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FIRMS' SPONSORED TRAINING AND PERFORMANCE: A COMPARISON BETWEEN FRANCE AND SWEDEN BASED ON FIRMS DATA

by

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I. Introduction: The puzzle[1]

The idea that a highly skilled workforce is an essential factor for the performance of firms is commonplace[2]. Very often another statement accompanies the preceding. Firms do not have a sufficiently skilled workforce and they are partly responsible because they do not train enough[3]. This sentence really contains two different statements. The first states a fact and should be tested. The second deals with a normative statement since the employees may also be held responsible for acquiring their skills. Moreover the skills of the labor force should enhance the competitiveness of the nation. The latter is a public good and the government may also have to share some of the expenses. Finally the firms should perhaps hire more educated workers[4]. Another popular theme is that the increased pace in R&D and physical investment in the 80s has been accompanied by a decrease in productivity growth. Some authors such as DEIACO et al [1990] suggest that the exploitation of technology sources may be hampered by shortages of competences and skills.

In countries with a rising unemployment, the issue of the relation between firms sponsored training and performance is then an essential economic and social issue on which very little econometric work seems t o have been done[5].

The present study is based on two data sets on French and Swedish firms with such variables as indicators of performance (profit rate for instance) and training expenses for a given year, as well as some measure of the stock of human capital . Samples of firms fairly

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[1] We thank F. SOULLIER for the cleaning of ERMES "Bilans Sociaux" panel, and M. NAJAR for the matching with the DIANE financial accounts. E.KAZAMAKI-OTTERSTEN has kindly computed aggregate data on training for Sweden. A grant from the Direction de l'Evaluation et de la Prospective, Ministère de l'Education Nationale, is gratefully acknowledged.

[2] See CEREQ [1989],p.17

[3] See for instance COMMISSARIAT GENERAL DU PLAN [1992], p. 67 for France, and DERTOUZOS, LESTER and SOLOW [1989], p. 93.

[4] TSANG, RUMBERGER and LEVIN [1991] however show that excess schooling may have adverse effect on productivity.

[5] Our single reference, DE KONING and GELDERBROM [1992], relates company training to labor productivity, in Netherlands. No study has been done for France and Sweden to the best of our knowledge.

similar for France and Sweden may allow to assess the differential efforts of the institutional settings. France has a law which requires firms to spend a minimal percentage of the wage bill on training or pay a tax of the same amount[6]. Sweden does not have such a law.

This paper sheds some light on the training expenditures and their determinants at firm level. Its main purpose however, is to quantify the relation between training expenses (flow and stock) and firms performance. The scope of our data does not enable us to evaluate on-the-job training and learning by doing, as distinct from the former since it is a joint output from work[7]. The training expenditures dealt with in this paper do not integrate training paid directly by the employees and other institutions (at least for France). This means that the flows and stocks of training measured constitute only a fraction of the total flow and stock which contribute to the production of the firm.

The training paid by French firms is at least partially of a general character, and for all the firms of the sample its level is above the minimum required by the law. The general nature of much of the training is certified by the requirement that the training should not take place on the trainee's work station except some practical exercises (4 September 1972 and 3 April 1985 "circulaires " of the french administration)[8]. This is very puzzling since standard human capital theory has a basic result, stated by G.BECKER, which is that firms do not pay for investment in general skills since they do not recoup the costs if workers quit (see PARSONS [1990] for a clear statement). Then one might argue that firms lower the wage during the training period to recoup their expenditures. They are however unlikely to lower the wages enough during the training period because of the minimum wage, and also because employees may then shirk according to the efficiency wage hypothesis.[9]

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[6] A french law of 1971 compels firms with 10 or over employees to spend a certain percentage of the wage bill on training its employees or pay a tax equal to the difference between its obligated and actual training expenditures. See BISHOP [1993] for a presentation in english.

[7] See KILLINGSWORTH [1982]. On-the-job training and learning by doing have large components of job and firm specificity. The mostly off-the-job training eligible for the french law has a normally large general component. The distinction is not only statistical. It is also theoretical.

[8] See BERTON and PODEVIN [1991].

[9] Except under apprenticeship contracts. These are left aside here.

One may argue that training is in reality specific, but there is substantial evidence in other countries that firms pay for some investment in general skills. This does not happen only in Japan where mobility is low, but also in the US where it is high.

FEUER, GLICK and DESAI [1987] show that employers pay for some general training while BISHOP [1991] finds no evidence that employees who receive general training get lower wages. BARRON, BLACK and LOEWENSTEIN [1989] also find that workers who receive on-the-job training do not have a lower wage. In a dutch sample, DE KONING and GELDERBLOM [1992] evaluate the general part of company training programs to two thirds of the total. Some other studies observe that the wage profiles are flatter in Australia and US than in Japan and that the minimum wages must be binding the firm's investment in on-the-job training, and conclude to the opposite (CHAPMAN and TAN [1992]).

Uncontroversial evidence will always remain difficult to obtain, notably because of the imposibility to control completely for the differences of ability between workers. BECKER'S theorem has such a logical force that it requires alternative theories to support recent results on the subject.

Some theoretical ideas have, indeed, appeared to explain that firms share some of the costs of general training[10]. They are based on problems of uncertainty, information and transaction costs. GLICK and FEUER [1984] show that joint investment in specific training protects the employee less than the employer because the latter controls the supply of skilled workers. He can create an excess supply and lower the wage. General training should then be offered as an hostage to induce the employee to accept to invest in specific training. This offer is viable i.e. not subject to BECKER'S argument.

