, Keeping Technology Constant, at SCOP and Conventional Input Levels
Data Set 2: 1989–1996, Firms with More than 20 Employees Only, GLS

Technology and group of firms	*Mechanical Engineering*	*Printing and Publishing*	*Paper and Wood*	*Metals*
SCOP technology				
SCOPs	0.957	1.063	1.061	0.896
Conventional firms	1.008	1.078	1.064	0.996
t-test	***	***	NS	***
Conventional technology				
SCOPs	0.923°°	1.052	1.043	0.905°°°
Conventional firms	0.722°°°	1.104°	0.813°°	0.574°°
t-test	***	***	***	***

***, **, and *: the means are significantly different at the 1%, 5%, and 10% levels, respectively; NS: difference is not significantly different from zero.
°°°, °°, and °: returns to scale are significantly different from 1 at the 1%, 5%, and 10% levels, respectively.

production from differences in returns to scale that could be due to differences in the investment demand behavior of the two groups of firms.

We find worker cooperatives to be as productive or possibly more productive overall than conventional firms in most industries; however, the two types of firms use different technologies. These differences are consistent with the existence of incentive and information effects associated with full employee ownership that are embodied in the inputs and result in different output elasticities. In some industries, conventional firms would produce more if they used the cooperatives' technologies, whereas SCOPs always produce at least as much with their own technology as with conventional firms'. On average across industries, SCOP technologies yield higher outputs than conventional firms' technologies do at SCOPs' input levels with both data sets, and the same output as conventional technologies or a higher output at conventional firms' input levels. These findings are unlikely to be due to endogeneity—the results are maintained or improve slightly in favor of SCOPs when we use System-GMM estimation, which is robust to endogeneity. Furthermore, it should be noted that differences in sampling imply that our findings may underestimate the productivity of SCOPs relative to that of conventional firms. These findings suggest that the way in which worker cooperatives organize production is probably more productive overall than conventional firms' way. In several industries, French worker cooperatives produce in such a way that they use their current inputs better than conventional firms, which could produce more at their current levels of inputs if they behaved in the same way as worker cooperatives.

We find no evidence that systematic differences in input levels cause the cooperatives to produce at inefficiently small scale. Using a given technology, both groups of firms operate at constant returns, or both operate at decreasing returns (with one case in which both operate at increasing

returns). We do not find any industry in which under a given technology the cooperatives' input levels are associated with increasing returns to scale and the conventional firms' with constant or decreasing returns, as predicted by the underinvestment hypothesis.

Univariate comparisons show that worker cooperatives are not smaller than conventional firms in all industries and are observed to expand their capital at least as fast as conventional firms. Capital intensity is often the same in the two groups of firms, and they adjust their capital intensity at the same rate in all industries. We find no prima facie evidence of underinvestment, or of capital starvation, among French labor-managed firms. Employment may be more stable in cooperatives over the business cycle, but the differences with conventional firms are only weakly significant, and differences in labor composition do not strongly affect the comparative productivity of the two groups of firms.

Generally, the two groups of firms are more similar than is usually thought. Although we find consistent evidence that worker cooperatives are at least as productive as conventional firms and do not produce at inefficient scale, behaviors observed for both types of firms, as well as differences between the two groups, seem to vary across time periods and stages in the business cycle, and are not entirely homogeneous across industries. This confirms the importance of testing hypotheses regarding labor-managed firms on a range of industries and over different parts of the business cycle in order to produce reliable stylized facts. Our findings also suggest that there is more to understand about cross-industry differences, and about the comparative dynamics of labor demand and investment in labor-managed and conventional firms, with appropriate models allowing for pay adjustments in cooperatives over the cycle and differences in the cost of capital across firm types.

Appendix A. Variable Definitions

L	Annual average of monthly employment level, in logs for the estimations. We do not have information on the number of hours worked.
K	Fixed assets at book value in € 1,000s, base year 1990, in logs for the estimations; measured at the end of the calendar year. This is the measure that was most consistent across data sources. It was not lagged in order not to lose a year of data (which would have been problematic with our short, unbalanced panels). Experimentation with using fixed assets measured at the beginning of the year showed no significant change in the results.
VA	Annual value-added (standard accounting definition) in € 1,000s, base year 1990, in logs for the estimations.
% Women	Percentage of women in the firm's workforce (annual average of monthly levels).
% Managerial	Percentage of managers in the firm's workforce (annual average of monthly levels).
% Supervisory	Percentage of technicians and supervisors in firm's workforce (annual average of monthly levels).
% Market share	Percentage represented by firm's annual sales in total annual sales of industry of the firm's main product at the three-digit level (French industry

classification NAP600) estimated with sum of output of all sample firms in that industry in the original representative firm sample from the Annual Enterprise Survey used for each data set. A weighted sum was used in the case of Data Set 1, for which we had the sampling proportions. We did not have sampling proportions for the manufacturing sample covered by Data Set 2, but since all firms with 30 employees or more were included in that sample (together with a sample of firms with 20–29 employees), the unweighted sum of sample firm sales in the industry is a reasonable estimate of total industry sales.

