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A Cost-Sharing Model of Worker Training

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Virginia Stouffer

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Virginia Stouffer

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Government and industry have entered into new partnerships to jointly train their employees in work-related skills. These partnerships use cost-sharing arrangements based on convenience rather than efficient allocations. This paper revisits Gary Becker's theory of training and extends training theory to discuss the payoffs to firms, students, and employees from training, both on the job and student-funded. The paper discusses who should pay for wage-increasing training, considering local economic climate, the nature of the training (general or specific), job risk, and the rewards to training. Employers systematically profit from employee training and education and should pay accordingly. Employers gain returns on training from both increases in productivity and wage stagnation over several time periods following training. Firms reward employees trained in firm-specific skills with wage increases but do not reward general training, creating paradoxical incentives. An efficient cost-sharing arrangement for a government-industry training partnership is proposed based on the discussion of employer's wage and productivity premiums derived theoretically in the paper.

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LOGISTICS MANAGEMENT INSTITUTE
2000 CORPORATE RIDGE
MCLEAN, VIRGINIA 22102-7805

A Cost-Sharing Model of Worker Training

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Executive Summary

Defense funding has been falling for over a decade and further shrinkage is expected. While military training costs have lessened somewhat by having fewer people in active and reserve positions, there has been little relief from the vast variety of training subjects that must be taught, from the geographic diversity of the trainees, and no change in the method of labor-intensive recruit training. Additionally, training demands are changing. Fewer people in the force and lowered retention of experienced personnel means that trained personnel are needed in their units and have less opportunity to leave their units to obtain instruction. The Office of the Under Secretary of Defense for Personnel and Readiness recognizes that new solutions are needed to meet changing training needs under a still-shrinking budget and promotes new partnerships between military and nonmilitary organizations.

The number of military-nonmilitary training partnerships in effect now is an isolated few. To attempt to quantify the potential benefits of these partnerships, this inquiry into the incentives and economics of the partnership was undertaken. This paper offers the very first theoretical guidance on how to analyze partnerships and shows how the large upfront government investment can be recouped.

Generally, partnerships formed now are funded by ad hoc contributions. This is inefficient and will not encourage more partnerships. Building a model to determine partners' efficient contributions is the subject of our analysis. Key points about the model are as follows:

- Relative contributions should be driven by the degree to which each partner can recoup its training costs. Employers experience return on training investment from the increased productivity of their trained employees. Wage increases lag these improvements in employees' increased productivity. Employers' ability to capture the return on training investment depends on how long the trained employee continues to serve the employer, whether the training is specific or general in nature, how much the employee's wage increases lag behind training, and labor market conditions. Simply put, the longer the employee stays with the employer, and the

longer it takes wages to adjust, the more the employer can capture increased productivity increments to repay the cost of training.

- As an example of an application of the model, when two employers such as a military service and a commercial firm fund training, the military employer expects a longer period of service from its trained employee and so has more years to recoup training costs through increased productivity. The commercial firm will raise the wages of its trained employee more quickly. If the training is firm-specific, the commercial firm follows microeconomic incentives and gives a higher raise than if the training is general in nature. The balancing of these incentives across an equal number of employees determines the contributions each partner should make upfront.

As training partnerships become more common, it is expected that cost-sharing arrangements will begin to mirror firms' ability to capture productivity over wages, as part of the natural competitive process. Empirical evidence may be gathered at that time to test the theoretical derivations presented here. In the meantime, our model can assist analysts in evaluating training partnerships and guide the procedural and budgetary changes needed for governmental participation in competitive training partnerships.

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INTRODUCTION

Worker training is a common activity, and its role may be increasing as reasons for work-related training rise. Just as computers and new telecommunications have increased the pace of business transactions, worker training can be used to shift skilled workers more quickly from sector to sector in response to the evolving economy. As the economy grows more complex and supports more and more vocational specialization, worker training supplies the knowledge to accommodate specialization.

Simultaneously, the technical possibilities have expanded. With continuing new developments in communications, computers, and the Internet, new training possibilities arise constantly. Businesses that could not previously afford to offer training now take advantage of classes through intranets, the Internet, or shared electronic classrooms. Adults with little time to commute to school find that training and education can reach them at home or the workplace. On-the-job training has moved well beyond repetition and memorization as technological tools help people in virtually any profession to access information on the job, when they need it to do their work.

The procuring of training can be modeled as a transaction. Some of these transactions involve partnerships. Some traditional training partnerships are reviewed in this paper to provide examples. The impetus for this paper is the appearance of a new partnership, that of military and industry to offer on-the-job training to their service members and employees. This form of collaboration is interesting because it is new, it is likely to grow, and its potential is limited mostly by the ability of the military and industry to enact a transaction. Further, work is needed in this area to assist military planners in facing their training challenges.

The military-commercial pairing is a result of innovations in the training field. Advances in electronic technology have made this partnership viable. Military funding and training trends make it desirable. The partnership we model as a case study at the conclusion of this paper is an example of both cutting edge technology and emerging distributed training practices, and is being developed as a military-commercial service joint venture.

