Digitization and the Contract Labor Market: A Research Agenda

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1. Introduction

Online contract labor platforms globalize traditionally local labor markets, enabling employers, most of which are in high-income countries, to more easily outsource jobs to contractors, primarily located in low-income countries. In such settings, for example, a two-week data entry job needed by a company in Toronto, Canada that would attract applicants primarily from the Toronto area in an offline setting may, once moved online, draw applicants from and be completed by workers from distant locations such as India, the Philippines, or Russia.

The growth of these markets has been fast and steady. According to Horton (2010), workers in online labor markets earned about $700 million by 2009, and the *Financial Times* (2012) estimated these markets to be worth $1 billion annually by the end of 2012. Additional details from oDesk, the largest online market for contract labor in terms of earnings, help gauge the size of this phenomenon. The number of employers billing on the site each month has increased exponentially over the past five years, from less than 3,000 in 2008 to over 40,000 in 2013, with most of them being located in high-income countries. This trend is mirrored by the rapid increase in the number of contractors working on the platform, but with an opposite trend in terms of the countries of origin (contractors are increasingly from developing countries).

Jobs performed on this platform range from software coding to administrative services (data entry, translations, copyediting) and web design. Although differences exist among countries in terms of their "specialization" in certain types of jobs (e.g., more or less technical), the general trend is toward contractors and employers from different countries utilizing the platform for a wide variety of tasks; for contractors in several countries, especially in the developing world, earning opportunities appear to be significantly more appealing than those from offline, low-skilled local jobs, as expressed by the local minimum wage. These basic facts, of which more details will be provided below, are a first indication of the potentialities and key features of this

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market: rapid expansion, both in geography and job types, and a reduction in the relevance of distance between employer and contractor.

In this chapter, we outline three lines of inquiry that are central to the digitization research agenda in the context of the market for contract labor: 1) How will digitization affect the efficiency of employer-contractor matching and the production of work? (e.g., will increased matching efficiency enhance welfare?; will lower transaction costs for distributing jobs lead to a disaggregation of services work into smaller components?) ; 2) How will digitization's effect on matching and production affect the distribution of work? (e.g., geographic distribution, income distribution, distribution across firm boundaries); and 3) How will market design features influence user behaviour? (e.g., allocation of contractor visibility, contractor investment in human capital, contractor and employer investments in reputation). We address the first line of inquiry in Sections 2 and 3, the second in Section 4, and the third in Section 5.

In Section 2, we analyze the "basic economics" of online markets for contract labor. We consider the characteristics of both the demand and supply sides, stressing the incentives that lead employers as well as contractors to utilize this channel. The main trade-off that we consider is the one between the reduction in search, communication, monitoring, and transportation costs on the one hand and the potential for new sources of informational asymmetries to arise on the other, leading to a new set of costs. We then describe the role that online contract labor platforms play in facilitating matches between demand and supply and in solving some of these trade-offs. Again, we use knowledge and evidence from oDesk to provide an in-depth illustration.

These basic insights guide our considerations and conjectures about the challenges and opportunities that these markets present. In Section 3, we explore how these environments might change the operating and structure of the labor market as well as the organization of work. We first ask whether and how matching between demand and supply is made more efficient and the role that online platforms play. We then report and discuss how actual tasks are organized on these platforms and in particular the phenomenon of geographically dispersed work teams, made possible by the "elimination" of distance.

In Section 4, we discuss how the digitization of labor may affect broader economic trends and institutions. We consider three broad areas of research and policy interest that might be substantially affected: 1) the global geographic distribution of work as a consequence of these markets connecting demand and supply at large distances; 2) the distribution of income, given

the increased competition from workers in lower-wage countries as well as the tendency of some online markets toward "superstar" types of outcomes whereby only a few actors capture most of the rents; and 3) the organization of economic activities within and between firms as a consequence of the reduced costs of outsourcing, with potential impacts on firms' boundaries, scale and scope.

Finally, in Section 5, we identify market design elements that may significantly influence the ability of platforms to facilitate trade in services between employers and contractors as the industry evolves. Platforms in these (decentralized) online contract labor markets do not have the match-setting power that has been typically analyzed in the market design literature (i.e., directly matching trading partners as opposed to facilitating partners in selecting each other). However, through a number of features, platforms influence which matches are ultimately formed and under what terms. We discuss, for example, the implications for some choices agents in these markets make, such as on the accumulation of human capital, particularly around which skills to learn. More generally, we speculate on how this "softer" match-setting power of online contract labor platforms resembles that of (or can be applied to) other institutions.

2. The economics of online contract labor markets

The most salient features of online labor markets are, just like for other digitized markets, the potential for a large number of transactions and services to be provided by suppliers who are distant in space from the buyers. What are the implications for the demand and supply of services in this context? Who offers their job services online? What entities search for online services, and what are the trade-offs they face? What institutions contribute to "clearing" these markets? This section tackles these basic questions.

Labor supply

What are the incentives for individuals to provide their job services online? Perhaps the most important benefit to having access to online contract labor markets, especially for individuals participating from lower-income countries and more constrained in terms of opportunities, is that they dramatically increase the pool of available jobs to which these individuals can apply and be hired to perform. In addition to increasing the size of opportunities, individuals are also more likely to find good matches for their skills and preferences.

