

# Matching Workers With Jobs Through Intermediaries: Incentives and Effects

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Over the past twenty years firms have begun to hire through contractors for both high and low-skill positions. Current research suggests that this trend is spreading rapidly, transforming our labor market into a spot labor market. Some suggest that the primary firm incentive behind this trend is lowering compensation costs. This paper examines a theoretical model of the incentives to use job-matching intermediaries, using empirical evidence to both ground and assess the model. Results suggest that the trend has more or less stabilized in most occupations and that there are many incentives in addition to compensation to outsource. In particular, the paper finds that incentives differ across occupations, with compensation playing a greater role in some occupations than in others.

## 1 Introduction

In recent years popular discourse has suggested that the labor market is moving towards a spot labor market, or a market in which labor contracts are constantly renegotiated. This transition could happen through many different mechanisms. One way is through firms employing intermediaries to negotiate short-term contracts. We might think of these intermediaries as temporary help agencies, hiring out their workers' labor to other firms, or even technical consulting services, that contract their workers' specialized skills for short periods. Many hypothesize that the primary incentive to enter these types of arrangements is the potential savings on labor costs as evidenced by lower salaries and fewer benefits for contracted workers, particularly in low-skill occupations (Houseman et al., 2003a; Kalleberg et al., April 2000). There are many difficulties in this research, first in determining the extent of the trend itself and second in determining the incentives behind the trend. Understanding these incentives and trends is vital to predicting the ultimate trajectory. There are two main obstacles. The first is that there

is simply insufficient data. As we will see in the empirical section, different methods can lead to wildly different descriptions of the trend. Second, as qualitative work has already suggested, the entire process of outsourcing, from firms' incentives to workers' incentives, to the overall incidence of outsourcing, and the consequent compensation gaps, might be a different phenomenon in different occupations.

The evidence collected on the firm side of the labor market suggests that outsourcing is growing rapidly. In the past decade, firms increased their purchases of services more than they increased direct hires, meaning that fewer services are produced within the firm. Consequently, business services grew at a rate of 5.8% every year from 1988 to 1997, twice the rate of the rest of the economy (Clinton, 1997)<sup>1</sup>. The fastest increasing sub-sector within the business services category is the temporary help industry (largely clerical), which grew 11 percent annually from 1979 to 1995, five times more quickly than all other non-farm employment (Autor, 2000). While these numbers are very impressive, it is difficult from the firm side to detect what the true extent of outsourcing is. For example, one paper asserts that "more than 90 percent of the cleaners in business services were employed through establishments which provide services to dwellings and other buildings" (Clinton, 1997). This sounds as if 90 percent of cleaners are outsourced, but the denominator actually excludes cleaners at schools, universities, and retail establishments—the largest employers of janitors. Estimates including these workers suggest that less than a fifth of cleaners are employed indirectly and that the proportion in indirect employment is stable. Self-employment confounds these measures even more as do employees in ambiguous contexts, working partially at the contractor's site and partially at the client's site (Kunda et al., 2002). This study empirically estimates the level of outsourcing over time using both employer-side and employee-side data, and models the spread of outsourcing contingent on various organizational incentive schemes.

There are many hypothesized incentives to outsource. Some argue that firms save on compensation by reducing returns to tenure<sup>2</sup>. Weakening the link between employers and workers (a spot labor market) can allow firms to continue to pay lower wages initially, during the period where they assess the worker's unobservable skills and the quality of the match. The firm can then offer permanent employment, rather than higher wages (or returns to tenure),

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<sup>1</sup>"Business Services" is a Bureau of Labor Statistics category including advertising and public relations services, computer system design and related services, employment services, management scientific and technical consulting services, and scientific research and development services.

<sup>2</sup>See (Gibbons and Murphey, 1992) for theoretical background and (Medoff and Abraham, December, 1980) and (Medoff and Abraham, Spring, 1981) for empirical evidence on the career model of compensation and returns to tenure exceeding the worker's returns to firm specific skill and match quality.

as an incentive. Researchers have found returns to tenure can range from 10% (Topel, 1991) to zero (Abraham and Farber, 1987). In contrast, in the high-skill labor market some argue that firms *underpay* direct-hires, using indirect employees as a stop-gap while searching for permanent employees willing to accept lower wages (Houseman et al., 2003b). Further, contracting could hypothetically match workers and jobs more efficiently (Katz et al., 1999). Other hypothesized outsourcing incentives include maintaining a flexible labor force, testing low quality or risky workers, contracting infrequently demanded specialized skills, decreasing search costs, and increasing employee-job match quality. In addition, in high-skill positions, outsourced workers might be more productive working with their co-occupational peers (i.e. programmers working together to customize software for multiple clients will produce a better product than individual programmers customizing software at individual firms.) The same economies of scale might exist in accounting, where in 2004 already one-quarter worked for accounting, tax preparation, bookkeeping, and payroll services. Perhaps the most overlooked incentive is that firms *can*. Changes in computing and human resources technology mean that firms can closely monitor work effort, assign tasks to workers on-the-fly, and match workers and jobs more quickly. There are also many hypothesized disincentives including the importance of firm-specific skills, intermediaries' fees, large firms' ability to internally smooth labor consumption, and union regulations prohibiting outsourcing.

One of the most-mentioned incentives is that outsourcing allows firms to reduce compensation costs, particularly the cost of health insurance. In the United States this incentive is embedded in our tax structure. There are federal tax incentives for businesses to provide *equitable* benefits. Firms can use outsourcing to simultaneously access these tax incentives while denying some workers health insurance<sup>3</sup>.

Despite claims that outsourcing is a function of firms trying to evade compensation, the empirical evidence has mixed findings about whether firms actually save money on compensation with some case studies actually finding that on-site outsourcing can be a net loss (Benson, 1999; Young and MacNeil, 2000; Mayall and Nelson, 1982; Mangum et al., 1985). At the same time, some studies find firms with higher wages are more likely to contract out

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<sup>3</sup>US Code Title 26, subtitle A, Chapter 1, Subchapter D, Part I, Subpart A, Section 401 a(4) states, if the contributions or benefits provided under the plan do not discriminate in favor of highly compensated employees (within the meaning of section 414(q)). For the purposes of this paragraph, there shall be excluded from consideration employees described in section 410(b)(3)(A) and (C).

This section of the US code says that if an organization offers benefits to only the top 20% of its paid employees, or only to those employees paid more than \$ 50,000, their expenditures on pensions, health insurance, and life insurance will be taxed 25%.

work, suggesting a compensation-related incentive (Abraham, 1990; Gramm and Schnell, 2001) while others find no relationship at all (Deavers, Fall 1997; Davis-Blak and Uzzi, 1993). From the employee's side, in some occupations outsourced workers receive fewer benefits and lower wages; some argue this is because workers with alternative sources of benefits gravitate towards contract work where they can cash out their benefits in the form of higher salaries (Houseman et al., 2003b), while others argue it is because the workers are less skilled, imperfect substitutes, while still others argue that these indirect relationships are a tactic to depress compensation for equally skilled workers.

Most of the work on outsourcing is empirical, estimating the number of outsourced workers, which firms are most likely to outsource, or the size of firms offering job matching services. The data is generally flawed, either counting from the employer side using gross approximations, or from the employee side using mistaken self-reports, and for both sides ignoring contracting masquerading as self-employment. For this reason, I take a new approach, using an agent-based model to predict the final level of jobs that would be matched to an employer through an intermediary depending on different labor market scenarios, and comparing these levels to empirical estimates.

Methodologically, this paper follows the tradition of matching models more than the outsourcing literature. The model is based on the Gale-Shapely marriage matching algorithm (Gale and Shapely, 1962), in which men and women rank each other as possible mates; then boys propose to their highest ranked girl; if they are rejected, they propose to their second choice, and so on. Girls accept proposals if they do not already have a partner or if the new partner is preferable to the old. This algorithm finds a stable solution where everyone is matched and no unmatched pair would rather be with each other than their current partner. The solution is optimal for men and pessimal for women with men matched to their highest ranked feasible partner and women to their lowest. In this model, companies are equivalent to men making offers to workers instead of potential mates.

There are several labor market models using similar models. The most similar is Stovel and Fountain (2003), which combines explores Granovetter's "strength of weak ties" theory (Granovetter, 1973), testing whether workers are most likely matched to their jobs through their close friends or acquaintances ("weak ties"). Stovel and Fountain test how the shape of a social network limits information in the labor market and affects the quality of worker-job matches. Leigh Tesfation also used an extension of Gale-Shapely in an agent based model, testing whether the ratio of jobs to workers or of firms to workers is more important in allocating negotiating power between firms and workers (Tesfation, 2001). In another paper, Tassier and Menczer

used social networks in a job matching model similar to Stovel and Fountain's (Tassier and Menczer, 2001, 2005). Their first model examined how networks evolve through job matching while in the second they assessed how employment rates vary between social groups as a function of their networks. Other models use job matching algorithms to examine frictional unemployment rates (Hosios, 1990) and explore many to one matching (Echenique and Yenmez, 2005), or in wage posting games (Montgomery, 1991; Peters, 1991; Shi, 1998).

## 2 Model Description

This model describes the spread of intermediaries in four US occupational labor markets, (all workers, minimum wage workers, accountants, and programmers). The model is laid out on a 2-D grid with four types of objects: firms, jobs, workers, and contractors, with firms and workers in fixed locations. Experiments vary 6 parameters controlling outsourcing incentives. Included (dis)incentives are: intermediaries' ability to screen more workers, their relative labor and matching costs, and workload variability. Firms decide to outsource vacancies initially when they have persistent vacancies and later based on a comparison of their utility from intermediary matches compared to direct matches. This utility is based both on match quality and labor costs. The primary output is the level of outsourcing in each scenario, although the model also measures the unemployment rate, vacancy rate, firm utility, and job and vacancy duration. The model's algorithm is illustrated in figure 1. First workers, firms, and jobs are created. Then workers are matched to jobs using a variation of the Gale-Shapely algorithm. Next, workers and jobs suffer separations, and finally all the contractor arrangements are updated. Then the model starts the process all over with the unmatched workers and jobs.