Defense funding has been falling for over a decade, and further shrinking is forecasted. While military training costs have been lessened somewhat by having fewer persons in active and reserve positions, there has been little relief from the vast variety of training subjects that must be taught, from the geographic diversity of the trainees, and no change in the method of labor-intensive recruit training. Additionally, training demands are changing because fewer persons in the force and lowered retention of experienced personnel means that trained personnel are needed in their units and have less opportunity to leave their units to obtain instruction. Increased sales of defense vehicles abroad means worldwide demand for trained maintenance technicians is increasing. The Office of the Under Secretary of Defense for Personnel and Readiness (USD[P&R]) recognizes that new solutions are needed to meet changing training needs under a still-shrinking budget and promotes new partnerships between military and nonmilitary organizations.

Usually, any sort of collaboration in training, whether industry-industry, college-industry, or government-government, involves an informal cost sharing born of convenience. This is inefficient and will not encourage more partnerships. Building a model to determine partners' efficient contributions is the subject of this paper.

Cost sharing among partners may be difficult to compute, compared to go-it-alone ventures. A nonpartnered entity computes the costs and benefits of training itself or its employees, knows exactly the cost of the training and its forgone alternative (for example, hiring another worker), and compares the alternatives to select the proper one for its internal rate of return. In the case of any collaboration, the costs are known, and the benefit to each entity is privately known, but the meting out of costs to effect the training is ad hoc.[1] This theoretical examination of cost sharing was undertaken in order to recommend more efficient partnership structures.

The bulk of this paper consists of a lengthy derivation of a cost-sharing model, starting with known theory and familiar examples, and gradually progressing to analysis of a new partnership. First we will examine the traditional training transactions, explaining in words how parties are trading. Traditional examples include nonemployment-related training. Then we turn to traditional economic training theory, as espoused by Gary Becker, and introduce our extensions on his work by the seventh equation. Our derivation is then extended further, by mathematically expressing cost sharing for some of the familiar, real-life training examples we have already prefaced. We introduce a theory of repayment completely different from Becker[2] in the subsection "Specific Versus General Training," and illustrate its application in two commercial examples. We then apply our theoretical derivations, now very different from Becker, to government training. In the penultimate sections of the paper, we take a real world partnership between a military service and a commercial firm and use our accumulated theoretical extensions to model efficient cost shares for each partner.

TRAINING TRANSACTIONS

Training is provided via transactions. Parties to those transactions are referred to here as partners. The simplest training transaction is the case of a student buying

[1] For example, a university may have the required facilities, and an office of a corporation desiring training may have $20,000 available in its budget. Often then the partnership agreed to has the university providing facilities and the office paying $20,000.

[2] As explained in his work, *Human Capital: A Theoretical and Empirical Analysis, With Special Reference to Education,* 2nd Ed., New York: National Bureau of Economic Research, 1975.

education or training from a school, college, or university. The student makes an up-front investment—in the form of tuition, expenses, time, and effort—in exchange for a higher level of wage over his or her lifetime that will exceed his or her investment in real and discounted terms.

A business makes a similar investment when it trains a worker on the job. The student invests effort; the firm invests worker time, tuition, and expenses. Generally the student can be expected to reap a higher wage over his entire lifetime, in excess of the cost of his learning effort. The reward to the employer for his investment is the output of a skilled worker, capable of producing more than the unskilled worker, over a period of time. The firm makes money on this trade because wages take time to adjust and the firm is able to enjoy skilled worker labor at an unskilled wage for some period of time following training, making the transaction cheaper than the cost of hiring a skilled worker. Additionally, the firm does not have to face uncertainty about the output of a newly hired skilled worker; instead, there is little uncertainty about the output of an existing employee.

When a student attends a college or university and obtains a university scholarship, the college or university is in effect paying the student or offering a rebate for certain students to attend that school. For that rebate, the school receives the prestige of adding a bright mind or brilliant athlete to its school body and continues to receive prestige for many years as the accomplishments of that individual are attributed to an alumni of that school.

In fact, there is already a partnership prevalent in many university educational processes and vocational college training: state funds. Government finds it a positive investment to help fund schools. Consider this the academia-government partnership. In the case of the university, there is prestige for the state associated with a popular school and/or good sports team, and a well-educated populace is both a source of civic pride and has a positive effect on state finances.

Vocational schools and community colleges also provide training and a step into a job for persons who would otherwise be underemployed or unemployed, both drains on the public purse. Marginally employed, seasonally employed, and unemployed persons can all be made better off by receiving training that leads to a better paying, more stable job. Community colleges also provide a step for persons who are unprepared for university study; it increases the public good and, indirectly, the tax base for states to provide money for education.

Employers often form partnerships with community colleges and vocational schools to train their workers. Partnerships can be either grants that allow the college to train all comers as potential employees of a firm or can be direct payments for facilities and/or teaching staff to teach existing employees specific skills. An example of the first is a car dealership that donates money, cars, and car parts to a local school. The school then trains all students who have purchased tuition, in car maintenance and repair. The firm gets a pool of trained applicants, and may get some information via the instructor about which applicants will make the best future mechanics. The school gets training materials from the dealer and public good "gold stars" for placing graduates in jobs, sometimes followed by support from the state purse. The student pays the tuition that pays for the class; in return, he gets a skilled labor position. In areas where there is only one employer, the subsidy of the dealership is greater, and the dealership in turn pays a depressed wage to its skilled workers. In other words, in areas where the firm's monopsony power is greater, the firm must pay more of training but also can reap more of the difference through greater worker marginal product and sticky wages.[3]

Employers also train their own employees rather than the whole workforce, and they train in-house, with consultants, and through schools. Training payoffs follow the same general incentive and payoff structure as the partnership with colleges and schools, as above, differing only slightly depending on whether the training is firm-specific or general in nature. To better examine those rewards and the decision among different firms to partner to produce training, we need a theoretical training transaction framework.