A second advantage to accessing online contract labor markets is an increase in flexibility. For the most part, these transactions are contract-based: workers are not employees, and therefore, for example, have more control over their schedules and how they allocate time between the provision of these services and other activities (e.g., another job, family, leisure, etc.; *The Economist*, 2010). In a survey of workers on oDesk, more than 80% state that the flexibility and freedom associated with working on the site is a major benefit of online work. There is also evidence that the flexibility provided by telecommunication contributes to a significant increase in female labor force participation (Dettling, 2012). Therefore, these online labor markets could induce women who were previously out of the labor market to enter. Especially for suppliers in the developing world, who make up the vast majority of workers, easier access to job opportunities from entities in higher-income countries might also imply higher earnings.

Some of the characteristics leading to benefits in participating in these markets may also be sources of costs and risks for service suppliers. In particular, the contractual nature of these labor relations might lead to more uncertainty about the duration and conditions of a work relationship. The dramatic increase in participation in these markets and the typical profile of participants as relatively highly educated suggest that on balance these markets represent viable and appealing opportunities for a large set of individuals.

Demand for contract labor

The reduction of transportation and communication costs due to digitization is also the key feature of online contract labor markets for companies, which can now access a much broader pool of prospective workers for a variety of services and at competitive wage rates. Although oDesk has a range of organization types and sizes that use the platform, the access to a large and diverse pool of contract workers provided by these platforms is particularly unique for small, entrepreneurial ventures. For instance, in a survey of employers using oDesk, more than half consider themselves start-ups.

If the Internet reduces certain mechanical transaction costs, it also often reveals less-obvious underlying frictions. In the specific case of labor markets, the relative lack of personal, specific interactions might make it difficult for employers to extract “high-bandwidth” information (Autor, 2001) to infer the “type” of a given worker. Furthermore, the increased heterogeneity of applicants make comparisons among them more challenging; for instance, comparing seemingly

similar school degrees or job experiences of applicants from different countries may not be straightforward.

In addition to hidden-quality problems, an obvious issue for prospective employers is the difficulty in monitoring and verifying effort from a distance and through an Internet-mediated transaction.

Market-making platforms

Virtual marketplaces have developed online in order to facilitate the meeting of demand and supply. Four of the largest online contract labor markets are oDesk, Elance, Freelancer, and Guru. Elance and Guru were both launched in 1999, followed by oDesk in 2005 and Freelancer in 2009. These sites are similar in that they allow employers to find and hire short-term workers by registering on the platform and posting jobs to attract applicants. Similarly, they all allow registered contract workers from around the world to apply for jobs posted on the sites by bidding on them and to advertise themselves to employers with profile pages. These platforms earn revenue by charging a percentage of each transaction or member fees to workers and, in some cases, both. In addition to providing a (virtual) place for demand and supply to meet and for the market to clear, these platforms have evolved over time toward addressing some of the key challenges of labor markets in general and online markets in particular.

As mentioned above, a key challenge in online contract labor transactions is given by the limited access to specific or "high-bandwidth" information about both applicants and employers. Online contract labor platforms are increasingly providing features that attempt to solve these information problems. First, platforms provide a verification and standardization device for some of this information; for example, although "offline" work experiences and educational attainments cannot be easily compared across individuals, especially if they come from very different institutional and cultural contexts, employers can more easily compare work experience accumulated by service suppliers on the platform (i.e., the number of jobs, duration, types, as well as performance as expressed by the rating given by the employers and workers). This information is available in online contract labor markets on contractor profiles, and platforms generally do not allow contractors to delete or block this information from their profiles, thus reducing selectivity issues and increasing the reliability of these signals. Platforms also offer the possibility for applicants to perform standardized tests that offer some easy-to-assess quality measures for prospective employers. Moreover, some platforms support contractor agencies or

companies. Contractors in an agency can cooperate to apply for and complete jobs on the site. Some evidence illustrates that these groups help reduce information asymmetries (Stanton & Thomas, 2012).

In addition to providing quality information, online contract labor platforms also help solve challenges relative to the observability and verifiability of effort, on both the worker's and employer's sides, through various mechanisms. Direct monitoring is available on some platforms through virtual office applications.[2] Contractors who perform their work while logged into these virtual offices are monitored through regular screen shots and activity logs. To provide incentives for contractors to accept this degree of monitoring, some platforms guarantee contractor payment for hourly wage work only if it is performed while logged into the virtual office. Along with direct monitoring, workers' ratings represent a potentially powerful reputational mechanism for aligning their objectives with employer objectives.

Likewise, moral hazard issues can arise on the part of employers. For example, employers could refuse to pay for work performed outside virtual offices or to reimburse expenses. However, contract workers can rate their experience with an employer on most platforms, thus allaying concerns about the risk of exploitative behavior and reneging on previous agreements. Furthermore, both employers and contractors can file disputes if they feel they've been unjustly charged or paid. Platforms act as mediators in these disputes and ultimately decide how they should be resolved.

Work Process on oDesk

Further details on the working of our platform of reference, oDesk, illustrate the operating of online contract labor markets in particular, the specific challenges and opportunities associated with them, and how they are dealt with and leveraged.