Another simple idea has been developed by several authors and sometimes given the label of the "accreditation problem" (STERN and RITZEN [1991], p. 5). Employees have a

[10] One idea that we only mention is that if wages are attached to jobs which require general training, since firms pay the same wage to trained and not yet trained workers, they pay the general training by assumption. See SCHLICHT [1981]. This is an application of the job competition intellectual framework, yet jobs for trained and untrained workers can easily be labelled as different jobs, without hurting equity.

difficulty in signalling to other firms that the training they have received while holding a job is of a general nature[11]. This difficulty is much more likely than for schooling because certification often does not exist for such training. Then employees cannot get the full returns of an investment in general capital, which is considered as specific, and the firm has to share the costs. Moreover the contribution of the firm to the financing of the investment suppresses the signal of generality that financing by the employee conveys.

The idea can be refined to consider that there are several types of general capital. Firms require different mixes, and do not pay for those they do not use. Then the package of general skills that is taught at one firm is less valuable in the others (BISHOP [1991]).

These theories explain that firms can rationally sponsor general training in an economy characterized by a stable set of skills and competitive equilibrium. Our main interest is however the connection between firms' sponsored training and performance.

The question then is : How can the rates of return over the interest rate that appear in many firms be explained ?

Standard monopoly situations may be part of the story. However this is not sufficient to predict a positive link with training expenses.

If firms finance training (general and specific), they must recover these costs. However the assets measured by the firms'accounts include the physical and financial assets, and some intangible assets (such as patents) but not the educational assets they have financed.

These latter assets for the Swedish sample have been evaluated to be 2% of total non-financial assets[12]. Our evaluation of the "training stock" for the french sample is 8%, an obvious under-evaluation since on-the-job training is not measured.

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[11] KATZ and ZIDERMAN [1990], BISHOP [1991] p 91.

[12] ELIASSON [1992] p 88. However for the ten largest firms ELIASSON [1990] obtains 13% for 1986. The respective figures are : Machinery and buildings 39%, R&D : 22%, Marketing 26%. The evaluation is done on the assumption that the depreciation is equal to the growth rate (5.6%) for all assets.

Real rates of return are computed on assets which exclude the firm financed educational stock. They then normally must exceed the real interest rate. They do for many firms in the two countries studied. Then standard theory predicts a positive relationship between the rate of return over non educational assets and the level of educational assets, which we will test. Yet the dispersion of the rates of return in our two samples is enormous (see table 1) and may reflect the owners competence (one of the traditional views of profit: the entrepreneur's reward) as well as top management competence insofar that the latter is awarded wages under its productivity contribution to the firm (ELIASSON [1991]). Risk premia and some random shocks also concur.

However some of the randomness may be explicitly accounted for in a dynamic view of the relation between training and performance, a view that puts innovation and its diffusion in the center of the play because it implies a change in skills.

Part II will then sketch a theoretical framework which gives to innovation this central role. Part III will present the data and part IV some econometric results. Part V summarizes our findings and suggests further research.

II. Innovation implementation, rent seeking, and firms sponsored training.

II.1. Innovation and skills. Which causality ?

There is substantial evidence that recent technologies demand new skills. This statement needs some elaboration on two levels.

First, one can make the distinction between the phase of the production of the innovation (R&D), the phase of the decision of adoption, and the phase of producing with an existing innovation. The first phase, R&D process, requires more scientists and engineers than routine production. Afterwards, the decision of adoption is better made by competent managers (NELSON and PHELPS [1966], WELCH [1970]).

It is less often observed that the adoption of a technology will be profitable only if the workforce has the adequate skills. If the workforce does not have the necessary skills and is unable to learn within a reasonable time (which may in some circumstances be short), the firm will gain no market share and no profits[13].

There is some evidence that the relative demand for skilled workers, first, is higher for a recently adopted technology and, second, declines with experience with that technology. BARTEL and LICHTENBERG [1987] have summarized the arguments and contributed to that evidence. The tasks for a recent technology are not very well defined and the work cannot be broken into simple tasks as it is later in the product's life. Then workers with a high general education and/or training are more efficient in these circumstances (NELSON and PHELPS [1966]).

Substantial controversy exists on the more general statement that new goods require more skilled workers than old goods (OSTERMAN[1990]. Even if there were a tendancy to dualism, those new jobs which are more skilled would require more training. An important empirical point is that the implementation phase will require higher training for categories like technicians and manual workers and not only engineers. Some evidence has been given by econometric studies on the elasticity of substitution between capital and skilled labor which show that it is lower than the elasticity between skilled and unskilled labor (BOURDON [1990] on french data, BERGSTROM and PANAS [1992] on swedish data).

Concerning the innovation production (or R&D phase), the theoretical models have not treated specifically the competence factor. Hiring or training scientists is an implicit part of a global investment to obtain the innovation, through a patent race or not[14].

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[13] ELIASSON[1990] describes the different forms of the firm's competence. THUROW[1992] stresses the importance of the daily implementation oby skilled workers. It is essential in the success of the japonese firm (AOKI[1988]).