JOB-RELATED TRAINING THEORY

Employers' profit-maximizing incentive for training workers is to raise workers' productivity. Training may be specific to the firm or general in nature. This productivity improvement is usually followed by an increase in the workers wages. Gary Becker's theory of training indicates that employers will only pay for firm-specific training, since only firm-specific training can be exploited by the employer; otherwise, the employee could receive employer-paid general training and take it to a new firm, gaining an increased wage and foregoing the underpaid repayment period.[4]

Several caveats have been proposed to show that the firm will pay for training and education of a general sort: (1) general education has positive cross-products with specific training in producing additional productivity;[5] (2) worker training is cor-

[3] The firm must do more to train potential employees in rural or depressed areas because the basic level of education is lower to begin with than in competitive, technologically imbued labor markets. The depressed conditions correlating with an undereducated labor force also correspond to lower wages and a lack of other, large, technological employers. See Marcia Atkinson "Build Learning Into Work," *HR Magazine*, v.39, no. 9 (Sept. 1994), pp. 60–64.

[4] Gary S. Becker, *Human Capital: A Theoretical and Empirical Analysis, With Special Reference to Education,* 2nd Ed., New York: National Bureau of Economic Research, 1975.

[5] Jacob Mincer, "Job Training: Costs, Returns, and Wage Profiles," in Jacob M.M. Ritzen and David Stern, eds., *Market Failure in Training?* Germany: Springer Verlag, 1991, p. 17.

related with decreased worker attrition;[6] (3) wages are sticky and the firm can appropriate productivity gains after training is complete and before wages catch up.[7]

Rational employee behavior dictates that the employer can only underpay his newly skilled worker for some finite length of time before the employee seeks and finds a higher paying job, one corresponding to his new and higher productivity. In general, the marginal product of labor (*MPL*) equals going wage:

$$MPL_t = w \qquad \text{[Eq. 1]}$$

And in the spot market or at point of hire,

$$MPL_t = w_t \qquad \text{[Eq. 2]}$$

So when a firm trains a worker and his productivity is increased but pay does not adjust,

$$MPL_{skilled} > w_{unskilled} \qquad \text{[Eq. 3]}$$

over some period of time. Throughout this paper we refer to real wages and costs. Adding time, *t*, as a subscript, and letting subscripts *u* and *s* represent *u*ntrained and trained (or *s*killed), then the training story unfolds as follows.

$$Time = t = \{0,1,\ldots n,\ldots\infty\}$$

Equation 4 refers to the productivity of the untrained worker

$$w_{u,t=0} = MPL_{u,t=0} \qquad \text{[Eq. 4]}$$

$$w_{u,l} + K \cong MPL_{s,l} \qquad \text{[Eq. 5]}$$

The worker gets training in period *1*; *k* is the cost of training. Here, we are assuming the training payback period is one period; below, we examine the payback period and change this assumption.

$$w_{u,t} < MPL_{s,t} \qquad \text{[Eq. 6]}$$

[6] Michael J. Feuer, Henry A. Glick, and Anand Desai, "Firm-Financed Education and Specific Human Capital: A Test of the Insurance Hypothesis," in Jacob M.M. Ritzen and David Stern, eds., *Market Failure in Training?* Germany: Springer Verlag, 1991, p. 51.

See also, Marcia Atkinson, Sept. 1994, op. cit.

[7] Urs E. Gattiker, "Firm and Taxpayer Returns from Training of Semiskilled Employees," *Academy of Management Journal*, vol. 38, no. 4, (Aug. 1995), pp. 1152–1173.

Also, Jacob Mincer, op. cit.

The worker is underpaid for some period of time, $t>1$, such that,

$$\sum_{t=1}^{n} w_{u,t} + \sum_{t=n}^{\infty} w_{s,t} < \sum_{t=1}^{\infty} MPL_{s,t} \qquad \text{[Eq. 7]}$$

In other words, wages before adjustment with wages after adjustment never fully recompense the employee for his productivity.

Training occurs in period one, and the worker gets a raise at period n. Although classical economists theorize that training costs are completely netted out by near-term productivity increases, we submit that in the real world of monopolistic competition,

$$0 < (\sum_{t=0}^{1} MPL_{u,t} + \sum_{t=1}^{\infty} MPL_{s,t}) - (\sum_{t=0}^{n} w_{u,t} + \sum_{t=n}^{\infty} w_{s,t}) - k \qquad \text{[Eq. 8]}$$

i.e., the firm makes a residual profit off the training transaction.[8]

The employee will participate in training where it makes him better off:

$$\sum_{t=n}^{\infty} (w_{s,t} - w_{u,t}) = A, \quad A > e \qquad \text{[Eq. 9]}$$

where A represents the accumulation of a lifetime of the increments of higher wage.

The employee receives a higher wage over his entire lifetime, which exceeds the effort, e, needed to achieve the training objective. The working lifetime is presented as infinite.[9] If the worker receives additional training over time, the increases in salary and productivity are additive, shifting the individuals' supply curves upward with respect to hours of labor.

[8] Several empirical studies have found that productivity increases after training exceed the magnitude of post-training wage increases, substantiating that $MPL > w$, though it often is attributed to the presence of firm-specific training. See, for example, John H. Bishop, "On The Job Training of New Hires," in Jacob M.M. Ritzen and David Stern, eds., *Market Failure in Training?* Germany: Springer Verlag, 1991, p. 90; also Gattiker, op. cit.