INSERT FIGURE 1 HERE

In the standard run there are 1000 workers and 138 firms. Jobs are assigned to firms in a skewed distribution with most jobs at a few firms but no firm having more than 10% of the jobs. Workers are created with skill levels following four empirical distributions of education (overall labor market, minimum wage labor market, programmers, and accountants) and are assigned a skill floor (as a uniform deviation below their own skill levels) for the worst job they would take. The educational distributions used, from BLS and CPS data, are depicted in figure 2. Jobs are assigned skill levels and floors using the same methods. *Workers* have a location, employment status, an employer and a contractor (if outsourced), the date they were last

employed (if they are unemployed), an inherent tendency to quit, and their relative outsourced wages (when employed by a contractor- this is reassigned each time they are hired through a contractor). *Firms* have locations, jobs, vacancies, contractors (if they are outsourcing), employees, and their current and past utilities. *Jobs* have skill levels and floors, the firm they are located at, an employee (when they are filled), and dates marking the last time the job was filled or vacated. *Contractors* have assigned jobs, workers, vacancies, fee rates, revenues, and matching rates.

#### INSERT FIGURE 2 ABOUT HERE

When the model initializes, all workers are unemployed, all jobs are vacant, and there are no contractors. Workers sort through vacant jobs, calculating the distance to each job, applying to closer jobs with a higher probability. Jobs hiring through contractors seem closer to the workers and thus distant workers are more likely to apply to them than equally distant direct-hire jobs. High-skill workers also search in a broader radius than low-skill. When any worker is adjacent to a job they apply with a 100% probability; at the furthest distance across the grid, a graduate trained worker has a 7.7% chance of applying to the job and a high school educated worker has a .09% chance. Next, firms rank applicants based on the match between the vacant job's skill and the prospective employee's skill, and then offer the job to their top applicant. Workers accept tentatively if they are unemployed and if the job exceeds their skill floor. Firms can make offers to workers with tentative jobs, with the worker comparing the two jobs and taking the better match. Firms have four chances to offer jobs to applicants in a single hiring round, leaving some unemployment and vacancies. (If the stock of jobs were not constantly changing, there were no skill floors, and the offer process iterated more than 4 times, pairings would be stable.) After workers and jobs are matched, there are quits and fires. Workers are more likely to quit if they are very overqualified for their jobs and if they have an inherently high quit propensity (a constant personal trait that could be considered to incorporate marital status, age, educational debt, etc). When a worker "quits" he may be matched with the same job in the next round since both re-enter the matching pool. As such, "quitting" is more like "keeping their eyes open." Firms fire workers when they suffer random workload shocks, either adding or removing jobs. These shocks are not correlated across firms and when a big employer suffers a negative shock, the unemployment rate is strongly affected. When firing, firms first remove vacant jobs, then contracted jobs, and finally direct-hires. They fire workers without respect to tenure or match quality.

After matching and separations, the model updates contractor dynamics. Up to two new contractors can be born in a single model step. The first is

created if there is a high vacancy rate and another if there is high demand for existing contractors (competition). This represents a sort of continual, but spotty latent supply of contractors since these contractors are randomly placed on the grid and usually die. The new contractors are allowed to survive for less than 1% of the model duration (presumably on startup capital) before they are forced to meet a revenue threshold. Because contractors are continually born and because each contractor has a different number of clients, the number of contractors is not representative of contracting trends but is representative of the service availability. Firms decide to use intermediaries in two ways. First, they outsource persistently vacant jobs. If it is their first outsourcing experience, they choose the contractor with the best matching rate in their vicinity.<sup>4</sup> If the firm has experience with intermediaries, it continually compares its utility history from direct versus indirect hires. If contracting utility is higher, the firm outsources new vacancies and if it is lower, they match new vacancies in house. The firm continues to use the same contractor until it either removes its last outsourced job from the contractor or the contractor goes out of business. If the contractor goes out of business, the firm finds a new contractor, and partially uses its history with the earlier contractor to make decisions about future outsourcing. Finally, outsourced jobs that have been filled by the same worker for more than four periods become direct hires.

### 3 Outsourcing Without Compensation Incentives

The first experiment examines a trade-off between one incentive and one disincentive: intermediaries' ability to sort through more workers and their fees. In this experiment wages are constant, independent of using intermediaries. The experiment finds that non-wage incentives are sufficient to encourage outsourcing. There were two main parameters controlling these dynamics. First, I varied a parameter that controls intermediaries' ability to screen more workers when making a match. This parameter makes intermediaries' jobs appear closer to workers, and thus, more workers apply to these jobs, and allowing the intermediaries to make better matches. This parameter ranges from 1.0 to .1, where the worker sees a contract jobs with the same probability as a regular jobs at 1.0 and where the contract job appears twice as close at .5. The model poses a trade off where the firms pay the intermediaries. The second parameter sets contractors' fees, ranging from 5 to 35% of the employee's skill level. I ran all combinations of parameters 20 times, measuring the proportion of jobs using intermediaries at each setting. The consequent transition to using intermediaries using three different parameter settings is illustrated in figure 3 and the final proportion of jobs outsourced at

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<sup>4</sup>Firms do not have full information about contractors, ignoring their matching *histories* and fees.

all parameter settings is illustrated in figure 4. While practically the curves are close, the levels are significantly different from 100 ticks into the model and on.

#### INSERT FIGURES 3 AND 4 HERE

The transition plot, figure 3, shows that the transition to using intermediaries is rather abrupt, not a traditional S-curve. Rather, as soon as the intermediaries are available, firms rapidly adopt, with the transition happening early on and then rapidly leveling off. When outsourcing is most appealing (with lower fee rates and greater search radius enhancement) the transition is quicker, as we would expect. This pattern is mirrored in the empirical data, suggesting that firms rapidly adjusting to the new contractual options. The contour plot, figure 4, illustrates the final proportion of jobs matched through intermediaries when holding other parameters constant (constants are specified in the appendix). Higher intermediaries' fees discourage outsourcing while intermediaries' ability to screen more applicants increases it. Even when there is no positive effect, and high fees, firms still use intermediaries over 25% of the time. This is because firms constantly assess their utility from matching workers. With no matching advantage, contractors will find a better match %50 of the time (and a worse match %50 of the time). In fact, with no matching advantage and no fees, if the temp to perm parameter were removed, about one half of all jobs would be through intermediaries. This happens because firms look at a history of random noise, and conclude that their contractors are doing a better job than they could. In some sense, this is realistic; firms often make myopic decisions based on their experiences. Some sort of utility threshold could temper this effect. For example, perhaps firms will only outsource if their outsourcing hires have been much better- perhaps because it is more administrative hassle or perhaps because of the importance of firm-specific knowledge. However, even including this threshold, the trend would be the same while the absolute level would decline. Without any justification for a threshold, the model assumes that firms myopically interpret their experience, ignorant of the fact that true expected utility from an indirect hire might be identical to that from a direct hire. Looking at figure 4 it is clear that outsourcing levels at the end of the model vary as one might predict, decreasing steadily as fees go up and increasing as match quality increases. As parameter settings move towards the most attractive outsourcing scenarios, there are few early pockets of more outsourcing, and a small pocket of low outsourcing. Overall though, the relationship is monotonic with the pockets not deviating more



than 1.5 percentage points from the surrounding area.<sup>5</sup>

Other model outputs behave as anticipated. Firms gain utility as they outsource, increasing 37% with medium search enhancement and fee settings and 100% with the lowest fees and highest search enhancement. Utility gains are not monotonically related to parameter settings, with a contour plot (not illustrated here) showing some discontinuities in utilities when radius enhancements are low but fees are in middle range. Outsourcing is also associated with lower unemployment, primarily because outsourcing gives hard-to-match jobs and workers a better chance to find a match. The effect is significant though small, when there is a nine point increase the percent of jobs outsourced, unemployment declines almost a full percentage point. With respect to skill, contractors were more likely to match slightly less skilled workers while the model design would suggest that they would match workers at either extreme of the distribution.

There were several important findings from this experiment. The most important was that firms making decisions on their past experiences, can misinterpret accidental good placements and continue to pay more for intermediaries, even if globally the expected value of an outsourced worker is identical. Second, *when* intermediaries actually have better matching abilities, they can improve firms' utilities and reduce frictional unemployment. Finally, firms do not need compensation incentives to outsource more. This does not mean that in the real world this is not a concern (the empirical work later in the paper shows that outsourced workers often earn lower wages and receive fewer benefits) but does show that there are other plausible incentives.