To post jobs on oDesk, employers have to register on the site by giving their contact details and information on their company, including name, owner, and location. Once registered, employers are free to post as many jobs as they like. Job postings include a description of the task, the location of the employer, and the type of contract being offered. oDesk supports two

[2] Evidence shows that strict monitoring is important for the success of working from home. Bloom et al. (2013) study a Chinese travel agency that decided to try having some employees work from home. The study finds significant gains from working from home in terms of worker productivity and satisfaction. This may be partially a result of the firm's careful monitoring of telecommuting workers. Dutcher & Saral (2012) highlight the difficulties that may arise if telecommuting workers are not properly monitored by showing experimental evidence that non-telecommuting workers perceive that their telecommuting counterparts are shirkers.

contract types – hourly wage and fixed price. Beyond the different payment structures, the contracts have different implications for monitoring and duration specifications. Specifically, when posting an hourly-wage job, employers have to specify the expected number of hours per week and the number of weeks required to complete the job. They can also stipulate a limit on the number of hours per week a contractor can work. When posting a fixed-price job, employers have to specify the budget and deadline . Employers can make job postings public (so that any contractor can apply to them) or private (so that only contractors they invite can apply to them).

To be hired on oDesk, workers similarly must register on the site by giving their contact details, name, and location as well as by setting up a profile page. Profile pages are meant to advertise contractors to potential employers and can include a description of skills, education, work experience outside of oDesk, oDesk-administered test scores, certifications, whether or not they belong to an agency, and oDesk-specific work histories and feedback scores. Once they have set up their profile pages, contractors can apply to jobs by submitting cover letters and bids to job postings. A bid indicates the amount a contractor is willing to be paid to work on a job.

Employers have the option to interview and negotiate over bids with applicants before hiring and to hire as many contractors as they like. Once hired, contractors complete tasks remotely. Contractors submit their work to employers online and are paid via oDesk. Employers have the option to give contractors bonuses and can reimburse expenses through oDesk, too.

After each job, employers give contractors a rating out of five based on six criteria: skills, quality, availability, deadlines, communication, and cooperation. Each contractor also has an overall feedback score, which is a job-size-weighted average of the individual scores. Contractors can provide their employers feedback scores based on the same criteria; employers have a similarly constructed overall score. oDesk does all this in exchange for 10% of every transaction made on the site.

The other major platforms in the industry share several features with oDesk; however, they have their differences. The primary variations lie in the services they provide participants. For instance, some sites support contractor employment agencies and some do not, some offer guaranteed payment for hourly wage contracts and some do not, and Freelancer does not have a virtual office while the other three sites do.

Perhaps the most significant difference between the sites is that Freelancer supports both traditional hiring and crowdsourcing whereas the rest do not support the latter. Given that

crowdsourcing likely has different implications for matching and production, findings from research on oDesk may not generalize to crowdsourcing sites.

3. The effects of digitization on labor markets and organization

There are two immediate consequences to the reduction in the cost of distance for online labor markets. First, the pool of both prospective workers and employers increases dramatically, and second, jobs or specific tasks can be performed at large distances from employers. In this section, we discuss the implication and challenges of these important changes.

Matching made easier?

The ease of access to online contract labor markets, thanks to the development of platforms such as oDesk, Freelancer, Elance, and Guru, has the potential to considerably increase the pool of both job seekers and employers and to reduce search costs. Matching models, particularly as applied to labor markets, predict that this will lead to efficiency gains thanks to lower search costs and a lower likelihood of mismatches (Petrongolo & Pissarides, 2001; Wheeler, 2001).

However, opposite forces are also at play in these markets. Just like information technologies reduce the role of distance for search and execution of work, they also lead to a more heterogeneous pool of both workers and employers. In addition, the absence of personal interactions typical of offline and more localized labor markets precludes access to "soft" or "high-bandwidth" information about both job seekers and prospective employers (Autor, 2001). This introduces uncertainty that in turn may lead to an overall reduction in the quality of workers (Akerlof, 1970) and/or to search frictions (Stigler, 1962). These search frictions could be exacerbated if quality is difficult to determine (Wilde, 1981), which is quite possible in these markets because of the diverse labor pool.

Although theories of search and matching specific to online labor markets have not been developed, a growing body of evidence points to the presence of these informational problems and the ways in which they are addressed in online contract labor platforms. A common pattern to a number of these studies is to look at the presence of preferences for certain geographic locations of workers as a way to alleviate uncertainty about workers' quality. Mill (2012), for example, finds that once an employer on Freelancer has a good experience with a contractor from a particular country, the employer is more likely to hire someone else from that same country. Ghani et al (2013) offer similar evidence from a specific case: members of the Indian

diaspora hiring on oDesk are more likely to hire workers in India than other employers are. Agrawal et al. (2013) also consider how location differences impact hiring practices on oDesk and find that while contractors from low-income countries are less likely to be hired by employers from high-income countries, they benefit relatively more than high-income contractors from previous experience and that contracts that allow for monitoring act as a substitute for prior experience on the site. An implication here is that online contract labor platforms contribute to the alleviation of informational asymmetries by providing verifiable, standardized information (such as previous experience on the same platform) for all workers, regardless of their origin. Further evidence that site-specific experience provides employers with valuable information is given by Pallais (2012), who shows that getting one job on the site significantly increases the likelihood of getting follow-up jobs. Horton (2012) provides experimental evidence of the role of another feature of oDesk meant to improve matching, i.e., recommendation. Horton finds that recommendations increase the likelihood of a hire in job categories with fewer qualified candidates. Stanton & Thomas (2012) investigate the impact of employment intermediaries on matching. They find evidence that employment agency membership increases the likelihood of being hired for contractors with no prior experience on the site.