[9] Since most training is given to younger workers, far from retirement, a worker's planning horizon may actually approach infinity. However, the firm's planning horizon is considerably shorter and will be defined in finite terms shortly.

Application of Theory to University Training

The cost of training to society consists of several cost components:

Cost of training = facility cost + administrative cost + instructor cost + learning materials + student psychological effort + student time

$$= fc + ac + ic + lm + e + t \qquad \text{[Eq. 10]}$$

Student's cost of training = tuition + learning materials + student effort + student time

$$= k + lm + e + t \qquad \text{[Eq. 11]}$$

While the student at a university bears a large portion of the costs of training, the worker on a job bears only the psychological cost. All other cost components are borne by the employer.

Employee's cost of training = psychological effort

$$= e \qquad \text{[Eq. 12]}$$

The rewards of university and job training to the learner are similar,

$$\sum_{t=n}^{\infty} (w_{s,t} - w_{u,t}) = A \qquad \text{[Eq. 13]}$$

though, clearly, the learner's rewards of self-propelled training, such as a university education, must be much higher, since the cost is so dramatically higher than the cost of training on the job. If we let ξ represent any nonmonetary premium, including psychological reward, then returns from university training, A_u, must exceed employee training returns, A_{ojt}, by an amount equivalent to tuition, learning material, and time. This concept is illustrated in the following two equations:

$$Students\ cost = k + lm + e + t = Au + \xi \qquad \text{[Eq. 14]}$$

$$Employees\ cost = e = Aojt + \xi \qquad \text{[Eq. 15]}$$

The rewards to the state from subsidizing university and college education can be expressed:

$$Reward = \rho + \tau \sum_{t=n}^{\infty} (w_{st} - w_{ut}) \qquad \text{[Eq. 16]}$$

where rho is the sum of the public good rewards such as prestige, educated populace, and positive area growth, and tau is the rate of taxation on income.[10]

Return on Investment

Several economists have quantified the return to training and found increased productivity substantially outstrips the cost of training.[11] Measuring return on investment is important because it is the basis of investment decisions and cost-sharing allocations.

Exceptions in Measuring Training Premium

How do we reconcile the model with the real world when additional education causes a person to accept a job earning less than he or she would have otherwise earned? A case in point here is educators. Persons who receive a Master's degree in order to teach schoolchildren usually earn a wage less than an uneducated skilled clerical worker or industrial worker could earn. The Ph.D. who chooses to teach physics rather than working for a successful defense company has chosen a smaller salary, a choice enabled by the additional education received. The problem is that these people have forgone monetary wages for psychological wages, which cannot be taxed but probably contribute to the state's public good reward.

Specific Versus General Training

According to Becker, firms will not pay for general education, because the returns cannot be isolated to that firm. An employee will not idly sit by earning a minimum wage after he or she has just completed his/her college degree, when the firm next door will pay twice the minimum wage. The employee will jump to a new firm and capture the increased returns. Any skills that can be used by another firm can be expropriated.

However, firms do pay for some general education. Several reasons have been suggested. Specific training is easier to absorb and dramatically more useful after general education. For example, it is easier and more effective to teach methods of

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[10] One could argue that state subsidization raises incremental income across the economy. The higher rate of college education in the United States over other countries ensures a ready supply of educated labor during periods of innovation-driven expansion. If the state did not subsidize universities, then fewer universities would exist and fewer persons would become college educated, causing labor shortages in high-technology fields, when expansion could otherwise have been accommodated, and causing slower economic growth in the country as a whole over an extended time. Clearly, the benefit of public subsidization of income has a huge effect on income for all individuals, such that it raises the level of the economy and floats all individuals' earning "boats."

[11] John H. Bishop, "On-the-Job Training of New Hires," in Ritzen and Stern, eds., *Market Failure in Training?*, op. cit.; Jacob Mincer, op. cit.; and Ann P. Bartel, "Employee Training Programs in U.S. Businesses," in Ritzen and Stern, *Market Failure in Training?*, op. cit.

single-piece axle forging when the employee already knows basic forging skills and practices. Education and training are employee morale builders that decrease attrition. And, as suggested earlier, the firm enjoys the higher productivity of a proven employee.

Another possible explanation, one that we will assume here, is that the firm does not have good information about content of general and specific training, and pays for general training by mistake. For example, a defense contractor teaches its employees about its own expense accounting procedures, unaware that since those procedures are based on the Defense Contracting Accounting Agency regulations, the information is capable of being expropriated by other defense contractors.

This paper will use a very narrow definition of specific training. Firm-specific training consists of training that the employee needs to perform an occupation at a particular firm, including identification of relevant employees, company procedures, writing formats, wayfinding, absorption of corporate culture, as well as the more obviously training-related skills of running proprietary software, filling company databases, and using company machinery within a company system.

Training for the occupation itself should be considered general, since it can be expropriated. Take for example the hypothetical duties of a bank teller. The duties of a teller at almost any bank include taking deposits, cashing checks, handling withdrawals, verifying customer identity, recording transactions, balancing the cash account, providing receipts, and interfacing with bank customers. The skills learned in performing these duties at First Union bank will transfer quite easily to Chevy Chase bank. Use of the particular software that each bank uses to record the transactions, the method of printing receipts, the position of the person consulted in case of unusual circumstances, procedures for checking cash drawers, even the amount of recordation the teller performs may all vary, and knowledge of those procedures should be considered firm-specific.