[14] Manuals on R&D do not mention human capital factors. For instance one can hardly find a line on the topic in GOMULKA [1990], BALDWIN and SCOTT [1987], or REINGANUM [1989]. SILVERBERG, DOSI and ORSENIGO [1988] in an evolutionary simulation model go one step in the right direction by taking into account the competence factor. However there is no cost to competence building, which happens through learning by doing.

Concerning the diffusion and implementation phase, a standard human capital treatment has been offered by MINCER [1993, chap 12]. Technical progress is considered as exogenous[15]. It leads to a demand for more educated workers, and later for more on-the-job training. The causal link put in forefront by MINCER, and based on his econometric results, is mechanically true: on-the-job training cannot precede the adoption of the technology. MINCER never touches the issues of formal training and the investment sponsoring. BECKER'S theorem is assumed to be true. However it is a very partial view of the relations between technological progress, education and training because of the ideas we have exposed before.

Education is necessary to make innovations. Then education of managers favors the adoption decision. Finally education and training (general and specific) is necessary for a successful implementation of innovations. The investment in human capital should be decided before the implementation process and the investment should be made before or at the beginning of the implementation.

This constitutes a reversed causality between technical progress and training. Education and training make technical progress possible. The proposed view , which does not preclude the first causal link, has different policy implications. A government may find it less costly to subsidize education and training than to raise the rythm of technical progress, which has a high random element.

In the following we are interested in this reversed causality which runs from the investment in skills to the production, adoption and implementation of new technologies. It requires a theoretical framework which allows rational firms to sponsor part of general investment in training as well as specific investments, i.e. going beyond human capital theory.

[15] MINCER [1993] p 346.

II.2. Innovation and firms sponsored general training : Two complementary views.

In industrial organization theory, there is a useful classification criterium of firms behavior. It may be strategic or not (TIROLE [1988], p 5).

In some cases, strategic considerations may not matter very much for the decision of firms to invest in general (and specific) training and to finance it. In a global economy, firms may not know where the potential competitors are, what innovation they should adopt, and the level of their investment in skills[16]. We start then by this non strategic view, and then consider a more strategic framework.

II.2.1. The non strategic case. Sponsoring training for the monopoly rent.

Let us consider an economy with many goods where the demand shifts a lot either through changes in consumers demand (entry of foreign competitors, fashions) or invention of new goods. This is how more and more markets are characterized.

Our central argument is the following:[17]

A firm will be willing to invest a sunk cost (including general training) to establish a monopoly on one good (or a share of a market too large for the incumbents), and the corresponding rent.

1. We consider that successful implementation of the new production process requires general training as well as specific training.

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[16] The market may also be large, so that financial constraints limit the capacity of firms.

[17] A first presentation can be found in BALLOT [1992].

2. Employees invest in too low levels of general training. Liquidity and borrowing constraints, risk aversion[18] and accreditation problems reinforce one another. Therefore, if the firm wants the monopoly position, it has to sponsor the investment.

3. We assume that training is, in many circumstances, less costly that laying off the workers who lack the general training and hiring new workers. This is all the more true that severance costs are higher, general skills required more numerous, and specific skills already possessed by incumbents higher. In the latter circumstances, quits will be fairly low, and this raises the returns to the firm, not only on specific, but also on general training[19].

4. The "training for the rent" theorem.

The firm can pay the general training by the rent (actually its borrows the funds and will pay back the bank). It will pay for it (or rather a fraction of it) even if there are quits.

5. In contrast to BECKER's theorem, the firm can pay the skilled competitive wage to the trained workers (higher than the previous non-skilled competitive wage), to avoid quits.

It may even share some of the rent with opportunistic workers if they can cause damage to the value of the innovation through some sabotage when quitting.

6. However there is no mechanism that dissipates the rent totally in the general training investment.

We can then state the following:

Result:

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[18] We have seen above that some types of general competences may lose value in the turnover of goods.

[19] There is a large literature which shows that the relation between quits and firm sponsored training is negative. However the training is assumed to be specific. See MINCER [1993].

The rate of profits of the firm is positively related to the cumulated training expenditures (or training or educational stock sponsored by the firm).

Additionally the rate of growth of cumulated training expenditures may have a positive effect on the rate of profits, since the firm may benefit from shortening the period which is necessary to implement the innovation. It starts to train the workforce before the adoption and accelerates the pace of training after. The delay reduces the discounted value of the quasi-rent.

7. The same line of reasoning applies to the training of the engineers and researchers involved in the production of innovation. The firm pays for some of their general training to get the monopoly and the rent from the sale of the innovation.

8. The rent is often temporary because other firms will innovate or adopt innovations and produce new substitutable goods. This is not essential and is better integrated in the strategic framework below. Yet it not contradictory with the preceding framework, and it is an essential part of SCHUMPETER's creative destruction paradigm.

In many circumstances, the existence of rents will however attract other firms and yield a strategic behavior.

II.2.2. The strategic case. The race for competence and Schumpeterian competition.

If the firms on a market can observe one another, there should be a race for the adoption of the innovation and the production of the new good (or the use of the new process). In our context, this race is a tournament for achieving the competence.

Let us assume that the firm which reaches first the level of competence necessary to master the technology gets the market (there is preemption). The market is assumed to be below feasible capacity.