The broadening of the pool of workers and employers and, at least potentially, the increased likelihood of good matches, is likely also to have implications for wages and income distribution. The fact that in online contract labor markets the number of workers outweighs the number of employers in every job category suggests that while many workers may be left unemployed in online markets for contract labor, employers have a relatively good chance of finding a worker who meets their criteria, with wages driven down (Petrongolo & Pissarides, 2006). However, because worker backgrounds may vary more than in traditional labor markets, a relatively small number of workers may meet the job requirements. As a result, wage offers could be higher than expected. This suggests that in job categories with many qualified workers, the wages will be lower than in those with few qualified workers relative to the number of job postings. As the market evolves, wage differences between job types should begin to disappear.

The digitization of labor and its organization

In addition to impacting how employers and workers are matched, the combination of geographically dispersed inputs, diverse labor forces, and short-term contract workers found in online labor markets has consequences for how labor is organized and, more generally, how and where production will occur.

Of course, international outsourcing and offshoring predates the development of online contract labor markets. Of particular relevance here are theories of service outsourcing and offshoring (e.g., Bhagwati et al., 2004; Francois & Hoekman, 2010). Combined, these theories predict that the gains to service outsourcing are potentially significant. However, they focus on relatively long arm's-length contracts between relatively large firms rather than on the short contracts between potentially very small organizations and individuals typical of online markets.

Outsourcing services to online contract labor markets is also likely to lead to geographically dispersed production, even within narrowly defined tasks. For example, work teams may be composed of individuals who are not necessarily co-located. Lazear (1999) argues that cultural diversity in work teams is costly and should only occur when there are skill complementarities between teammates to offset these costs. It may be harder to meet these conditions in very diverse online labor markets than it is in more traditional labor markets. Two recent studies based on online labor markets focus on task completion and the effects of team organization, communication structure, incentives, and motivation on performance. Lyons (2013) provides field experimental evidence on how nationally diverse communication impacts online team production and finds that nationally homogeneous teams benefit from working together but that diverse teams perform better when members work independently of one another. Related to the topic of online labor market partnerships, Horton (2011) uses survey data from the crowdsourcing site Mechanical Turk to show that workers believe employers on the site are more fair and honest than offline employers.

4. Digitization and the distribution of work

The effects of the digitization of work may go well beyond the functioning of labor markets. At least in principle, these changes have the potential to affect more broadly the distribution of work and production across countries, the decision of companies about their boundaries, and ultimately income distribution and welfare. The "market-making" features of online contract

labor platform can also offer insights for similar institutions in other contexts. We refer to a number of economic theories and evidence to advance these conjectures.

Geographic distribution

The reduction in search, communication, and monitoring costs brought by the digitization of contract labor markets as discussed above raises the possibility of improving employer-contractor matching and thus enhances gains from trade. A consequence of this is a potential impact on the geographic distribution of work. Perhaps the most immediate and dramatic gains are those based on cross-region wage variation. Indeed, the dramatic growth in activity on oDesk seems to be primarily of this nature. Specifically, employers in high-income countries hire contractors from low-income countries. As reported in Figure 1, not only were there more than 10 times as many employers from high-income countries by late 2012, but the growth rate of employers from high-income countries was much higher than that from low-income countries. The gap was even greater if expressed in terms of the wage bill rather than the number of employees (Figure 2). Conversely, by 2013, approximately 4.5 times as many contractors are from low-income countries as from high-income countries by 2013 (Figure 3). The trends so far suggest that the spread will continue to increase over time since the number of contractors from low-income countries is growing at a faster rate. Figure 4 confirms that this trend also exists in terms of the total monthly wage bill, not just the number of contractors, despite the fact that, as one might expect, wages are higher for contractors in more developed countries.

Although access to lower-cost labor is one reason for recruiting distant contractors, employers report other reasons as well. In a survey of its users conducted by oDesk, 76% indicated that "remote is less expensive" was a primary reason they were interested in using the platform. However, 46% selected "can get work done faster remotely," 31% selected "difficult to find local talent," and 21% selected "no room/equipment." Thus, in addition to the reduced cost of accessing lower-wage workers, enhanced matching seems to benefit from gains on multiple dimensions.

Differences in participation to online contract labor markets exist even within countries at similar levels of income, development, and size. As shown in Figure 5 in particular, where we plot the number of contractors on oDesk per country against a country's population, nations such as Nigeria, Kazakhstan, and South Korea appear to be "under users" (participation below what

their population would predict), whereas the Philippines, Bangladesh, and India appear to be "over users."