The line between general and specific training is hazy. The method for checking cash drawer balances may be the same at First Union bank and Chevy Chase bank, but different at Sandy Spring bank. In one case, the skills learned can be transferred; in the other, they must be relearned. It is easy to see that the firm may instruct its employees in general skills, believing they are specific. An employee conducting the training at Sandy Spring bank, having little other bank experience, may believe that some high percentage of the teller skills are unique to Sandy Spring when in fact they are not. When training a new employee with no previous bank experience, the bank may believe it is teaching specific skills, since they are skills required to perform that job at that location; but, with more information about teller jobs at other bank, the bank would realize that much of the training is general. It is not worth the effort to the employer to discover the extent of generality, however, since the firm is making a positive return on hiring and training an unskilled worker.

TRAINING TRANSACTION EXAMPLES

Industry should sponsor training because it increases the value of worker output while wages are sticky, so the firm is receiving greater output value from the worker than it pays out in wages. Generally, the adjustment in wages takes place after the cost of training has been repaid through the margin of productivity over wage.

This is the case where the firm trains the worker while the worker is employed. If the firm hires an employee already trained (i.e., experienced), then as long as the worker is informed, the worker gets his $MPL = w$; there is no period where productivity exceeds wage. The firm makes money from trained workers whose wages have not caught up, and that can take sometime. The *MPL* of the training worker is a gradually increasing line as he moves away in time from training.[12] Employees will figure out at some point after completing training that they can get a better wage now—they are "experienced"—and will force firms to equalize *MPL* and *w*. The *MPL* of an experienced worker equals w_s.

In the case where the firm arranges with a local university to train the unemployed, the firm does itself a disservice, because now it must hire "experienced" workers at a higher wage than if the firm hired them and trained them. The only advantage the firm gets back from having an outside party do pre-employment training is that the firm does not have to deal with uncertainty of training outcomes, and the firm does not have to pay for the labor hours consumed during training. We will look at a simple example using automobile mechanic training.

Example—Automotive Repair: College or In-House

A local General Motors dealership donates training material or money to a local vocational school on the condition that the school conduct auto mechanic courses every semester. The costs are depicted in Equations 17 and 18 and Table 1.

$$Cost\ of\ training = fc + ac + ic + lm + e + t \qquad \text{[Eq. 17]}$$

$$Student\ cost\ of\ training = k + e + t \qquad \text{[Eq. 18]}$$

[12] In fact, productivity increases after training and reaches a peak at some point on the job. If we described the absorption of the training with a differential equation, we could illustrate the surplus that the employer gets during the training and break-in period. This level of detail is left to the reader.

Table 1. Costs of School-Based Automotive Training

Party	Cost	Reward
Dealership	Donated training materials	Reduced hiring risk from larger, better labor pool
Student	Tuition, effort, and time	Higher wages
School	Facility and instructor	Tuition and intangibles

The result in terms of lifetime wages is

$$\sum_{t=n}^{\infty} w_{st} = \sum_{t=n}^{\infty} MPL_{st} \qquad \text{[Eq. 19]}$$

More specifically,

$$w_{st} = MPL_{st}, \ \forall t \qquad \text{[Eq. 20]}$$

The dealership in return faces a competitive pool of trained auto mechanics, to whom it must pay a competitive wage; the local Ford dealership and Chrysler dealership are also hiring out of this school. However, if the GM dealership gets recommendations from the instructors on student performance and gets first shot at hiring the students by virtue of its donations, then the return is somewhat higher. GM is then assured of getting the above-average mechanics, whose *MPL* may exceed their wage; whereas if GM had hired mechanics off the street, they would get average *MPL* for the average wage. So, in fact,

$$\sum_{t=n}^{\infty} w_{st} \leq \sum_{t=n}^{\infty} MPL_{st} \qquad \text{[Eq. 21]}$$

due to a risk-reducing adverse selection effect enabled by the training partnership.

If this same dealership hired untrained individuals and trained them, for example with some time in a classroom and then out on the repair floor, total costs would be apportioned according to Table 2.

Table 2. Non-School Automotive Repair Training

Party	Cost	Reward
Dealership	Training materials, variable facility costs, trainee wage time, and instructor/mentor time	Wage below *MPL* for *n* periods
Student	Effort	Higher wage in *m-n* periods
School	Nothing	Nothing

We enumerate the dealership's costs in this case, because we will need to refer to them later. Facility costs are preceded by a ratio, variable over total, expressing the fact that only variable facility costs are rightfully included here:

$$C_{dealer,non-school} = lm + \frac{v}{T} fc + ac + ic \qquad \text{[Eq. 22]}$$

Whether the wage exceeded *MPL* or *MPL* exceeded wage during on-the-job-training (e.g., the second scenario) would likely depend on the local labor market. If the market was tight, dealers might well hire unskilled persons at a full mechanic's wage, knowing there would be training. In a loose labor market, unemployed laborers may plead to be paid an unskilled wage while training to become a mechanic.

In fact, Ford does offer training to its employees and suppliers in a quality process known as Global 8. The tuition of taking the course online is $375; the tuition face-to-face is $750, which indicates, in this case, the facility cost is equal to the variable costs of instructor time and materials.

Example—Accounting Firms' Contracts

In another example, it is common for large accounting firms to arrange for pre-employment training, which is covered under an employment contract. The firm gets the trained worker at an untrained wage, guaranteed for a certain amount of time (e.g., 6 to 24 months.) Contracted training guarantees $MPL > w$.