## 4 Incentives by Occupation

While the first experiment focused on firms' decisions to use contractors in the absence of compensation incentives, the second experiment looks at how incentives could vary across occupations. This experiment leaves the two parameters from the first experiment (contractors' fees and match quality) as fixed, instead varying workers' compensation, firms' workload fluctuations,

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<sup>5</sup>There are several dynamics in the model that could generate this. For example, when the firms start using contractors they have better matches, which is good for them. But with worse matches firm could make up for this with turnover, their bad matches were likely to quit, and then they could screen more applicants, slowly finding the best employee. With an intermediary they will find a better match sooner, but could get stuck with a worker who's not a great match, but not so bad that they will quit. We can think of this almost like getting stuck in a local maximum. Of course this is just one theory. In a complicated model we expect the gradient to be perfectly linear because of interactions like the one just outlined.

and the worker and job skill distributions.<sup>6</sup>

Four cases representing four hypothetical occupational scenarios from the 72 experiments run are outlined in table 1. These scenarios are roughly based on empirical data. For example, the skills distributions used for the four cases are taken from the Bureau of Labor Statistics and CPS data. The second parameter, indicating the wage premium (or penalty) for an indirect hire, is based on the empirical wage gap between indirectly and directly hired workers (see the empirical section). We treat this wage gap as a premium since evidence suggests that it cannot be explained by outsourced workers' different characteristics (education, work locations, age, or work effort). The third parameter, the variance of the second parameter (the gap), is the most difficult to set based on empirical evidence and uses a normal distribution based on the empirical distribution of the raw wage gap. Empirically, the standard deviation of wages is highest for high skill occupations and lowest for low (in the 2006 CPS accountants had the highest wage variance, then programmers, then clericals, and then janitors.) In contrast, using log wages there is the exact opposite ranking. Since the model calculates raw wage premiums, the raw variance ranking is used in our hypotheses, though all conditions are tested in different runs (see the appendix). Overall, the wage variance setting had no significant effect on outsourcing levels. The last parameter, work variability (or firm shocks), is difficult to estimate empirically. Less educated occupations have more variable work hours (CPS data suggests that janitors have the most variable work effort, then clerical, then accountants, and finally programmers) but hours worked is not a good indicator of a firm's fluctuations. Looking at changes in workers' total hours across the economy by year, accountants have had the most variable hours, then programmers, then low skill workers are the most constant (BLS, 1988-2004). In the simulation there are just two parameter settings, and I hypothesize that the middle level of work variability applies to most occupations and the low one applies to accountants.

INSERT TABLE 1 HERE

Hypotheses and predictions are highlighted in table 1. Theoretically minimum wage workers are the most likely to be outsourced because first, there are compensation savings for the firm and because there is a wide skill distribution, meaning that contractors (having broader search radii) can improve match quality. In contrast, accountants should be the least outsourced since there is a small compensation gap, low workload variability, and a narrow skills distribution, meaning that the firm is capable of finding a good match

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<sup>6</sup>There were also some minor programming changes between the two experiments, detailed in the appendix.

without engaging a contractor. The hypothesized levels might not match the true levels because the model omits some important (dis)incentives to use intermediaries like the importance of firm-specific skills, worker substitutability, the ability to oversee indirect hires, the existence of high risk workers, or intellectual returns to scale. As such, the simulation estimates the level of outsourcing in *absence* of those incentives. Within the model firms should realize the greatest utility gains in professions with wider skill distributions, larger wage gaps, and more work variability. The presented results highlight the four hypothetical cases highlighted (the 1,440 simulations with 72 parameter settings are compared using multiple regression).

INSERT FIGURE 5 HERE

The model's predicted level of outsourcing, depicted in figure 5, bears out the theoretical expectations, though the empirical data often contradicts these predictions. The model finds that firms transition towards outsourcing their high-skilled jobs more rapidly than low-skill jobs. There is not a significant difference between the overall labor market scenario and the minimum wage scenario except from approximately tick 100 to 200 (standard errors are omitted from the graph for visual clarity, but there is a consistent significant difference between the 2 most outsourced scenarios and the 2 least outsourced scenarios). The model does not predict a classic S-curve transition towards outsourcing, but finds that firms rapidly adjust once the service is available, and then hover about a final stable level of outsourcing. In trial runs of a longer duration, the outsourcing level remains more or less constant past the 600th tick. Across all scenarios the average proportion outsourced ranges from 20% to 52% of the labor force while empirically at most 28% of any single occupation is in these arrangements. There are many reasons for the difference. This model excludes some important disincentives like firm-specific skills. Also, as mentioned earlier, without the temp to perm parameter 50% of this hypothetical workforce would be outsourced with no incentives simply because firms will misinterpret natural variability for intermediaries' competence.

The results are primarily driven by the width of the skill distributions. As such, insofar as the breadth of skills in the overall occupational pool is irrelevant to an employer's ability to appropriately fill a position, the overall labor market scenario will over-estimate the final level of outsourcing. The two high skill occupations have almost significantly different rates of outsourcing throughout the model (significant at .10 but not .05). This almost-significant difference probably exists because while the two occupations have similar skill distributions, programmers' higher workload variability creates more turnover, creating more outsourcing. Accountants' narrower and slightly

higher skill means it is easier for firms to achieve good matches and it is more costly to outsource accountants (because fee rates are percentages of higher salaries).

INSERT FIGURE 6 HERE

A simple multivariate analysis predicting the proportion of jobs outsourced based on the four different parameter settings for all 1440 runs of the simulation shows that all the parameters except the compensation variability are significant at the .01 level, while compensation variability is significant at the .1 level. Together, these parameters explain 22% of the variance in outsourcing across models. Including the model's "time," they explain 69% of the variance. Rather than display the actual coefficients (which are awkward to interpret since they do not correspond to any real -world measurements) Figure 6 shows the two scenarios that would predict the most and the least outsourcing according to the OLS regression coefficients are depicted in figure 6. The left bar shows that in the parameter space that I tested, the minimum level of outsourcing would be 6.47% of the labor market and the right bar shows the maximum level is 54.24%. For the first parameter, the maximum case uses the all-labor market skill distribution and the minimum case uses the accountant skill distribution, lowering outsourcing by more than ten percentage points. These results are expected since a wider skill distribution means that firms have more difficulty obtaining good matches. For the second parameter, unexpectedly, higher contractor costs increase outsourcing. The minimum outsourcing scenario uses a 110% labor cost while the maximum scenario uses 90%. This seemingly counter-intuitive finding could result from the fact that with higher costs, contractors earn more revenue. This means that more contractors survive, and firms have more opportunities to outsource. If there are no contractors within a certain radius on the grid, firms directly hire a worker instead. Thus there has to be some minimum wage benefit to sustain an organizational ecology of intermediaries. Perhaps, if the model were to explore even higher compensation differentials, outsourcing would again increase (a non linear relationship between outsourcing and compensation). The third parameter, the variance in the premiums, has almost no effect and is almost insignificant. The fourth parameter, workload fluctuations, works as expected; in the highest setting (where firms, on average, have to adjust their workforce ten percent in each time period) firms outsource almost 10 percent more than they do at the lowest setting (when their labor demands only have a five percent average adjustment).

As in the first experiment, the model also produces descriptive statistics of the simulated labor market, including: unemployment rates, vacancy rates, job duration, and vacancy duration. These measures are used to verify that

the model is a reasonable approximation of the labor market. The model has very consistent levels of unemployment and vacancies fluctuating around 5% regardless of parameter settings or the time in the model run. By design, firms' labor shocks are auto-correlated since they adjust their labor force as a percent change from employment in the last period. Since most jobs are at a few firms, this means that the overall unemployment and vacancy rates are also autocorrelated, and generally resemble a real-world labor market.

The model's prediction for the skill levels of the outsourced workers compared to other workers is inconsistent with empirical evidence. In the CPS data outsourced workers are consistently more educated than their direct hire counterparts (except in the least skilled occupations like janitorial work, where outsourced workers are less educated.) In the model, unemployed workers are consistently the least educated, then outsourced workers, and then direct hires. In the model one might expect the *mean* skill level of outsourced workers to not differ from indirect hires since firms should outsource jobs that are difficult to match, in other words, those at the extreme ends of the distribution. In addition, the least skilled workers should receive fewer job offers and the most educated should be the least likely to find a job filling their minimum requirements. On average, these characteristics should balance out leaving no difference between direct hires and indirect hires. While the differences in figure 7 look small; they are actually significant, with outsourced workers having significantly less skills. Generally the literature's assumption is consistent with the model: outsourced workers are imperfect substitutes, particularly in low-skill jobs. So, in some sense, the empirical evidence presents the conundrum: why do outsourced workers have more education? Perhaps one reason is the idea of intellectual economies of scale (when specialized workers produce more working with their peers), which is excluded from this model.

INSERT FIGURE 7 HERE

How does model specification influence the skill gap between direct and indirect hires in the model? A multivariate regression comparing the different parameters settings and the resulting skills gaps suggests that when indirect employees are paid more, the skill gap increases. This occurs because firms pay higher contractor fees for more skilled positions, meaning that the firm outsources proportionately more low-skilled jobs. Second, the regression finds that when firms have more workload shocks there is a lower skill gap (changing the model from "low" to "high" shocks leads to about an MA versus BA average skill gap). This probably occurs because the low-skill workers who would stay on and transition into direct hires (thus diminishing the skill difference) in a stable market, but are the first to be fired in a

volatile market. Third, the regression finds that using the minimum wage skill distribution results in the smallest skill gap, while programmers and the general market, and particularly accountants have a higher skill gap. Accountants have the narrowest skill distribution, so there is less distance between the most and least skilled workers, but accountants have an overall high skill level, meaning that headhunter fees are high and the marginal savings of keeping the relatively higher skill worker in-house are higher, so firms segregate their workforce.

The model outputs other statistics not depicted here. Firm utility is one of the most important measures; it is continuously calculated with firms adjusting their behavior based on its value. The experiments including contractors, compared to a baseline model with no contractors, have on average a utility gain of about .05, where utility ranges from 0 to 1, with the mean firm in runs with contractors having a utility above .5, and the mean firm in those without contractors having a utility below .5. The increase in productivity is relatively constant across scenarios, and is therefore not depicted. A multivariate regression of utility levels suggests that high contracting premiums and more workload shocks increases firms' utilities as does using programmer or accountant skill distributions. The premium effect is attributable to the fact that higher fees maintain the organizational ecology, allowing firms the opportunity to outsource. Workload shocks give firms the opportunity to fire workers and offer the positions to new workers. This cycling increases match quality, increasing firms' utility. The third result is the most surprising since firms should gain the most utility when they outsource an occupation with a wider skill distribution (through improved match quality). Other model output not depicted includes the unemployment rate, vacancy rate, average vacancy duration, and average unemployment duration. All roughly matched the labor market, with unemployment hovering around 5% and most unemployment spells being short, but with a few chronically unemployed.