The variation in usage of this digital marketplace may simply reflect offline employment opportunities. We provide evidence of this in Figure 6, where we compare the average hourly wage on oDesk for contractors in a given country with that country's minimum wage. oDesk contractors from Bangladesh and the Philippines, for example, do indeed earn significantly more than local minimum wages, perhaps partly explaining their "disproportionate" use of the platform. However, contractors from China also earn significantly above the local minimum wage on average yet "under use" the platform relative to other nations. Furthermore, contractors from several countries, like Australia, earn only slightly more than the local minimum wage, on average, and yet seem to be "over users." This variation reflects the relative benefits and costs, including opportunity costs, faced by the labor force in each country. Factors such as proficiency in English (the language used on the site), Internet access, and education levels all affect the returns to engaging with a digitized labor market platform such as this. As these online markets grow, they will provide researchers with useful data to better understand offline employment opportunities, particularly where reliable government data is sparse, and the relative returns to different forms of education in a global work environment.

The different composition of online contract workers across countries may also explain the unexpectedly high average wages received by contractors in certain countries, such as China, Poland, and Russia, as reported in Figure 7. Contractors from these three countries in particular are primarily concentrated in software development, information systems, and web development, which offer higher wages on average: by 2013, the average wage in software development ($16) is approximately double that of writing and translation ($8) and more than triple that of administrative support ($4) as well as customer support ($5) and sales and marketing ($5) (Figure 8). Furthermore, the monthly spend in software development and web development is significantly greater than in any other category (Figure 9). We plot the concentration of total contractor wage bill by country over time in Figure 10. Russia and Ukraine stand out as especially concentrated in only a few sectors (software development in particular). In contrast, contractors from the US and the Philippines do work across many categories. This variation in the geographic distribution of work by category likely reflects language, education, and offline

work opportunities. That said, Figure 11 indicates that software is not the most concentrated sector in terms of the distribution of total wages across countries.

Income distribution

The digitization of contract labor markets may affect the distribution of income across workers. However, the direction of this effect is ambiguous. On the one hand, digitization could amplify income inequality by way of the so-called "superstar effect," whereby the shift to lower search costs enables employers to identify and contract for the best workers (or workers offering the best value) in a global rather than local context such that the distribution of the total wage bill skews further towards a minority of contractors. On the other hand, digitization could reduce inequality and lead to a "long-tail effect" that similarly results from lower search costs and more efficient matching.

Researchers report evidence of both types of effects resulting from digitization. For example, Tucker & Zhang (2007) find that when consumers on a wedding vendor website are able to see the popularity of a given vendor, sales concentrate around the more popular vendors. This suggests that online feedback systems have the potential to increase skewness. Elberse & Oberholzer-Gee (2008) find similar support for video sales. In other cases, the reverse is true. Zentner et al. (2012) show that online video rentals are less concentrated around blockbusters than physical rentals, Peltier & Moreau (2012) show that online book sales in France are less concentrated around superstars than offline, and Brynjolfsson et al. (2011) find that Internet sales for women's clothing are less concentrated than catalog sales. All of these papers identify search cost differences as explaining the results.

These effects are not fully mutually exclusive and may in fact both be at work in the context of online markets for contract labor. This is because they are influenced by related but distinct characteristics of the services traded in this market. Vertical differentiation (quality) drives the superstar effect, whereas horizontal differentiation (variety) drives the long-tail effect. Therefore, subject to demand constraints, they may coexist. The superstar effect will result in increased income inequality as employers tend towards the highest quality (or best value) contractors based on a global rather than local search. Thus, income will shift from contractors offering the best value locally to those offering the best value globally. Increased demand will drive up the wages of the highest quality workers, mainly in cases where the spread is greatest between local and

global wages (i.e., low-income countries). The superstar effect may be exacerbated due to information asymmetries and features of the market.

At the same time, horizontally differentiated contractors (e.g., those who specialize in less common areas) whose offline wages are lower due to limited local demand for their expertise may particularly benefit from digitization since the shift from local to global matching may disproportionately increase the demand for their skills relative to the supply. For example, a software developer in Malaysia who learns to program in a new "cutting-edge" language (e.g., django) may benefit from digitization since by connecting to the global market that contractor will likely face a greater increase in demand for that skill than they will face an increase in competition for supplying that skill.

In summary, digitization may shift the income distribution in a manner that benefits contractors with skills that are vertically differentiated (i.e., higher quality), horizontally differentiated (i.e., scarce), or low-cost at the expense of those with skills that are neither differentiated nor low cost (i.e., mediocre quality, common skills, in high-income or mid-income countries). The net effect of such a shift is ambiguous, both at the country level and the individual level. At the country level, although the immediate effect of digitization may be to decrease income inequality as the total wage bill shifts from high- to low-income countries due to expanded search for skills and smaller costs in low-income countries, the resulting increase in productivity of firms in high-income countries may further increase offline wages there and offset the effect of offshoring. At the individual level, while digitization will favor the highly skilled relative to the less-skilled, particularly in high-income countries, unlike products with low marginal costs such as music, books, and software, the services provided by a contractor have increasing marginal costs. Therefore, enhanced matching and constrained supply may at least partially offset increased competition and thus temper the extent to which digitization amplifies the skewness of income distribution at the individual level.