It is easy to see that a firm has an incentive to train its existing, proven employees. It is less clearcut to see why a firm would pay for pre-employment training without a long-term contract. There are two rational reasons to pay to educate the unemployed: (1) risk; the skill set is unique and difficult and the uncertainty of students mastering the skills is large; (2) the firm is a monopsony hirer and does not have to pay the experienced wage to trained workers due to a local supply-demand imbalance. No other employer incentives exist.

For parties other than the firm, incentives to pay for training are as follows:

- The student pays a university or school for educational and vocational training because it raises his *MPL* and, thus, his wage, forever.
- The government pays (subsidizes) a university or school for "public good" reasons.

Government Training

If a government agency (in lieu of a school) provides vocational training for a worker, then the employer should pay the government agency. If a student is not an employee and receives training, the student pays for the training. If the student is an employee of the government and receives training, the student pays for training in the same way that industry employees do—the student pays for vocational training in labor hours, some guaranteed period of service in which the students' wage falls below his *MPL*. In this case, the government becomes like a firm because it is providing job training to its employee in exchange for a fixed time of performance where the individual student is paid less than his *MPL*.

Because government and industry have training needs in common, they may partner to produce training. Several arrangements are possible:

- government pays industry to train government employees;
- industry and government conduct joint training; or
- industry pays the government to conduct training.

There is no readily apparent real-life example for the final bullet above, though in a macro sense, the government ensures that the workforce is educated through public schooling; its reward is tax revenue on wages of all employees and tax revenue on the income of all firms.

The first bullet illustrates a common enough arrangement; for example, the government buys a new system and hires a consultant to teach its employees how to use the system. The second bullet, of sharing training and training technology, is the new entrant to the field of training partnerships.

Both the government, specifically a military department, and the firm have employer-employee relationships with the students. Both the military service and the firm will get the productivity differential:

$$\pi_{MPL} = \sum_{t=1}^{\infty} (MPL_{st} - MPL_{ut}) \qquad \text{[Eq. 23]}$$

Where π_{MPL} represents the firm's premium due to skimming marginal productivity, plus intangible additional productivity after wages have adjusted. Intangible productivity will not show up on any accounting sheet, since it has been "paid for" by equalized wages, but the firm still enjoys a more productive employee than before training, and it must realize some profit margin from the greater product and unchanged productive base.

Both the military service and the firm pay less than they receive in productivity:

$$\sum_{t=1}^{n} w_{ut} < \sum_{t=1}^{n} MPL_{st} \qquad \text{[Eq. 24]}$$

$$\pi_w = \sum_{1}^{n} w_{s,t} - \sum_{1}^{n} w_{u,t} \qquad \text{[Eq. 25]}$$

$$\Gamma = (\sum_{t=0}^{1} MPL_{u,t} + \sum_{t=1}^{\infty} MPL_{s,t}) - (\sum_{t=0}^{n} w_{u,t} + \sum_{t=n}^{\infty} w_{s,t}) \qquad \text{[Eq. 26]}$$

$$\Gamma_{tangible} = \sum_{t=2}^{n} MPL_s - \sum_{t=2}^{n} w_u = \sum_{2}^{n} w_s - \sum_{2}^{n} w_u = \pi_w \qquad \text{[Eq. 27]}$$

π_w and π_{MPL} represent the firm's premium from training on wages and marginal productivity, respectively. The premium from underpaying employees in the face of higher productivity is entirely measurable. The premium on productivity is not.

The military service in this case has a longer term contract. A first, basic stint in the military is 4 years, with multiple-year contract extensions possible. The government's "*n*" is further out; therefore,

$$\sum_{t=1}^{n} MPL_{s,t,mil} > \sum_{t=1}^{m} MPL_{s,t,ind} \qquad \text{[Eq. 28]}$$

And if productivity is improved by training in equal increments for employees of government and industry,

$$\Gamma_{mil} > \Gamma_{ind} \qquad \text{[Eq. 29]}$$

i.e., the military's "profit" on training is greater. The military is able to contribute a greater share of shared training costs than industry because the military can appropriate greater returns. The exact amount of cost sharing depends on how much of the returns can be appropriated. We will spend a little time developing our payback model and then turn to an example of sharing training costs.

Payback on Training

Becker lumps together the tuition, k, and forgone productive time in a cost of training for industry, C. He lets G refer to the excess of receipts (productivity) over outlays (wages) after training, equivalent in concept to our Γ;though Becker does not break out premium on wages and productivity, believing that wages adjust. Becker holds that

$$MP_0 + G = W_0 + k \qquad \text{[Eq. 30]}$$

i.e., that initial productivity plus the sum of future productivity increases equals the initial wage and the cost of tuition. Since MP_0 and W_0 are equal in Becker's assumed competitive world, future productivity increases are the payback for the cost of tuition. However, in the case of general training, workers are forced to pay for the cost of training by receiving lower wages:[13]

$$w_0 = MP_0 - k \qquad \text{[Eq. 31]}$$

Here our model diverges from Becker's. From our argument above, employees will only accept a lower wage, post-training, for a finite period of time. Becker allows for employees to accept a lower wage only in the case of general training, but he treats it as an exception to rational behavior, and it seems to be almost an afterthought in his notation system.