The model's primary limitation is that as a model, it necessarily excludes many incentives. As such, the predicted use of intermediaries does not match the empirical use. For example, had I included firm-specific skills and intellectual economies of scale, we would have anticipated more high skill outsourcing. On the other hand, the incentives that I did explore had strong results. I found that there are strong incentives for firms to outsource even in the absence of a wage premium and that with match quality and fees being the primary operating incentives, firms should be more inclined to outsource their least skilled jobs. I also found that firms will use intermediaries even if they are not systematically better, and are even economically inefficient. Firms do this, because by chance, their experience with contractor-hires can be better than their direct-hire experiences. In addition, I found that firms rapidly adapt to a new marketplace with intermediaries, adapting more quickly in

those markets with stronger incentives. The overall shape of the transition is confirmed empirically, though the difference in rates across occupations is not. Finally, the model found that given the included incentives, low-skill jobs are more likely to be outsourced than high-skill jobs.<sup>7</sup>

## 5 Empirical Data

Empirical data plays two different roles in this model. While the model’s estimate is inaccurate because of the aforementioned limitations, the empirical data is also inaccurate. I compare three measurements of outsourcing trends in the US economy, comparing the empirical measurements to each other and to the model’s prediction. Second, I used empirical data to design the model. One of the parameters in the second experiment set contracted employees’ wages in contrast to direct hires’ wages. I briefly present the empirical evidence on the compensation gap, suggesting possible accurate value settings for this parameter.<sup>8</sup>

Many studies claiming that the labor market is becoming a “spot market” use firm, not employee, data. This data shows that firms increasingly buy services rather than directly employing workers. The Economic Census data in figure 8 illustrates this; between 1997 and the 2002 employment at companies providing contract services grew more rapidly than the rest of the economy. However, this is an imperfect measure for several reasons. First, some indirect employment might not be through companies in these business service categories (for example independent contractors). Second, these employment numbers include direct hires. Assuming administrative costs are constant as these companies grow, or they grow more slowly, this is not a problem. Third, it is unlikely that most of these workers are actually outsourced workers. For some areas, like janitorial services, it is certain that the janitors go to the clients’ sites to perform their services. For others, like accounting, it is likely that these workers seldom go to the clients’ sites, and could be considered traditional employees of the accounting firms. Finally, there is only data from two periods.

INSERT FIGURE 8 HERE

In contrast, there are two measurement techniques that approach the question from labor market data. The first technique uses the March CPS, which

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<sup>7</sup>The National Organizations Survey directly asks firms’ human resources officers why they hire through intermediaries. HR workers respond that their firm does it primarily because of work fluctuations and because contractors’ have specialized skills. Most respond that it does not lower costs.

<sup>8</sup>Future work will decompose the compensation gap, determining whether it is a function of outsourced worker’s relative skills.

is advantageous in that it is a long time series, but is disadvantageous in that the identification method is indirect. First, an outsourced worker is defined as any worker in an occupation who works for a firm that specializes in providing his or her occupational services to other companies. For example, a janitor working for a janitorial services company is considered a contract worker. These workers can only be identified in occupations where there are industry codes for those same occupational services. Using this method co-occupational workers are misidentified if they are actually be working for the contracting company in the same occupation (i.e. the secretary at the secretarial services company). As with the employer side data, the method is particularly inaccurate for high-skill jobs. For example, a programmer employed in a computer systems design company could work the majority of time at his actual employer, seldom visiting the customer's site. Finally, both this method and the next use CPS occupational and industrial codes. Since the coding scheme changed in 1992 and 2002, there is a slight data discontinuity. Figure 9 shows the proportion of workers in a given occupation who are identified as indirect in this scheme. The figure, in contrast to the employer side data, suggests a much slower growth pattern, and a slight decline in the clerical sector. There is, of course, some error in these measurements. For example, accountants hover around the same proportion with no significant difference between outsourcing in different years.

INSERT FIGURE 9 HERE

The third method of measuring outsourcing directly asks workers their employment status. The infrequently-collected CPS Contingent Worker Supplement (February 1995, 97, 99, 2001, and 2005) asks workers whether they are temporary workers, on-call, contingent, day laborers, or work for a company that leases out their services. Combining all of these different groups should theoretically capture the workforce that has contingent or unstable employment, or in other word the workforce that inhabits a spot labor market. As illustrated in figure 10, this method suggests the opposite trend; temporary work arrangements have been falling since 1997. Using this method, we can measure outsourcing across the entire labor market, not just those occupations with matching industrial codes. Figure 11 illustrates the trend.

INSERT FIGURE 10 HERE

Why do the estimates of these trends vary so dramatically? Theoretically the third method should be the most accurate since there is no proxy measurement, the survey directly asks the workers their employment situation rather than inferring it from some other information. However, it is likely



that this data is flawed too since research has found that individuals are incapable of accurately reporting their own employment status, often reporting their indirect employers as their employers (Bjelland et al., 2006). The bias is confirmed by examining a single question from the contingent worker survey. Early on in the survey, the worker is asked to report his or her employer. Later in the survey, the respondent is asked whether they were paid by their employer or a temporary help agency. If they were paid by a temporary help agency, the interviewer then asks them whether their reported employer was the temporary help agency or the agency's client. Surprisingly, the majority of the time respondents report the client as their employer, and odder yet, over time temporary workers became more likely to report the client as their employer, as illustrated in figure 12. Extrapolating beyond the temporary help market, if workers consider themselves employees of their employers' clients rather than their actual employers, self-reports will grossly underestimate these working arrangements. This self-reporting problem also distorts estimates from the second method, which relied on the worker accurately reporting his or her employer's industry. As such, perhaps the employer side data is the most accurate. But using the employer-side data we can only estimate the size of the outsourced occupational workforce, not the direct-hire workforce, so there is no way of knowing what percent of workers in the occupation are outsourced, only how rapidly indirect employment is growing.

INSERT FIGURE 12 HERE

How does one reconcile the imperfect model measurements and the imperfect empirical measurements? The empirical evidence on outsourcing (figures 9, 10, and 8) suggest perhaps a mild growth from 1983 to 2006, with the initial explosion (if there was one) predating this time series. In contrast, the theoretical curves (figure 5) suggest initially rapid growth (that perhaps might be in empirical graphs predating 1982), generally petering out at a much higher level than our empirical curves do (around 30 to 40% of the occupation's labor force rather than 5 to 35%.) While the model predicts the general diffusion rate with moderate accuracy, it is particularly bad at ranking the relative incidence of outsourcing across occupations. Our model predicted that the low skill occupations, with wider skill distributions, higher work variability, and stronger labor cost incentives would outsource more. But the empirical data shows the exact opposite; high skill jobs are the most likely to be outsourced. Omitted incentives would have mixed effects if they were added. For example, employer-specific human capital should be more important for high skill jobs, so including it would have decreased high-skill outsourcing. An interaction between skill match and skill level could increase high-skill outsourcing's relative incidence. (i.e. The distribution of skills might be wide in the low-skill jobs, but the job-employee skill mismatch might be less

important at lower levels of education: does it matter whether the janitor is a 3rd grade graduate or a high school graduate?) Finally, adding incentives related to intellectual economies of scale (firms are incompetent to oversee specialized occupations or specialized workers are productive working with their peers) would increase high-skill outsourcing relative to low-skill.

In the model, one of the parameter settings was a compensation differential predicting whether outsourced workers earn more, less, or the same as their direct hire counterparts. While I tested all scenarios, I highlighted the hypothesis that firms would pay their lower skill workers less and their higher skill workers the same or more. Figure 13 shows the empirical annual wage gap between direct and outsourced workers using the March CPS (again, there is a discontinuity in coding in 1992 and 2002). The figure shows that while outsourced janitors and clericals are consistently paid lower wages, programmers and accountants seem to earn approximately the same, with indirectly hired programmers actually earning more in recent years. Plotting total income rather than wage income (not depicted here) outsourced programmers and accountants consistently earn *more* income than their direct-hire counterparts. (Alternative income sources could encourage these workers to accept these arrangements.) These empirical results substantiate our hypothesized parameter settings for the four occupational scenarios. Unsurprisingly, given the aforementioned tax incentives related to health insurance, in all occupations outsourced workers are less likely to receive health insurance from their employers, though the gap is the smallest for programmers, as illustrated in 14. An important question that is unresolved using this data, is whether these workers chose this type of employment because they have another source for benefits and can earn higher wages foregoing insurance. Regardless, the data suggests that the hypothesized lower wages under contracting arrangements for lower skilled workers is right.

In order to fully support the claim that there is a true compensation differential, one should calculate a wage gap decomposition, testing whether or not there is a substantive reason for this wage gap. (If the wage gap could be fully explained, the hypothesized parameter settings would be unjustified.) However, a full wage gap decomposition is beyond the scope of this short paper. However, longitudinal plots of possible explanatory variables would suggest that the gap is not entirely explicable. Empirical evidence shows that outsourced low-skill workers consistently work fewer weeks per year and hours per week than their direct-hire counterparts while outsourced high-skill workers work *more* weeks and hours (accountants work close to 10 hours more per week). The time trend suggests that these differences work effort are consistent from 1983 to 2006. While work effort seems like a possible explanation for wage gaps, other income predictors like education, residential location, age, and gender, do not explain the gap with outsourced workers being more

educated, living in more urban areas, etc.