Information asymmetries may also affect income distribution. The available evidence shows that even small amounts of (employer- or platform-provided) information have a large effect on future employment prospects (Agrawal et al., 2013; Pallais, 2012). On the one hand, this may increase the skewness of income distribution because contractors who obtain a small lead early on, in terms of online work experience with a positive public employer review, may experience subsequent gains and benefit from increasing returns (at least in the short term). On the other

hand, to the extent that online markets facilitate low-cost trials for employers to "test" working with novice contractors and then publicize their quality, the digitization of this market may decrease skew through the increased public revelation of contractor quality. The fact that a small amount of verified work experience online is associated with a disproportionate increase in winning subsequent jobs for contractors in low-income countries (Agrawal et al., 2013) seems consistent with this latter view.

Boundaries of the firm

How will the digitization of this marketplace influence the boundary of the firm? Economic theory suggests that because digitization lowers transaction costs (search, communication, and monitoring), the returns to contracting in the market increase relative to performing these services in-house. For example, Grossman and Rossi-Hansberg (2008) model the tension between the benefits (lower cost of labor) and costs (coordination and monitoring) of offshoring to examine precisely the effects of a decline in the cost of offshoring, focusing on the productivity effect of increased offshoring.

Similarly, Antras and Helpman (2004) present a model of North-South trade where final-goods firms choose whether to vertically integrate into the production of intermediate goods or outsource them. Their model offers an explanation for variation in firm boundary decisions (in equilibrium, some firms outsource while others do not, and those that do vary in their outsourcing location choice) based on the variation in firms' productivity levels. Although the authors do not focus on the effect of falling transaction costs associated with outsourcing per se, the influence of this on firm boundaries is a natural implication of their model.

Several studies report empirical evidence that digitization is associated with a contraction in the boundary of the firm. For example, Abramovsky and Griffith (2006) report that more ICT-intensive firms purchase a greater amount of services on the market (rather than vertically integrating) and are more likely to purchase offshore, Brynjolfsson et al (1994) report that investment in IT is correlated with a subsequent decrease in firm size, and Hitt (1999) shows that an increase in IT use is correlated with a decrease in vertical integration.

Other researchers have conducted empirical studies that relate firm boundary decisions to the digitization of the contract labor marketplace. However, a recent survey of its users given by oDesk sheds some light on this relationship. Two specific survey questions offer insight on how employers perceive the online platform relative to alternatives for performing contracted

work. Overall, these descriptive data indicate that digitization of the contract labor market may only affect firm boundaries in a minority of cases, suggesting perhaps that the primary motivation for using the platform is to increase the productivity of existing employees.

One of the survey questions asks: "If there had not been an appropriate oDesk contractor available for this project, then what would you most likely have done?" Of the 6,912 respondents, only 15% indicated that they would have turned to a local hire, whereas 22% replied that they would have worked extra hours, 9% replied that they would have delayed or canceled the project, and 50% indicated that they would have used some other remote source. Although there is room for alternative interpretations of these responses (for example, "other remote sources" could refer to other online contract labor platforms such that the results underrepresent the fraction who would hire locally in the absence of any online platforms), one interpretation is that the digitization of this marketplace directly affected the boundary of the firm in only a minority (15%) of the cases.

A second oDesk survey question asks: "Thinking about the last time that you hired a contractor through oDesk, what alternatives did you consider?" In this case, respondents were able to select more than one option. Again, only 15% selected "hiring an employee," whereas 58% selected "doing it myself." Shifting from local to distant contractors appears to be a more significant economic effect from the digitization of this market than contraction in the boundary of the firm. Indeed, 40% of respondents indicated that a "local contractor" was an alternative they considered when they last hired a contractor through oDesk.

It is important to note that the majority of oDesk users are small businesses (90% of 7,098 survey respondents indicate that their business had 10 employees or less, with an overall average firm size of 2.6 employees). This raises the question of how the effect of digitizing this marketplace may vary across firm size. For example, do small firms benefit disproportionately from digitization? We cannot draw this conclusion simply from observing a high fraction of small-firm users. First, the 90% small-firm user population may just reflect the distribution of firm sizes in the economy. However, for two other questions, respondents reveal that 68% are part-time businesses, 69% are home-based businesses, and the average firm age is 2.7 years. Second, the survey sample distribution may not reflect the population distribution. Perhaps small firms are more likely to respond to the survey. Still, one might conjecture that small firms are more likely to hire contract workers since large firms are better able to aggregate tasks into

full-time jobs and thus avoid the contracting and discontinuity costs associated with task-based hiring.

5. Market design

Platforms in decentralized online contract labor markets do not have the match-setting power typical in other contexts that the market design literature has considered (e.g. Roth & Peranson, 1999; Roth, 2002; Milgrom, 2011). However, an inability to set matches explicitly does not imply an inability to influence what matches are ultimately formed and under what terms.

The position of the platform vis-a-vis the marketplace is more like that of a government that sets policies to encourage efficient market outcomes without dictating trades. The platforms can generally decide how often and in what context participants are exposed to each other, what information is collected by parties and how this information is displayed. Platforms can also set policies about what trades are permissible, how entry is gained, what contracts and prices are allowed, and so on. The platform additionally has the power to make recommendations and set defaults. A few market-design decisions in this "softer" match-making environment are worth considering to explore how these features affect the agents' decision and whether similar features can be developed in other contexts.