However, the firm is imperfectly able to distinguish between the two kinds of training. Following our previous arguments, the firm believes that most training is specific. Specific training should be repaid from increased *MPL*. Under sticky wages, we hypothesize that employees are being stuck with part of the bill. Sticky wages may be a systematic recognition of the fact that most training is general, a "peso problem" for wages. And in fact, much of the empirical payback literature asserts that productivity increases are as much as three times wage increments after training:[14]

$$3\pi_w = \pi_{MPL} \qquad \text{[Eq. 32]}$$

A small digression is in order here: from now on, we will use large K in our modeling to represent a firm's total costs, not just tuition, in job training. Adapting only slightly the dealer's cost of training a mechanic in a nonschool environment, from Equation 22,

$$K = lm + \frac{v}{T} fc + ac + ic \qquad \text{[Eq. 33]}$$

[13] Gary Becker, op. cit., p. 21.

[14] Stern and Rosen studies.

Following internal rate of return logic, the firm's investment in specific training results in higher productivity and should be repaid in higher productivity. An investment in general training raises an individual's productivity and employability, and it should be paid from delayed wage raises; any higher productivity is assumed to be small. In terms of our mathematical representation, with subscripts *g* and *s* referring to general and specific training,

$$K_g \leq \pi_w \qquad \text{[Eq. 34]}$$

$$K_s \leq \pi_{MPL} \qquad \text{[Eq. 35]}$$

Consistent with Becker, contrary to outside market forces, the empirical literature indicates that firms obey internal incentives and are more likely to give raises to workers receiving firm-specific training. The economic logic is that the firm wishes to ensure that the employee stays with the firm so that the firm can appropriate the increased productivity, and the firm offers an incentive. This is contrary to the general market, since the other employers will not give the individual a higher salary based on firm-specific learning. And it creates a perverse effect in the opposite case: when the individual receives general training, the firm is less likely to offer a wage increase, increasing the likelihood that the employee can find more lucrative wages elsewhere. (A mitigating case occurs when the firm does pay for the general training but requires further time in the job after training completion.)

This self-enforcing set of incentives gives a clear reason why firms try to avoid financing general training. The fact that the firm prefers specific training, whose returns lie primarily in increased productivity, over general training, whose returns lie in underpaying an employee for a finite length of time, indicates the far higher value the firm places on the intangible benefit of training.

Having delineated repayment schemes, we now turn to a real example.

A New Form of Partnering: Government-Industry Training

Introduction: General Motors

General Motors developed a new approach to training for automotive maintenance technicians, using distributed learning technology, a just-in-time application, and a new clustering methodology. The current embodiment of GM's efforts is housed in a wearable computer, so we refer to this project as the "wearable computer," though this moniker expresses so little of the content that it is like referring to the sport of baseball as "swinging sticks." Several offices of the U.S. military, including the Tank Automotive Command (TACOM), have expressed an interest in cooperatively using the new training approach, and efforts were made to co-develop an application.

General Motors developed this training methodology at considerable expense, but so far, its application has been limited to three Cadillac systems. The Cadillac application, while a significant technological accomplishment, is really just a test-bed, as the development and refinement of the methodology continues.

The government cost-sharing approach used involves a consortium of industry and government members. The consortium officially sponsors the research and functions as program manager and contracting officer in one. Employees of both GM and the military are assigned to the development project; the Department of Defense funds the bulk of the project, and GM contributes "in kind" funding. When complete, the two partners expect to have developed a training methodology, which includes training materials and distributed learning technology, that can be applied both to military vehicles and to civilian vehicles.

Type of Training

To GM, the training is currently firm-specific. The methodology, materials, and technology are legally protected assets, and information about them is restricted. If a GM employee trained in the wearable computer takes a job at another auto manufacturer, that manufacturer will be unable to use the training knowledge—lacking the technology, facilities, course materials, and methodology. The wearable computer training is not currently expropriable and, thus, falls into the category of firm-specific training.

To the U.S. military, the training has a taint of the general. Persons trained in wearable computer could get a new job at GM and use their knowledge. (We assume GM workers will not quit to join the military, since at the enlisted level this would entail a pay cut, and because there is little evidence that employees quit jobs in peacetime to join the services.) The technology may be spread among other applications in the military and become very general.

However, the training should have equal effects across military and GM in terms of increasing worker productivity. Training payback, according to internal rate of return, must satisfy:

$$\pi_{MPL} - K_{GM} \geq 0 \qquad \text{[Eq. 36]}$$

$$\pi_{MPL} - K_{govt} + \pi_{w} \geq 0 \qquad \text{[Eq. 37]}$$

$$\pi_{MPL,\ govt} = \pi_{MPL,\ GM} \qquad \text{[Eq. 38]}$$

Thus, we see that the military department already is capable of contributing more to the cost of training based on the fact that it is training its workers in a transfer-able skill, which it will not match with a pay increase. The military department has the power to hold down wages to pay for the benefit of this training.