FUDENBERG and TIROLE [1987] study a similar situation, where there is a sunk cost of entry, decreasing with time of entry. In the case of process innovation (non drastic), they show that the leader will adopt when the cost of entry C(t) equals the capital value of the Bertrand profit

$V = (c_0-c_1)/r$

where c_0 constant marginal cost before innovation

c_1 constant marginal cost after innovation

r rate of interest.

Hence the rent will be totally dissipated.

An identical follower will never enter since he can make no profits.

This model can help to interpret the race for competence (see figure 1). Let C (t) be the cost of training the workforce up to the required competence level, a cost declining with time as BARTEL and LICHTENBERG [1987] have shown.

As such the model yields some unrealistic predictions. First the firm which invests $C(t^c)$ in t^c obtains the monopoly, yet gets only a return to its investment equal to the interest rate, unlike in the non-strategic case. Second, the other firms will not invest at all.

However first, if the innovation is a new good, FUDENBERG and TIROLE [1987] show that followers will enter in the long run. This is part of the creative destruction process. It will be by the invention of new goods substitutable to the present one (or new process).

Second, the human capital of the firms cannot be identical. Firms at one time have a set of general and specific skills that they have built, through hiring, laying off, induced quits and training. It is also an output of employees behavior in the past (quitting). Heterogeneity is the rule and prime-movers, which have a portfolio of general capital long to accumulate, have an advantage over others.

$C_1(t) < C_2(t)$ for t fairly small.

This means that adoption by firm 1 will take place in t_2^c, and that it will earn a rent π_i.

The relative rate of return on non-educational assets (averaged on a long period) should be positively related to firms sponsored relative training capital (rather than flow).

The empirical prediction is different from the preceding non strategic story, since it bears, as is usual for contest models of managers earnings, on variables defined in relative terms[20].

Some other firms will also invest because they are not able to evaluate the advantage of the leader. The human capital of the workforce of a firm is not easily measured. There is uncertainty and, if the expected returns from the innovation are high, the race will take place, even though an omniscient economist would predict the winner (in probability, since the success of implementation is stochastic).

The followers who invest will make no profits. Stochastic success of implementation means that some firms will make losses.

Finally one might argue in the strategic case that the rent is totally dissipated in wages. A rival firm may raise its wage to attract the trained workers of the leader, and win the race, since it may outcompete him by not paying for training, but this is BECKER's theorem in another disguise, and too simple. A firm will not gain all the competence by simply hiring trained workers if it does not have some prior knowledge, based or R&D and previous education (the firm's competence). This remark is based on the concept of absorptive capacity (COHEN and LEVINTHAL [1989]). Therefore opportunistic trained employees cannot reap the rent.

These two views suggest some test based on firms data.

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[20] For instance ANTLE and SMITH [1986].

III. The data.

The french source is a panel of large firms built at ERMES. It is based on the "Bilans Sociaux", which are a set of data on "Human Resources Management" that each firm over 300 employees must gather and communicate to the Labor Administration and its "Comité d'entreprise", on an annual basis, since 1981[21]. It contains, among many variables, data on the total training expenses, turnover, wages, tenure, percentage of workers on assembly line (Table 1).

We have matched this source with a much larger data set (DIANE), which contains the financial accounts of these firms, for years 1986 onwards. The french panel in any one year covers around 25 % of employment in manufacturing.

The swedish source is a panel of large firms or establishments or divisions of firms called the "Planning Survey", and collected by the Federation of Swedish Industries since 1975 (ALBRECHT et al. [1992]). It covers almost 50 % of total employment in swedish manufacturing. There is a wide variety of questions. For year 1989 only, questions on training expenses have been included. An evaluation of the education assts by the employers is also available.

The study will therefore be a cross-section analysis of year 1989, but we have used some data from other years extracted from the French data base.

Comparison of the levels of economic variables between countries is a delicate exercise, because definitions often differ. For instance financial assets are excluded in Swedish assets since these data relate to establishments. Moreover some statistics are available in one country only, as table 1 shows.

[21] These are not public data however, nor are they gathered by the Administration. We collect them from the firms, on a free will basis. Anonymity is required.

Gross (or net) R&D is available for both countries but very unreliable in France because firms decide on their reporting in the assets as they wish, and on the basis of their depreciation plan.

A look at some important variables show that the structure of the samples is not very different : fixed capital stock, annual wage, proportion of manual workers, or labor productivity are comparable, not only in the mean, but also in the spread.

The definitions for training expenditures are not a priori dissimilar. The french "Code du Travail" in its article L 990-2 and the "circulaires" already quoted define the types of actions that enter in the field of continued education and count for the tax that the firms must pay. Many of these have a general content. ALBRECHT et al. [1992], p. 26 for Sweden define education as courses and other education organized or paid for by the firm for their employees. It relates to firm specific as more general education. Both internal and external education costs should be included. Wages paid to trainees however are not included.

Yet expenditures are higher in the French sample even if one deducts the wages paid to trainees (about 40% of the expenditures): 4044 FF against 3290 SK (almost as many French Francs in 1989)[22]. An obvious determinant of the higher expenses in France could be the legal minimum (1.2% of the wage fund). However the large firms are all above the minimum in 1989 and the distribution is not as skewed as the swedish distribution (figure 2). The high expenses paid by the government in Sweden may induce firms to spend less.