First, just like in other two-sided platforms, contract labor sites allocate visibility by determining that labor markets are different in that sellers are inherently supply-constrained. Because of this constraint, even a worker that is the "best" match for a particular job might be a very poor match in practice because their availability is limited at a particular time. Ideally, workers would self-report availability, but because job offers are useful even if they are not accepted (e.g., for bargaining power) and workers have free disposal on offers, getting them to honestly report availability is challenging. A few research questions and ideas for structuring these platforms emerge, with regard to the allocation of visibility: How should it be allocated? Does this allocation preserve assortativity (i.e., worker with higher feedback or hours worked are always given more visibility than workers with less)? Does each worker get at least some visibility? If visibility is auctioned off, what would be the efficiency and distributional properties of such an allocation?

Second, platforms potentially may need to control congestion due to the fact that posting (and applying for) a job is almost costless. It is not difficult to imagine how the low cost of

applications causes an "everyone-applies-to-everything" equilibrium in which each application also carries virtually no signal value.[3]

Accordingly, platforms might want to consider job application quotas. However, as described above, this strategy might penalize new entrants with low probabilities of being hired (Pallais, 2012). It also ignores employer heterogeneity, with some employers probably requiring many applicants and others few.

Another potentially interesting approach is to allow the employer to decide the "cost" of applying. These are additional areas for research to be tailored to the peculiarities of these markets.

Third, because both workers and employers have many decisions to make, such as what jobs to apply to and at what wages, what skills to learn, etc., the digitized nature of these platforms, just like in other online markets, might lead to the development of algorithmic assistance with decision-making, for example through a recommendation system We might think of these recommendations as augmenting the decision-making and/or reducing the search costs of market participants. However, one problem with recommending people is the issue of crowd-out. Recommending one worker presumably puts another worker at a disadvantage. Horton (2012) shows that the quantity and quality of matches can be improved via algorithmic recommendations to employers about candidates to recruit for their openings, without significant crowd-out effects. Aside from these obvious recommendations about who to trade with and at what terms, the platform can also make other kinds of informational interventions/recommendations. It can, for example, advise parties of best practices in how to manage a working relationship, perhaps suggesting more communication, periodic raises, performance evaluations, etc.

One interesting challenge of any recommender system is the trade-off between learning and recommending: any recommender system relies on "natural" decision-making to explore the space of alternatives to train models, but any sufficiently good recommender system that saves its users substantial costs is likely to displace natural decision-making.

One area where algorithmic recommendations might be particularly valuable is helping individuals make good decisions about the accumulation of human capital, particularly around

[3] This was partly the motivation for introduced the AEA signaling mechanism (Coles et al, 2010), in which job-market participants are given two (and only two) “signals” to send to schools. The school’s knowledge of the scarcity of signals makes those signals informative.

which skills to learn. Such decisions are made a small number of times by relatively uninformed individuals who receive one-time feedback about their choices.

In traditional markets, decisions about human capital investments are difficult to observe. In online labor markets, these choices are more visible and measurable. On platforms like oDesk, an enormous amount of information illustrates which skills tend to go together, the wages associated with those skills, and even common career trajectories, allowing recommender systems to distill which skills to learn and then learn how they perform via experimentation.

A fourth interesting market-design feature of these platforms is the creation of submarkets and categories that are often defined through some combination of geography and time to coordinate activities and thus create a sufficiently thick market (e.g., the creation of industrial districts for specific sectors). The platform must attempt to define at some level of detail the various services being offered and then organize the market accordingly. In the language of machine learning, there is both a "clustering task"(finding the meaningful groups of jobs/contractors based on historical data)and a "labeling task" (being able to assign a new job to one of the identified clusters based on that job's attributes).

Conclusion

We identify three broad lines of inquiry as central to the digitization research agenda. All three focus on the effect of digitizing the market for contract labor. The first concerns welfare effects, the second distribution effects, and the third user behaviour effects. All three are set in the context of the market for contract labor but have broader implications for digitization in other settings.

Access to data will pose a challenge to fully addressing these questions. In contrast to data from online platforms that collect information on hiring (as well as pre- and post-hiring) transactions at a granular level and at low cost, it is costly to obtain even a basic level of offline contracting data. Yet, to fully address the first two lines of inquiry outlined above, offline data is required to estimate the causal effect of digitization on changes in welfare and distributional properties (geography, income, firm boundaries). This is likely why most of the first wave of studies concerning the digitization of this market focuses on market design related subjects (e.g., experience, agencies, ratings) since these questions only require observing within-platform variation in user behaviour and do not require linking these data to non-platform-participants.

While the third line of inquiry, market design and user behaviour, is largely spared from the requirement to link with offline data, the greatest challenge to this research in the short and medium term will likely be the rapid evolution of the industry. As illustrated above, the industry is growing at an exponential rate. In addition, complementary technologies, such as those associated with mobile and social, are changing rapidly. As such, market design features that seem salient today may be less relevant relative to other features in the future. For example, monitoring technologies such as work rooms with screen shots was only recently introduced and is already standard practise across many platforms and likely to be replaced soon with streaming screen video. While the ultimate goal of research of this type is obtaining a deeper understanding of human behaviour rather than of a particular market design feature, the economic salience of the feature is often important for generalizability and yet may be fleeting due to the rapid pace of change in this setting.