GM is endowing its employees with greater firm-specific productivity and will, accordingly, pay them an incrementally higher wage, to incite the capture of the intangible productivity premium. If it holds true that firms reap in productivity a premium three times by that which they reward their employees in wages, and we assume that this pay raise lowers the premium firms receive in productivity, or at least extends the repayment period, then

$$\pi_w = x; \; \pi_{MPL} = 3x \qquad \text{[Eq. 39]}$$

$$\pi_{MPL} + \pi_w \geq K_i, \; i = \{GM, govt.\} \qquad \text{[Eq. 40]}$$

$$\pi_{MPL} \geq K_{GM} \qquad \text{[Eq. 41]}$$

because π_w at GM is zero. But military employees forgo their wage increase:

$$\pi_{MPL} + \pi_w \geq K_{govt} \qquad \text{[Eq. 42]}$$

As a result, the payments balance appears to be

$$3x \geq K_{GM} \qquad \text{[Eq. 43]}$$

$$4x \geq K_{govt}$$

$$\sum K_i = \frac{4}{7} govt \; payments + \frac{3}{7} GM \; payments \qquad \text{[Eq. 44]}$$

In other words, the military should pay for a greater share of training costs simply because it does not reward its workers, as GM does, for firm-specific training. Taken in conjunction with the military's longer enforceable repayment period, the share of military payments grows further, as derived below.

Working from our previous definition of Γ (Equation 26):

$$\Gamma = (\sum_{t=0}^{1} MPL_{u,t} + \sum_{t=1}^{\infty} MPL_{s,t}) - (\sum_{t=0}^{n} w_{u,t} + \sum_{t=n}^{\infty} w_{s,t}) \qquad \text{[Eq. 26]}$$

we shorten this expression to capture the period up to industry's wage adjustment time, *m*, because this is the time period in which the firm's premiums are being extracted:

$$\Gamma_{ind} = (\sum_{t=0}^{1} MPL_{u,t} + \sum_{t=1}^{m} MPL_{s,t}) - \sum_{t=0}^{m} w_{u,t} \qquad \text{[Eq. 45]}$$

We are continuing to express quantities in real terms, and ignore that employers continue to extract premiums beyond m by lagging pay adjustments behind inflation experience, so that the premium never really goes to zero. Under current assumptions the unskilled wage rate is equal to unskilled productivity:

$$MPL_{u,t} = w_{u,t} \quad \text{[Eq. 46]}$$

$$\Gamma_{ind} = \sum_{t=1}^{m} MPL_{s,t} - \sum_{t=1}^{m} w_{u,t} \quad \text{[Eq. 47]}$$

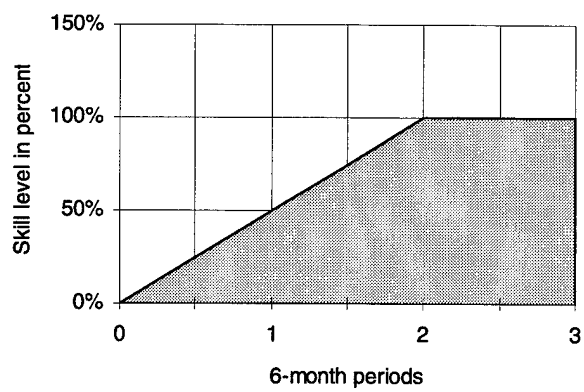
$$\Gamma_{ind} = (m-1)(MPL_{s,t} - w_{u,t}) \quad \text{[Eq. 48]}$$

We can similarly derive the premium for the military:

$$\Gamma_{mil} = (n-1)(MPL_{s,t} - w_{u,t}) \quad \text{[Eq. 49]}$$

Turning again to our specific example, we can hypothesize real values for m and n and derive a new payments sharing balance. In this case, we assume that formal training takes place over 6 months, and the employees are allowed to rehearse with the tool for an additional 6 months. During that initial year, employees' productivity rises on a gradual slope from unskilled to 100 percent skilled. The shape of the slope is not important here; we can assume that if we calculated the increase in productivity that occurs over the two periods, it would equal a 50 percent skill rate (see Figure 1); this is represented in our notation with period 1 productivity at an unskilled level and period 2 at a skilled level.

Figure 1. Employees' Productivity Increase in Periods One and Two



Setting t=6 months, we postulate that the basic length of service for an enlisted soldier is 4 years, so m=8. But a competitive firm cannot retain its labor force without adjusting wages once each year; assume in this case that GM can reap back its investment in 1 year and adjusts wages in period 3. Letting x represent here the basic one-period increment of *MPL* over wage, we find:

$$\Gamma_{GM} = 2x \quad \text{[Eq. 50]}$$

$$\Gamma_{mil} = 7x \quad \text{[Eq. 51]}$$

$$\sum K_i = \frac{7}{9} govt\ payments + \frac{2}{9} GM\ payments \quad \text{[Eq. 52]}$$

Compared with Equation 44, taking repayment periods into account leaves the military paying for an even greater fraction of the training costs.

CONCLUSION

As a direct result of the imbalance in the own-firm-specificity of shared training, the military should pay more up front for development, based on the fact that it can recover these costs from their employees' increased productivity and lower wages. Once this technology becomes widespread, however, the balance of payments shifts and military's increased share of payments would depend solely on how far out its n is in relation to its industry partner. As the ability to write partnerships matures, it is expected that cost-sharing arrangements will migrate to mirror the partners' ability to capture productivity over wages. Firms' own cost-minimization incentive provides the motor to drive firms to pay no more than they can expect to recoup.

The above analysis reflects training costs for an approximately equal number of trainees from each partner. It should be possible for military services to change the balance of payments by teaming with industry partners who have more persons to train, or teaming with multiple partners. Additionally, if the military service teams with several industry partners, for instance three automakers, the industry training will be more general and the commercial firms will be inclined to extract a wage premium. In this last case the military service will pay close to one-quarter of total training costs, and slightly more than industry on a per-trainee basis.