The availability of the training expenses and of the ratio of permanent workers since 1981 in the french sample has allowed us to compute an evaluation of the a "firm sponsored training stock" as follows :

[22] It should be mentioned that on average French firms spend much less, 2255 FF (wages excluded). The corresponding figures are not available. It seems that the increase with size is not as strong as in France.

$$EDSTOCK = \sum_{t=1981}^{1989} \left\{ \prod_{i=t}^{1989} \frac{PER_i}{EMP_i} \right\} WAGE_t * EDSH_t * (1-\delta)^{1989-t}$$

where PER_t number of permanent employees (present on January 1 and December 31)

EMP_t average number of employees in year t

$WAGE_t$ annual wage

$EDSH_t$ ratio of firm sponsored training expenses on total wage bill

δ rate of depreciation minus rate of inflation

This computation is based on three assumptions:

1. Employees receive training equally[23].

2. The training stock of an employee is lost when he leaves. There is no educational stock of the organization inherited from past employees, for instance through training younger employees on the job at no financial cost.

3. $\delta = 5\ \%$

The important results of the computation are the following :

1. The mean share of the year 1981 in the training stock is only 3 %, which means that the non availability of the preceding years is not a problem.

2. Year 1989 accounts on average for 25 %, which means the preceding years represent a dominant share in the stock, which is much larger than the flow.

[23] Further work will use the breakdown by broad professional category to suppress this assumption. We may also assume the polar assumption that only permanent workers receive training.

3. During the period 1981-89, one can see a steady increase of the percentage of the wage bill which is devoted to the training expenses, rising from 1.76 % in 1981 to 3.35 % in 1989.

4. The training stock as computed remains a fairly small part of total assets (8 %), as we have already mentioned. When the point of view of the factors of production is taken, however, important educational assets non sponsored by the firm but by the employees or the government should be added.

IV. Econometric study.

This study will try to test only the first view relating absolute levels of rent and training capital/flow. The race for competence requires relative statistics that we do not presently possess but could be gathered, at least for France.

Although our main interest concerns the influence of the training expenditures on the performance of the firms, we have also looked at the determinants of these expenditures. This seems to call for a simultaneous equation system. However the training expenditures enter as a stock in the determination of the 1989 performance while the dependent variable in the training expenditures equation is the 1989 flow. This calls for the estimation of equations by ZELLNER's seemingly unrelated equations (SURE) methods since the error terms of both equations may be correlated.

IV.1. France

The training equation (1 in table 2) explains a very high proportion of the variance of the training expenditures in 1989. The rate of return on assets has a positive effect on the investment in training since it lowers the financial constraint and makes that investment more attractive. The R&D expenditures also affect positively the current training expenditures, showing the complementarities between the two actions, as stressed in our framework.

High wages have also a positive effect. One possible interpretation is that high wages are here a proxy for a high general education stock (or high ability). Such a stock favors the investments in training which then have a high return[24].

However the percentage of manual workers on assembly line, AUTRAT, has a very negative effect which was expected. Technologies which use assembly line do not require much training. The labor productivity (in log terms), LPRODUCT, is finally an important determinant of training. As far as it corresponds to advanced technologies and not high skills, whose effects should have been captured in the WAGE variable, the positive sign indicates that the demand for training is higher.

The stability of employees, PERWSH has a positive effect. Firms will invest more in training if their employees are more stable. Finally, the average age of the managers, AGEM 89, has a significant negative effect. This result could be interpreted as the effect of an aging management introducing less innovations.

The rate of return equations (3a and 3b in table 3) support the first view we have proposed. The training stock accumulated over the years has a very significant and positive influence on the rate of return over total assets, as predicted by our theoretical framework. This is probably the major result of the paper.

Since the French law gives to the firms the choice between spending at least 1.2% of the wage fund on training their workforce or paying an equivalent tax, it is interesting to check if the firms which have not spent more than about the minimum, do not care about training and therefore spent it in an inefficient way (paying the tax or giving a fringe benefit to the employees). The coefficient of the dummy is not very significant but positive, showing it may not be the case.

[24] There is widespread evidence that workers with a high general education are selected for training. There is also some indication that firms may select high ability workers when hiring if they intend to provide substantial on-the-job training (BARRON, BLACK and LOWENSTEIN, 1989).

The R&D has a negative effect which at first glance is surprising. However RDEDUC, the interaction of the training stock and R&D, shows that the joint effect is positive. This supports strongly our view that spending on R&D without having trained the employees does not increase the rate of return. On the contrary it appears as a cost that has been sunk inefficiently.

EDGROWTH, the growth rate of the training stock in 1989, has an effect independent of its level. It confirms our point 6 according to which firms may get a higher return if they accelerate their rate of investment in training. They may implement their innovation faster and obtain a higher return from it.

Average tenure of employees has a positive effect that could be explained in terms of accumulated on-the-job training and learning-by-doing, which is not measured by the training stock as computed here.

There is a strange positive effect of the use of assembly-lines, which may reflect some joint cyclical and sectoral effect and will necessitate further investigations. Finally growth is a positive determinant of RRTC, as expected. It improves capacity use and also represents unobserved variables such as the exogenous shifts of demand for the firm products but also the competence of the managers and the successful innovations they have introduced.

IV.2. Sweden

Equations of training (table 2a and 2b) reveal a strong influence of R&D expenses and automation (AUTLEVEL) which confirms again the complementarity between the two variables. As for France, the wage has a very significant positive effect. The rate of return has no effect. But for that variable, the results then are similar to the french results.