## 6 Conclusion

This paper had two significant areas of findings. First, estimated the longitudinal trend towards using intermediaries, and compared trends across occupations. Second, it explored possible incentives for firms to outsource and then examined how those incentives differ by occupation.

With respect to current outsourcing levels, the major transition (if there was one) has already happened and that growth has stabilized since the 1990s; this transition does not seem to have followed a traditional S-curve. Over time it is becoming more difficult to measure these trends, as the definition of one's "employer" blurs. These estimates are uncertain. The empirical data measuring from the business side overestimates outsourcing by counting all employees at certain firms as outsourced workers and does not allow measurement of the number of directly hired workers, making a good measure of growth impossible, and it includes workers who don't really work on site at their clients. Worker side data is also flawed as it relies on self reports of workers' contractual arrangements or employers' industries while workers erroneously consider themselves employees of where they go to work, not who signs their paycheck.

With respect to the firm's incentives to outsource, there are several interesting findings. The first experiment showed that independent of compensation differentials, match quality is a sufficient advantage to encourage job matching through intermediaries. Second, both experiments showed that simply because of natural variability in match quality, sometimes contractors will make better placements, encouraging firms to use their services. Surprisingly, at a low level, higher contractor fees might increase firms' propensity to outsource by sustaining an organizational ecology of contractors. In addition, the firm's incentives seem to depend on the occupation of the job that the firm wishes to outsource. In high-skill jobs compensation savings play less of a role while their (in)ability to oversee the work or the advantage of having co-occupational workers work together, might be more important. In sum, employers of high skill occupations seem to use intermediaries for different reasons than for low skill occupations, and possibly with different repercussions.

Future research should explain the wage gap between the two types of employees and should explore the wage effects of outsourcing. Theoretical and descriptive evidence suggests that in some occupations outsourcing is more

driven by wage savings than others, but it must be confirmed using a more sophisticated empirical analysis. In addition the model might be expanded to include more incentives, testing whether including more incentives is related to more realistic predictions.