K and VA have been deflated by the French consumer price index. This choice is due to the absence of continuous producer price series for the industries and the time periods our data sets cover. Values in French Francs (for years before the adoption of the Euro) have been converted into euros.

Appendix B. Data Set Construction and Numbers of Observations

For both data sets, we used data on all French worker cooperatives (SCOPs) communicated by the SCOP federation, CG-SCOP. These data concern about 1,500 worker cooperatives a year from 1987 to 2004 and include all accounts as well as some information on the gender and occupational composition of the workforce.

We merged these data with different subsets of official survey data including the French Annual Enterprise Survey (Enquête Annuelle d'Entreprise) conducted by the French statistical office INSEE on a stratified representative sample of about 12,000 firms with entry and exit; the Employment Composition Survey (Enquête Structure des Emplois) also conducted by INSEE, which provides information on the occupational and gender composition of the workforce of some 22,000 firms; and the balance sheets and selected accounts of 10,000 of the firms in the Annual Enterprise Survey Sample, from the Bilans Industriels et Commerciaux database.

Data Set 1 was constructed by merging the SCOP data with an existing data set constructed for a previous project from the Annual Enterprise Survey, the Employment Composition Survey and the Bilans Industriels et Commerciaux database in manufacturing, construction, and services from 1987 to 1990. The industrial classification used in this data set is the French classification NAF40.

Data Set 2 was constructed by merging data from the CG-SCOP data with the manufacturing subsample of the Annual Enterprise Survey and the Employment Composition Survey and covers 1989 to 1996. The industrial classification in this data set is the French classification NAF36.

Because the official survey samples include only firms with 20 or more employees, we selected SCOPs with 20 or more employees for most estimations, but included all SCOPs for the GMM estimations to increase observation numbers. To make estimation industry by industry possible, industries in which the number of SCOPs represented was less than 2% of the number of firms available in the other data sets were eliminated as well as industries in which there were no SCOPs (Energy Generation & Distribution and Real Estate Rentals in Data Set 1 and Pharmaceuticals, Cosmetics & Cleaning products in Data Set 2).

Observations on cooperative firms that appeared in the conventional firm samples were used to test that variable definitions were consistent between SCOP and official survey sources (all the data sets we accessed use firms' registration numbers from the exhaustive national firm register Sirene). There were 54 such SCOPs (representing 191 observations) in Data Set 1 and 75 (representing 337 observations) in Data Set 2. The consistency of variable definitions was checked variable by variable in each of the two data sets, and only variables that took identical or very nearly identical values in different sources were used. No bias one way or another between SCOP and INSEE sources was detected.

Table B.1. Number of Observations and Firms, Data Set 1 (1987–1990)

	Observations	*Firms*		*Observations*	*Firms*
Capital Goods			Transport		
SCOPs	157	47	SCOPs	71	22
Conventional firms*	3,211	1,084	Conventional firms	1,700	611
Consumer Durables			Business Services		
SCOPs	128	41	SCOPs	71	24
Conventional firms	2,583	909	Conventional firms	2,788	1,172
Consumer Goods			Consumer Services		
SCOPs	272	88	SCOPs	47	15
Conventional firms	3,660	1,265	Conventional firms	1,412	520
Construction			Total		
SCOPs	645	194	SCOPs	1,391	431
Conventional firms	914	295	Conventional firms	16,268	5,856

*Conventional firms' sample

Table B.2. Number of Observations and Firms, Data Set 2 (1989–1996)

	Observations	*Firms*
Mechanical Engineering		
SCOPs	303	43
Conventional firms*	5,311	873
Printing and Publishing		
SCOPs	564	80
Conventional firms	2,063	326
Paper and Wood		
SCOPs	92	13
Conventional firms	2,362	373
Metals		
SCOPs	221	30
Conventional firms	4,412	694
Total		
SCOPs	1,180	166
Conventional firms	14,148	2,266

*Conventional firms' sample

The resulting numbers of observations for each data set are presented in Tables B.1 and B.2.

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