The rate of return equation (table 3, equations 4a and 4b) differs substantially from the french equation. For the educational stock, we tried different specifications and retained one with both a linear and a log term which allows for non-monotonicity. The two coefficients are significant and reveal a U shaped relation, with the rate of return declining first and then

rising as the educational stock increases. The minimum corresponds to an expenditure of 17,000 SK, more than the mean value. The rising part concerns 42% of firms. For firms which spent little an absence of effect could have corresponded to low training expenditures spent as a fringe benefit for employees. A negative effect is more difficult to interpret and leads us to recall that these estimates come an evaluation by the firm officials themselves, and may not be very reliable.

The rate of growth of the educational stock has a positive effect as in France. Other variables are not significant except the labor productivity, which has a positive effect.

V. Conclusions.

Our results are twofold. First we show that training expenditures in a given year are positively correlated with the R&D expenditures and the level of wages in the two countries. R&D appears complementary to training, as our framework assumes it should be. Wages are higher, indicating a higher general human capital stock and/or a protection against poaching as our framework suggests.

Secondly, they show clearly that the training expenditures, cumulated over time , have a positive effect on the rate of return in France, and also in Sweden for those firms that spend relatively large amounts. R&D has no efect or a negative effect alone. This is a very provocative result which needs confirmation on larger data sets.

The positive relation between training expenditures and rate of return, although corresponding to accepted wisdom, is by no means easy to reconciliate with standard economic theory, and we have developed a more suitable framework to interpret it. This framework also yields two complementary predictions. First, joint interaction of R&D and cumulative training has a positive effects on the rate of return, and this is supported by the french sample. Secondly, the rate of growth of the training stock should increase the rate of return, and this is supported by the data in both countries.

Further theoretical research would be valuable. Game theoretic models of R&D, and of innovation implementation (diffusion), have completely neglected the human factor. Modern labor economics theory has not shown much interest for the technical progress either. The dynamics of change is not a very easily tractable topic. Yet the two stories we have told can probably be modelled, and it is agenda to do it, with analytic and simulation tools.

More detailed empirical work is possible. We have made a distinction between the effects of the different phases of innovations on the need for training different categories of employees, engineers during the R&D phase, managers for the adoption (i.e. they should be competent any time !), and all the employees for the implementation. We have a breakdown of the hours of training and the number of trainees (France)[25] and of the training expenditures (Sweden) which should allow us to study in more detail the effects on the performance of the firm of the allocation of the training expenditures between these categories of employees[26].

Finally data on training expenditures and rates of return by sector could in principle be collected in France (in the panel dimension), and the strategic model of the race for competence be tested.

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[25] Expenses can be computed using wages.

[26] TAYMAZ [1992] has preliminary results for Sweden.

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Figure 1
The race for competence