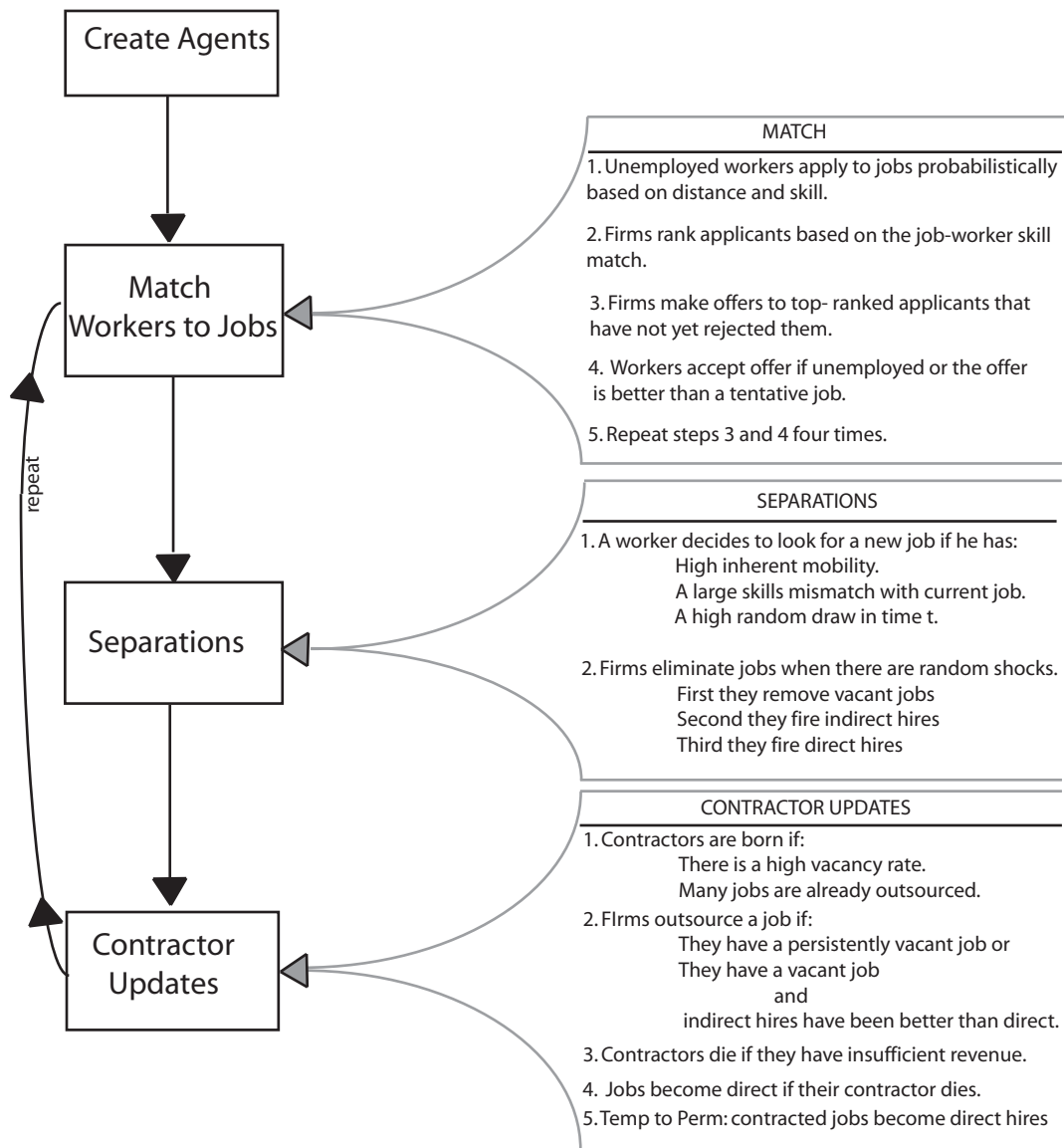


Figure 1: Program Structure

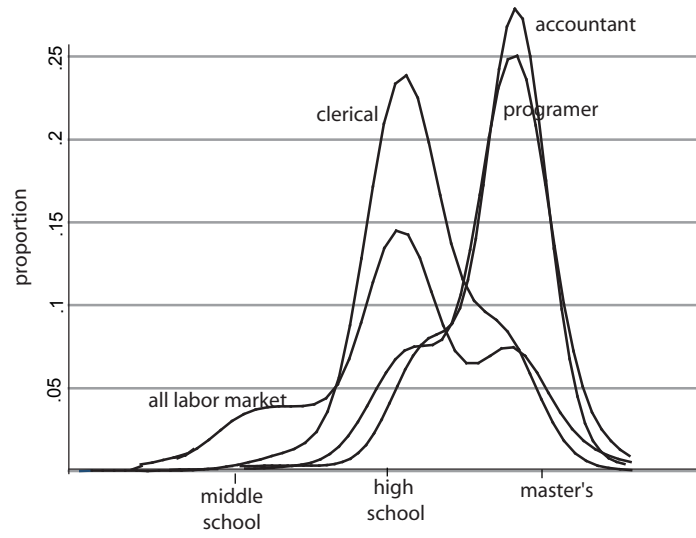


Figure 2: Workers' Educational Distributions

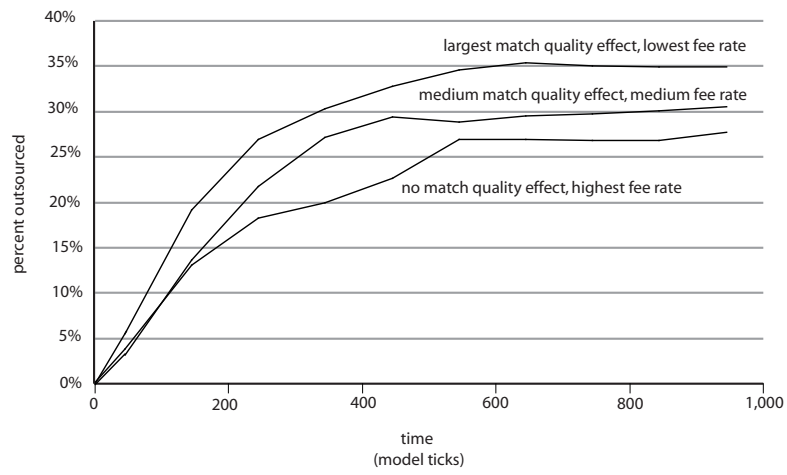


Figure 3: Transition to Outsourcing

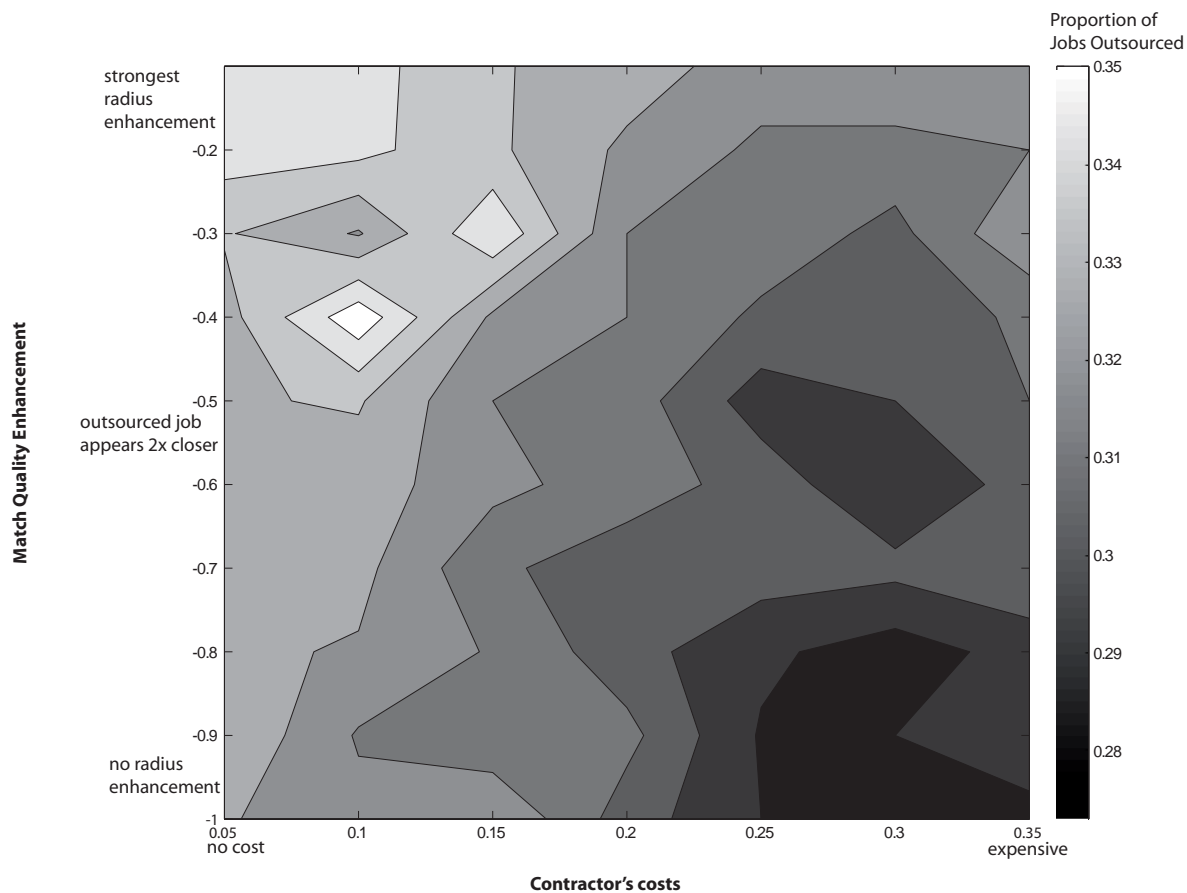


Figure 4: Proportion of jobs matched through intermediaries, varying intermediaries' fees and matching ability (end of run)

<i>parameters</i>				<i>hypothesized outcome</i>
skill distribution	contract premium (3)	premium variance (3)	work variability (2)	outsourcing level
minimum wage all labor	negative	low	normal	++++
programmers	none	high	normal	+++
accountants	positive	medium	normal	++
	none	high	low	+

Table 1: Model Predictions

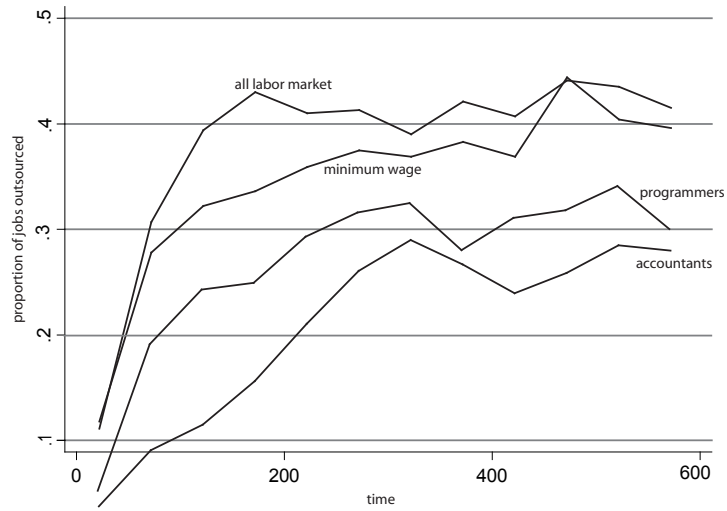


Figure 5: The theoretical spread of outsourcing under four hypothesized scenarios.

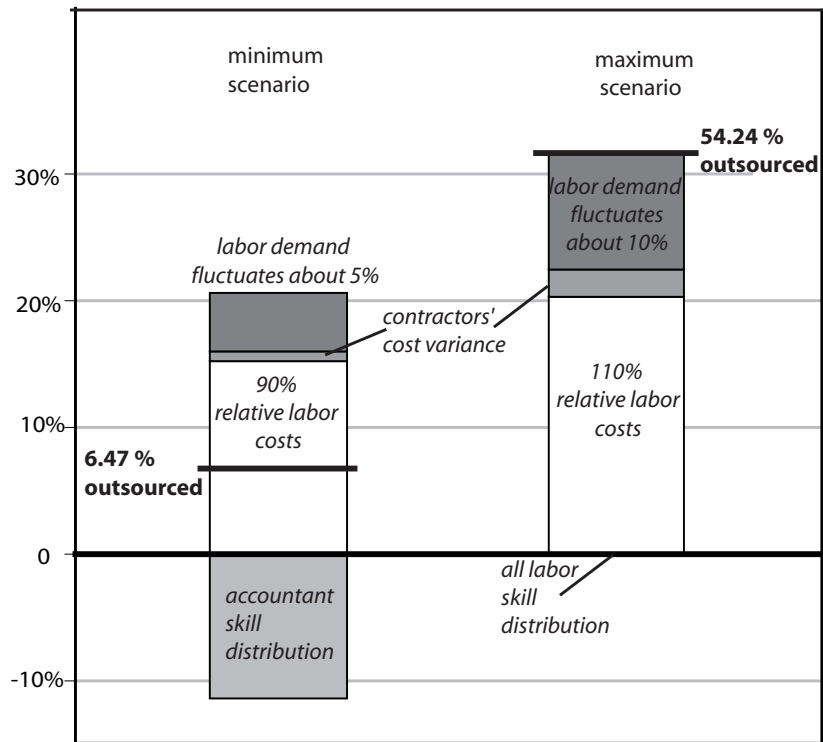


Figure 6: OLS results for how the parameters influence outsourcing.



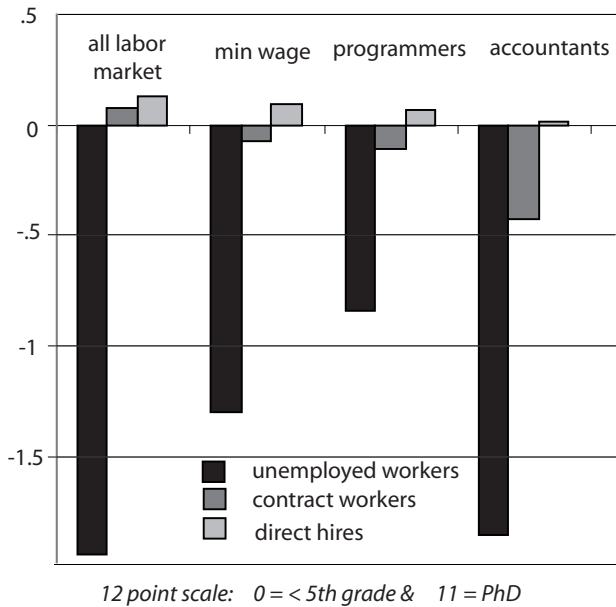


Figure 7: Deviations from the average worker's skill.

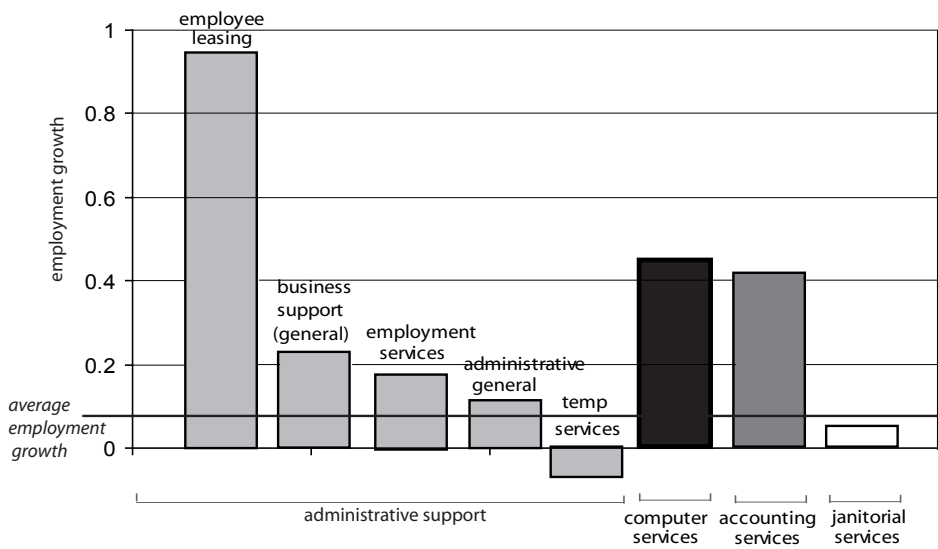


Figure 8: The change in employment by sector, 1997-2002 (CensusBureau, 1997 & 2002).