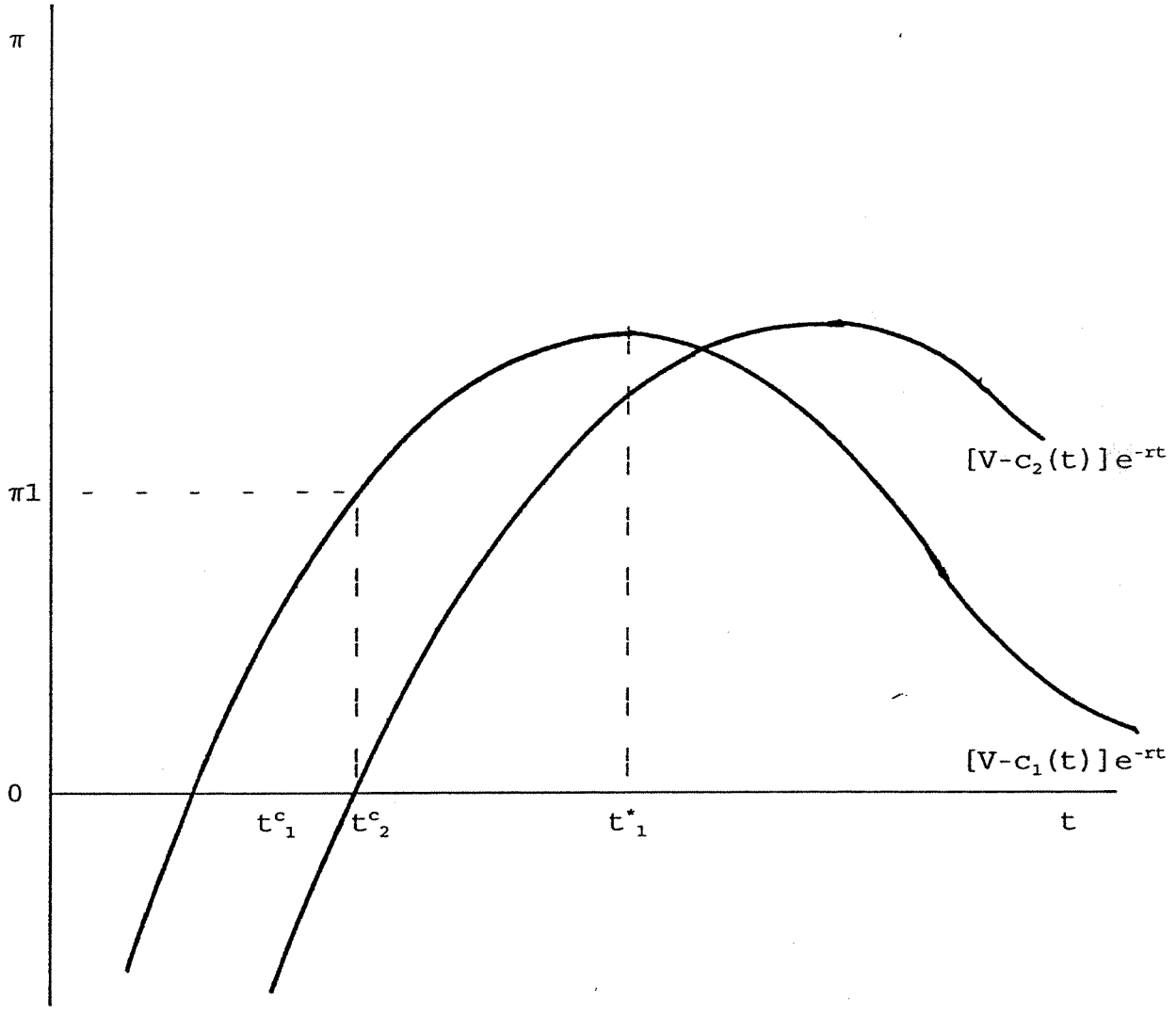
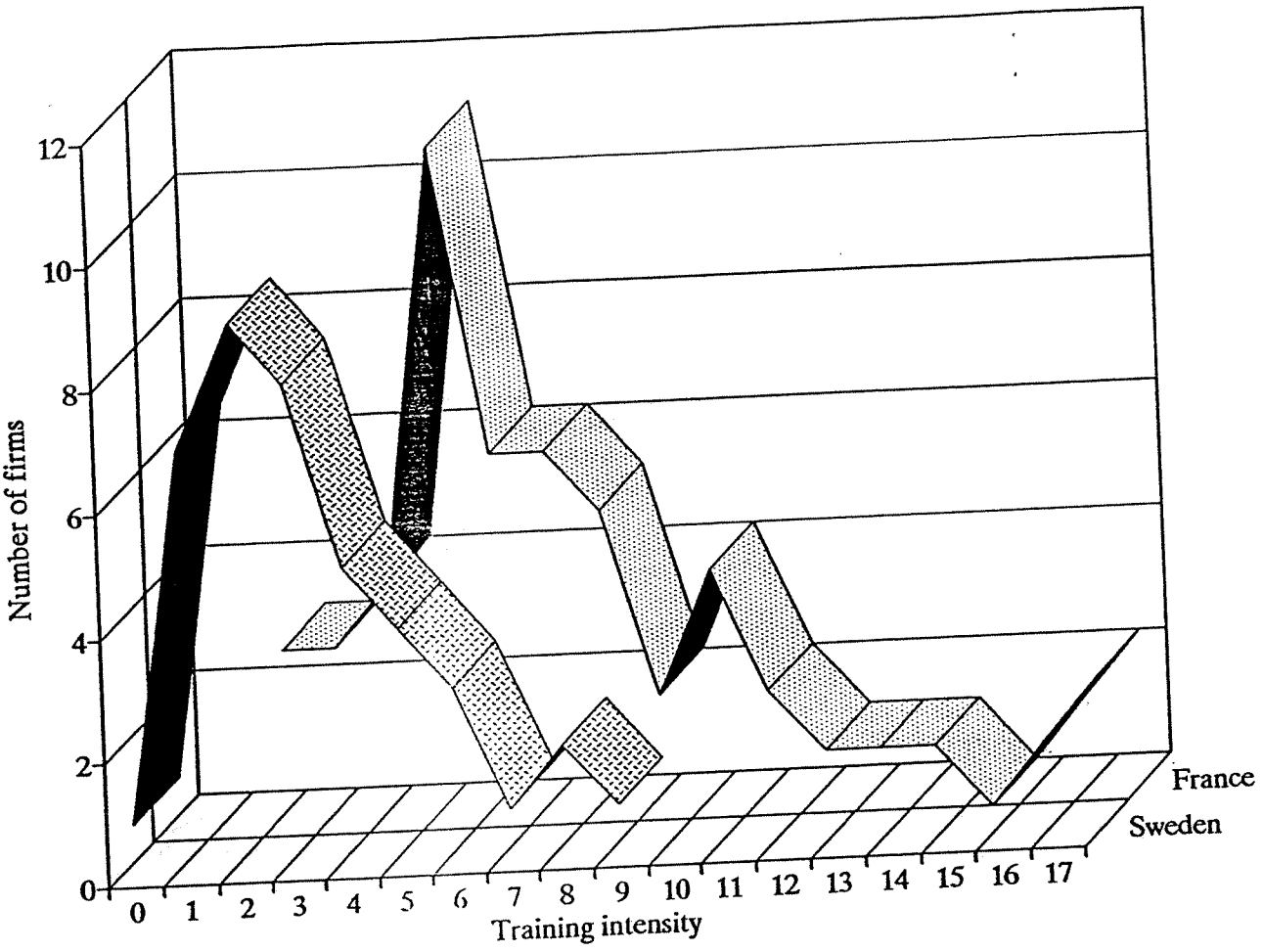


Figure 2
Training intensity in France and Sweden



France: 1000 FF per employee.
Sweden: 1000 SEK per employee.

Table 1
Variable definitions and some selected statistics

		Country					
		France			Sweden		
Variable	Description	Mean	Max	Min	Mean	Max	Min
RRTC	Rate of return on total assets	7.5	21.7	-17.5	11.4	41.7	-3.2
EDINT	Training expenditures per employee (thousand FF or SEK per employee)	7.2	17.5	1.8	3.4	9.4	0.4
EDSTOCK	Educational stock per employee (idem)	25	75.5	5.4	19.2	66.9	2.4
EDGROWTH	Growth rate of educational stock (%)	30.3	48.4	15.9	25.2	84.4	2.2
RDINT	R&D expenditures per employee (idem)	7.8	185.6	0	24.2	140.2	0
WAGE	Average annual wage rate (idem)	147.5	267.3	88.3	192.1	295.4	123.1
SIZE	Number of employees	4913.9	71600	579	1957.5	26153	56
PRODUCT	Labor productivity (k sales/employee)	1740.2	12185.5	381.3	1191.4	5128.6	468.3
AUTRAT	Share of employees on assembly line (%)	8.3	67.5	0			
AUTLEVEL	Proportion of automated production (%)				53.2	87.5	5.0
DIGIT4	Number of 4-digit sectors in the industry at (2-digit level)	8.7	28	1			
PDIVER	Product diversity (Herfindahl index)				0.9	1.0	0.2
NUMF	Number of firms in the industry	2950	16436	41			
GROWTH	Sales growth, 1988-1989	7.8	27.1	-26.6			
TENA	Average tenure (in years)	16.7	27.0	7.7			
PERWSH	Share of permanent employees (%)	90.1	96.2	80.2			
AGEM	Average age of managers	42.6	47.0	38.0			

Table 2

Determinants of Training Expenditures

Dependent variable: LEDINT (log of training expenditures per employee in 1989)

	1a	1b	2a	2b
	FRANCE		SWEDEN	
	OLS	SURE	OLS	SURE
RRTC	.015 ***	.024 ***	-.002	.003
	[3.42]	[5.73]	[-.22]	[.36]
RDINT	.0016 ***	.0019 ***	5.04 **	5.13 **
	[3.25]	[2.88]	[2.27]	[2.30]
LWAGE	.79 ***	.72 ***	2.01 ***	2.02 ***
	[5.35]	[4.97]	[4.43]	[4.42]
LPRODUCT	.20 ***	.18 ***	.04	.01
	[3.97]	[3.83]	[.18]	[.07]
DIGIT4	.0077	.0070		
	[1.21]	[1.14]		
PDIVER			-.09	-.10
			[-.20]	[-.24]
AUTRAT	-.01 ***	-.81 ***		
	[-2.71]	[-3.12]		
AUTLEVEL			.01 **	.006 **
			[2.10]	[2.02]
AGEM	-.047 ***	-.040 ***		
	[-2.81]	[-2.64]		
PERWSH	.02 **	1.44 **		
	[1.81]	[1.71]		
Constant	-3.10 ***	-2.73 ***	-10.12 ***	-10.2 ***
	[-3.10]	[-2.97]	[-4.49]	[-4.45]
R2	78.2		39.0	
Adj.R2	74.1		28.3	
F	19.25		3.63	
n	52	52	41	41
SSR	2.876	3.05	12.21	12.27

Note: *,** and *** mean statistically significant at the 10%, 5% and 1% level, respectively (1 tail)

Table 3

Determinants of the Rate of Return

Dependent variable: RRTC (rate of return on total assets in 1989)

	3a	3b	4a	4b
	FRANCE		SWEDEN	
	OLS	SURE	OLS	SURE
LEDSTOCK	6.73 ***	8.64 ***	-7.00 **	-6.18 **
	[3.70]	[5.03]	[-1.71]	[-1.71]
EDSTOCK			.37 **	.36 **
			[2.34]	[2.34]
EDGROWTH	11.64 ***	14.33 ***	2.72 *	3.53 **
	[3.38]	[4.60]	[1.38]	[1.83]
RDEDUC	.11 ***	.091 ***	.04	.02
	[6.68]	[5.93]	[.13]	[.08]
RDINT	-.46 ***	-.40 ***	-.16	-.16
	[-7.11]	[-6.60]	[-.19]	[-.19]
AUTRAT	.11 **	.14 ***		
	[2.16]	[3.01]		
AUTLEVEL			.04	.03
			[1.07]	[.91]
GROWTH	.21 ***	.17 ***		
	[2.63]	[2.44]		
TENA	.31 **	.26 **		
	[2.02]	[1.87]		
RELSIZE	.25	.19		
	[.26]	[.23]		
LSIZE			-.67	-.59
			[-.65]	[-.58]
LNUMF	.69	.57		
	[1.13]	[1.05]		
LLEDUC	3.19 **	2.06 *		
	[2.00]	[1.56]		
LPRODUCT			5.50 *	5.36 *
			[1.58]	[1.56]
Constant	-12.45 **	-12.94 **	-8.48	-8.43
	[-1.86]	[-1.95]	[-.34]	[-.34]
R2	45.9		28.7	
Adj.R2	32.7		10.8	
F	3.48		1.61	
n	52	52	41	41
SSR	1396.4	1446.75	2140.3	2150.1

Note: *,** and *** mean statistically significant at the 10%, 5% and 1% level, respectively. (t-test)