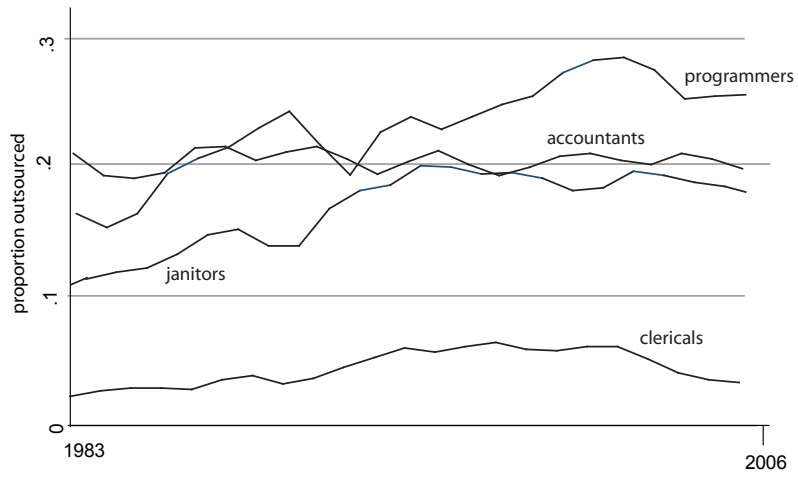


Figure 9: The empirical spread of outsourcing for four occupations, inferred status (King et al., 1983-2006a).

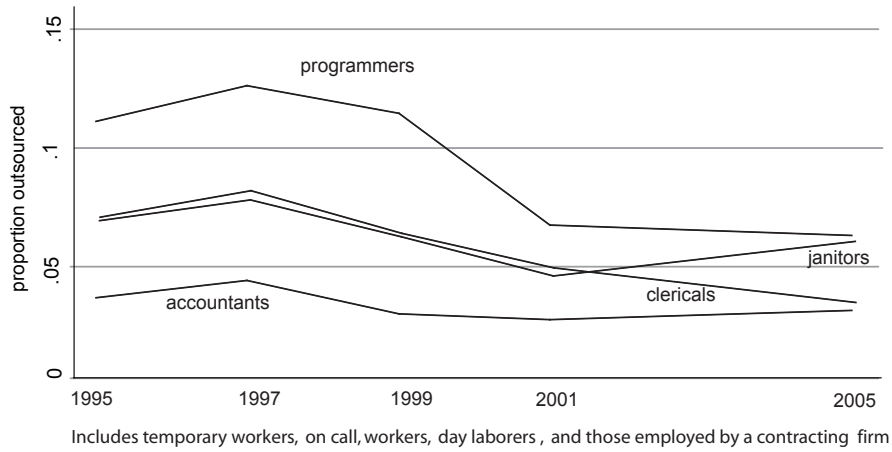


Figure 10: The empirical spread of outsourcing for four occupations, self-reported status (King et al., 1983-2006b).

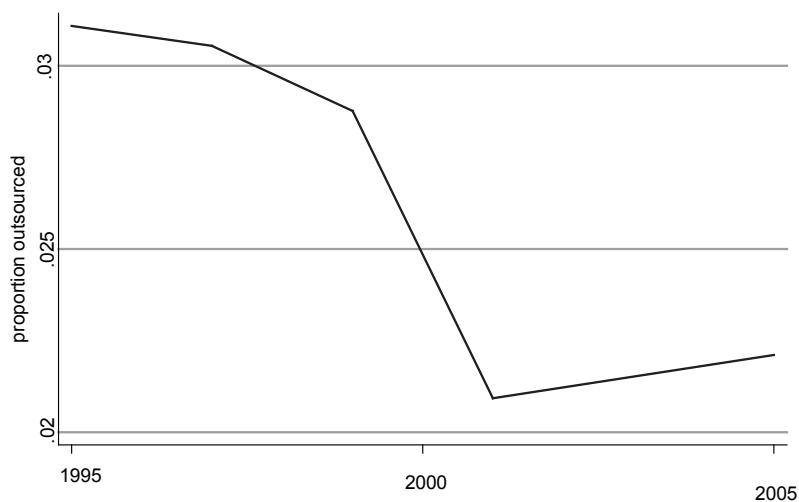


Figure 11: Self-reported alternative work arrangements in the whole economy (King et al., 1983-2006b).

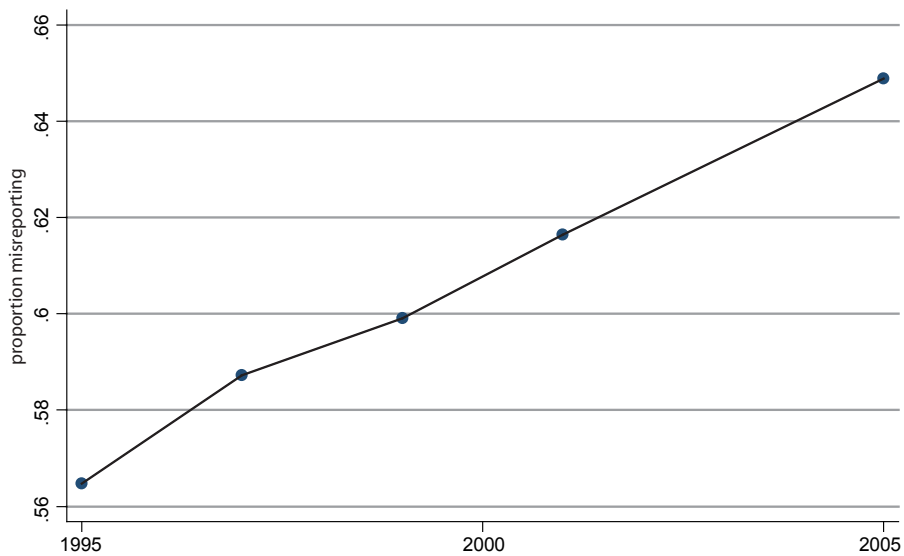


Figure 12: Proportion of temp workers reporting indirect employers as their primary employers (King et al., 1983-2006b).

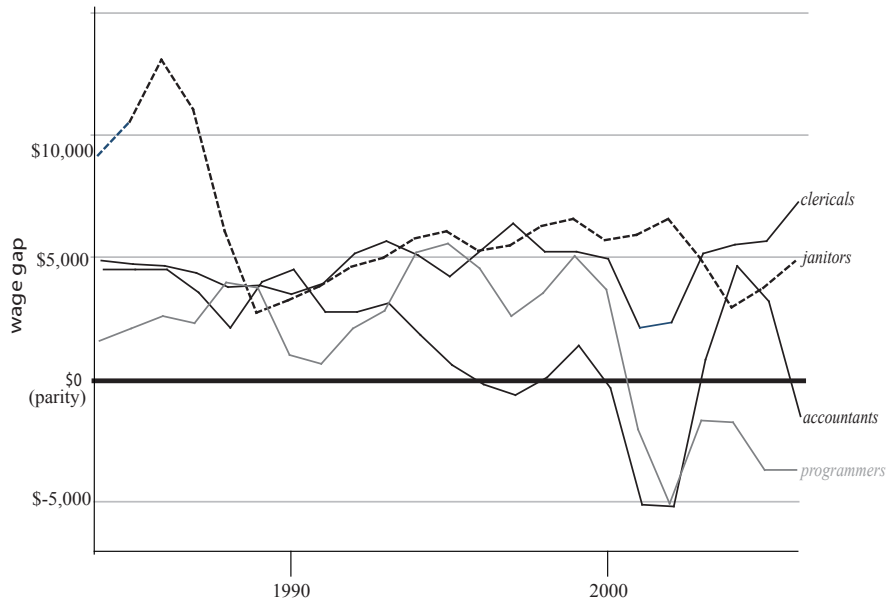


Figure 13: Wage gap: direct hires' annual wages - outsourced annual wages (King et al., 1983-2006a).

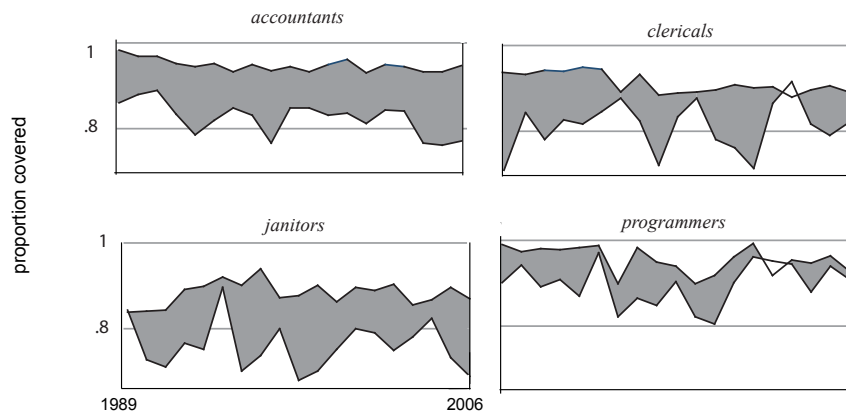


Figure 14: Gap in the incidence of health insurance coverage from employers (outsourced workers are always the lower line)(King et al., 1983-2006a).

## 7 Technical Appendix

### 7.1 parameter list

The first part of the list includes the unswept parameters, while the second list includes the 5 parameters I tested. Many in the first list (like model length or grid size) are arbitrary. Some like the distribution of jobs across firms are based on empirical data, while others, like the search radius of a worker, are more loosely based on empirical research (i.e. skilled workers look for jobs in a broader radius, so I set a small effect for this.) Other variables like the skill floors, the continual generation of contractors, or the contractor's startup grace period have almost no effect on the model's findings.

Parameter	Definition	Default Value
stopTicks	length of run	600 or 1000
numWorkers	number of worker agents	1000
numFirms	number of firm agents	142
sizeX sizeY	grid size	100
feeRVar	variance for contractor fee rates	.08 or .05
maxCDistance	firms' search radius for contractors	.2
$\alpha$	exponent distributing jobs across firms	2.1
tPerm	contract worker's transition to direct hire	5
rDeath	revenue a contractor must maintain	.1
vSContractors	vacancy rate generating contractors	.04
oSContractors	outsourcing rates generating contractors	.02
cSTime	time for contractors to find initial client	3
ceiling	a ceiling on unemployment and vacancy	.15
sSearchRWorker	worker's skill effect on search radius	5
maxWSTolerance	maximum deviation for job floor	3
minWSTolerance	minimum deviation for job floor	1
maxJSTolerance	maximum deviation for worker floor	3
minJSTolerance	minimum deviation for worker floor	1
hWeighting	weights firm's utility histories	.75
fRFloor	a floor on contractors' fee rates	.025
vDisutility	disutility for firms for vacancies	-.1
fRMean	contractors' mean fee rates	swept(exp 2= .2)
cRWorker	contractors' mean search radius	swept(exp 2= .5)
wSDist	workers' edu distribution	swept(exp 1 = overall)
jSDist	jobs' edu distribution	swept(exp 1 = overall)
cAlphaMean	contracting's effect on compensation	swept(exp 1 NA)
cAlphaVar	variance of above	swept(exp 1 NA)
wVar	firms' workload fluctuations	swept(exp 1 = .05)

*feeRateMean* and *contractorRadiusWorker* were varied in the first experiment, while *workerSkillDist*, *jobSkillDist*, *contractedAlphaMean*, *contractedAlphaVar*, and *workVar* were varied in the second.

## 7.2 Classes and Their Instance Variables

- Firms have:
  - X and Y locations
  - a list of their jobs
  - a list of their vacant jobs
  - a list of their employees
  - a change in workload (updated each round)
  - a pointer to their contractor
  - a utility (from contracted and direct hires as well as vacancies)
- Jobs have:
  - a pointer to their firm
  - a pointer to the contractor
  - a skill level
  - a skill floor for the least qualified worker they will accept
  - a pointer to their worker
  - the tick the job was last filled
  - the tick the job was last vacated
  - a comparator used to sort workers by how well they match the job
  - a list of unemployed workers, sorted by how well they match the job
- Workers have:
  - x and y locations
  - skill levels
  - a skill floor for the lowest job that they would accept
  - a quit propensity
  - the date they were last employed if currently unemployed
  - the date they were last hired
  - a list of vacant, visible jobs
  - their employer
  - their job
  - an effect on their salaries for a contractor match
- Contractors have:
  - x and y locations

- a list of the firms employing them
- a list of their assigned jobs
- a fee rate (a percent of the worker’s skill level)
- the percent of assigned jobs they matched in the last round
- revenue (based on their fee rate and their employees’ skills)

### 7.3 Equations

There are some slight differences between the models used in the first and second experiments. In the second experiment contractors have a short grace period before dying if they have insufficient revenue. In the first experiment they die based on the number of assigned jobs and have no grace period. There were also slight adjustments to the skill-match quality formulae, and tenure- based quits and one time hiring fees were removed. Utility was also scaled down to a 0 to 1 range in the second experiment. In the notation below  $normal(x,y)$  means a draw from a normal distribution with mean x and standard deviation y. Similarly,  $uniform(x,y)$  is a draw from a uniform distribution ranging between x and y.

- initial job creation

For each firm, j, draw a number of jobs at the firm. If the number of jobs exceeds 10% of the workforce, redraw.

$$nJobs_j = [1 - uniform(0, 1)]^{\frac{-1}{\alpha}} \quad (1)$$

- probability of quitting for worker i in time t

- Experiment 1:

$$pQuit_{it} = .333(\rho_{it} + \tau + \sigma) \quad (2)$$

- Experiment 2:

$$pQuit = .5 * (\rho + \sigma) \quad (3)$$

- For both:

*iff*  $pQuit > uniform(0,1)$ , quit  
*iff*  $pQuit < uniform(0,1)$ , stay

**where,**

$\rho_{it}$	random quits	$normal(qP_i, .05)$
$qP_i$	quit propensity	$uniform(0, .3)$
$\tau_{it}$	tenure effect	$normal(1 - \frac{currentjobsticks}{total\ life\ ticks}, .05)$
$\sigma_{itj}$	match quality	$normal(\frac{sl - jsl}{sl}, .05)$
$sl_i$	worker skill	
$jsl_j$	job skill	

- work fluctuation for firm j in time t:

$$jChange_{jt} = \psi + \Delta * \psi \text{ where,} \quad (4)$$

$\psi$	=	firm's current number of jobs
$\Delta$	=	normal double(0,.sweep)
if unemployment > 15%	$\Delta =  \Delta $	
if vacancy > 15%	$\Delta = -1 *  \Delta $	

- worker's and job's skills

Skill distributions are set based on empirical educational distributions for workers in different occupations. Skill floors are assigned to workers or firms in the beginning of the model and remain constant. The skill floor is a uniform deviation from -1 to -3 less than the worker's or job's skill. (The education scale ranges from 1 (less than fifth grade) to 11 (PhD).)

- How firms search for contractors:

Firms find the contractors within a static search radius and pick the contractor who had the best match rate last round.

- workers apply to all jobs they "see"

$$Pi, j, t = e^{\frac{-\delta * d}{sl * \alpha}} \quad (5)$$

$Pi, j, t$	=	probability of worker i seeing job j in time t
$sl$	=	skill level
$d$	=	distance
$\alpha$	=	skill's effect on search radius
$\delta$	=	if $\neq$ contract job = 1 if = contract job = cRWorker

- the cost of contracting

- Experiment 1

In experiment 1, the contractor and the firm's cost from matching worker i in time t through contractor z is,

$$cost_{z,i,t} = workerskill * fRate_z \quad (6)$$

- Experiment 2

In experiment 2 I also use the fee rate, but now the cost structure is a deviation from direct-hire costs. This cost function is used in the firm's utility calculation and the decision to outsource.

$$WCI_{i,j,z} = S_i^{\alpha-1} * (1 + fRate_z) \quad (7)$$



WCI	=	worker relative cost
$S_i$	=	worker's skill level
$fRate_z$	=	normal(fRMean, .08)
$\alpha_{i,z}$	=	normal(cAlphaMean, cAlphaVar), for a contracted worker
$\alpha_{i,z}$	=	1 for a direct hire

This means the direct hire always had a fee of 1 while contractors' fees rates are assigned individually to each contractor, but don't change during the model. In contrast, the alpha, or pay premium for the contract worker is reassigned each time a worker-job match is made through a contractor. Depending on the fee rate and the pay premium, the contract worker could cost the company more or less.  $WCI_{i,j,z}$  is used in combination with match quality when we measure firms' utilities. In turn, their utilities are used to determine their actions.

- The firm's utility & outsourcing decision:
  - Experiment 1

$$ind = \frac{\beta_{Cpast}}{\beta_{Cpast} + \beta_{DHPast}} \quad (8)$$

iff  $ind > \text{normal}(.5, .2)$ , outsource

iff  $ind \leq \text{normal}(.5, .2)$ , hire directly

$$\begin{aligned} \beta_{Cpast} &= \alpha * \beta_{Cpast} + (1 - \alpha) * \beta_C \\ \beta_{DHPast} &= \alpha * \beta_{DHPast} + (1 - \alpha) * \beta_{DH} \\ \alpha &= \text{history weighting } (.75) \\ \beta_C &= \text{avgMQuality}_C - \text{average match fee } C \\ \beta_D &= \text{avgMQuality}_D - \text{average match fee } D \end{aligned}$$

avgMQuality is a function of the combined employee and job skill:

$$\begin{aligned} \text{if the worker is underskilled: } & 1 - \frac{js - ws}{js} \\ \text{if the worker is overskilled: } & 1 - \frac{(ws - js)^2}{js^2} \end{aligned}$$

- Experiment 2

The basic idea remains the same, but the formulae were simplified and standardized. The formula begins by combining average match quality with fees to create a firm-level score for their average experience with direct hires and contract hires. These are then used in a weighted average to calculate utility. Match quality remains the same, except it was adjusted so that the denominator was switched from job skill to worker skill or vice versa if the numerator ( $js - ws$ ) or  $(ws - js)$  exceeded 1.  $WCI_{dh}$  and  $WCI_c$  are defined above under “the cost of a contractor”

$$U = N_c * (\mu_{MQ_c} - .5 * \mu_{WCI_c}) + N_{dh} * (\mu_{MQ_{dh}} - .5 * \mu_{WCI_{dh}}) + (-.1 * N_v) \quad (9)$$

$U$	utility
$N_c$	number contractor hires
$N_{dh}$	number direct hires
$N_v$	number vacancies
$\mu_{MQ_c}$	average match quality for contract workers
$\mu_{MQ_{dh}}$	average match quality for direct hires

Utility is later used when the firm chooses whether to outsource an *additional* job. First I update,  $\mu_{MQ} - .5 * \mu_{WCI}$ , to incorporate history, calculating the values for direct hires and indirect hires separately. If we say,

$$\begin{aligned} i &= \mu_{MQ} - .5 * \mu_{WCI} \\ \text{hScore} &= (.75 * (i - 1)) + (.25 * i) \end{aligned}$$

$$\begin{aligned} \text{iff } \frac{\text{hScore}_{contracted}}{\text{hScore}_{contracted} + \text{hScore}_{dhire}} &> \text{normal}(.5, .1), \text{ outsource} \\ \text{iff } \frac{\text{hScore}_{contracted}}{\text{hScore}_{contracted} + \text{hScore}_{dhire}} &\leq \text{normal}(.5, .1), \text{ hire directly} \end{aligned}$$

- Contractor death

Assuming that contractors maintain overhead that is relative to their size, I measure their health by dividing their total revenue by the number of jobs they have been assigned. If this revenue is less than 10% of the average worker's skill (remember that depending on the experiment being run, fee rates average around 20% of a worker's skill), the contractor dies. Thus the contractor's health depends on their ability to match workers with jobs and their fee rates.

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