Whereas the former two lines of inquiry are most likely to be led by scholars and policy makers, the latter will almost surely include important contributions from industry since this issue is of first order importance for product development and competition. This has already been the case with oDesk (Horton, 2010; 2012) as well as with other market design issues on platforms such as Google (Varian, 2007; Choi & Varian, 2012), eBay (Blake et al, 2013), and Yahoo (Lewis et al, 2009; Ghosh & McAfee, 2011). Industry interest coupled with their access to high quality data may significantly accelerate progress on this research frontier. At the same time, the competitive implications of market design insights may inhibit the dissemination of this type of research and thus the overall impact of industry interest in this subject on the rate and direction of progress on this part of the agenda is ambiguous.

Given the role that platforms play as the central collectors of data in these markets, they will influence the direction of research on all three lines if inquiry through the decisions they make with regards to providing researchers with access to their data. Early signs are promising for the research community since many of the most prominent platforms have established "Chief Economists" or similar types of research-friendly leadership positions and encourage employees to participate in the scholarly community by publishing their research and participating at conferences and other scholarly events.

Given the rapid growth rate of the online market for contract labor, this research agenda is economically important. The first line of inquiry will help us better understand the potential

welfare benefits due to digitization in this sector of the economy. The second will shed light on how these benefits may be distributed across countries and individuals and their impact on the structure of the firm. The third will provide us with further insight into human behaviour in the digital world as we explore user reactions to market design features, many of which are widely used in many sectors outside of just contract employment. Overall, these insights will be of great interest to scholars, policy-makers, and industry participants alike.

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Figures

Figure 1: Employers on oDesk Over Time and By High- vs Low-Country Income Level

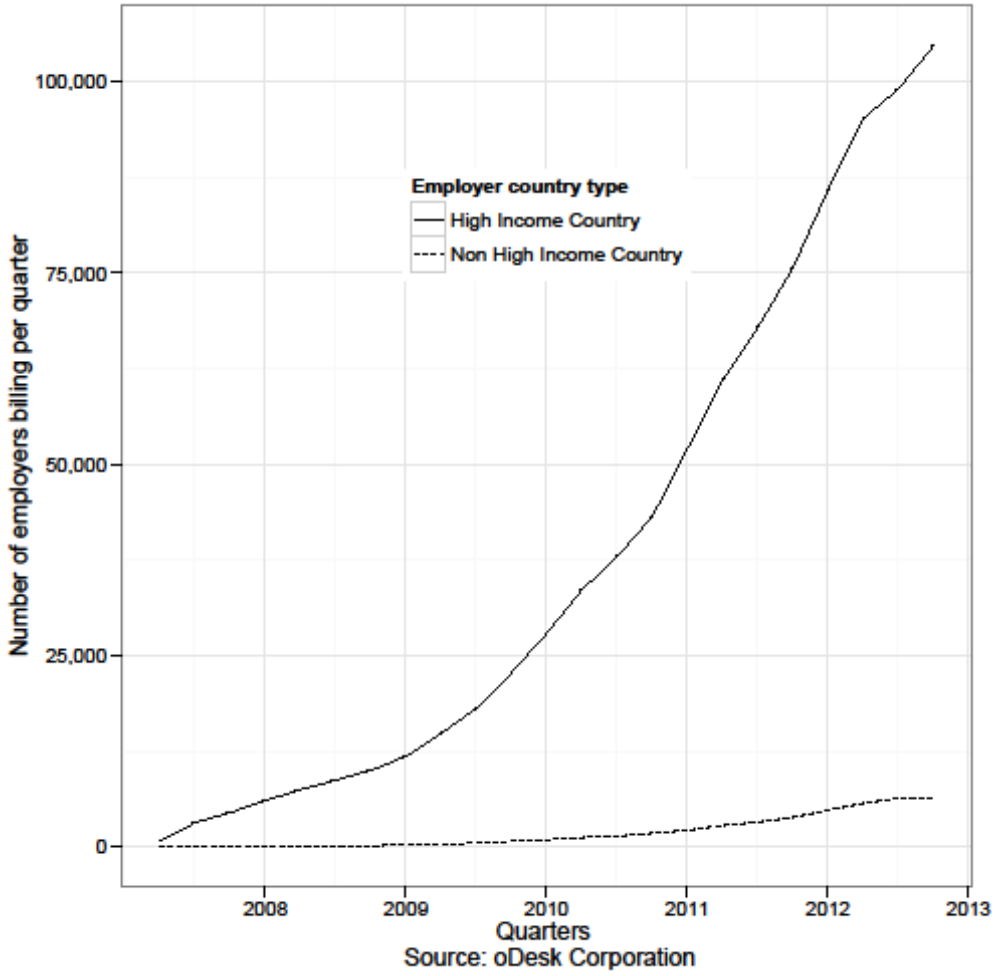

Figure 2: Employer Spending on oDesk Over Time and By High- vs Low-Country Income Level

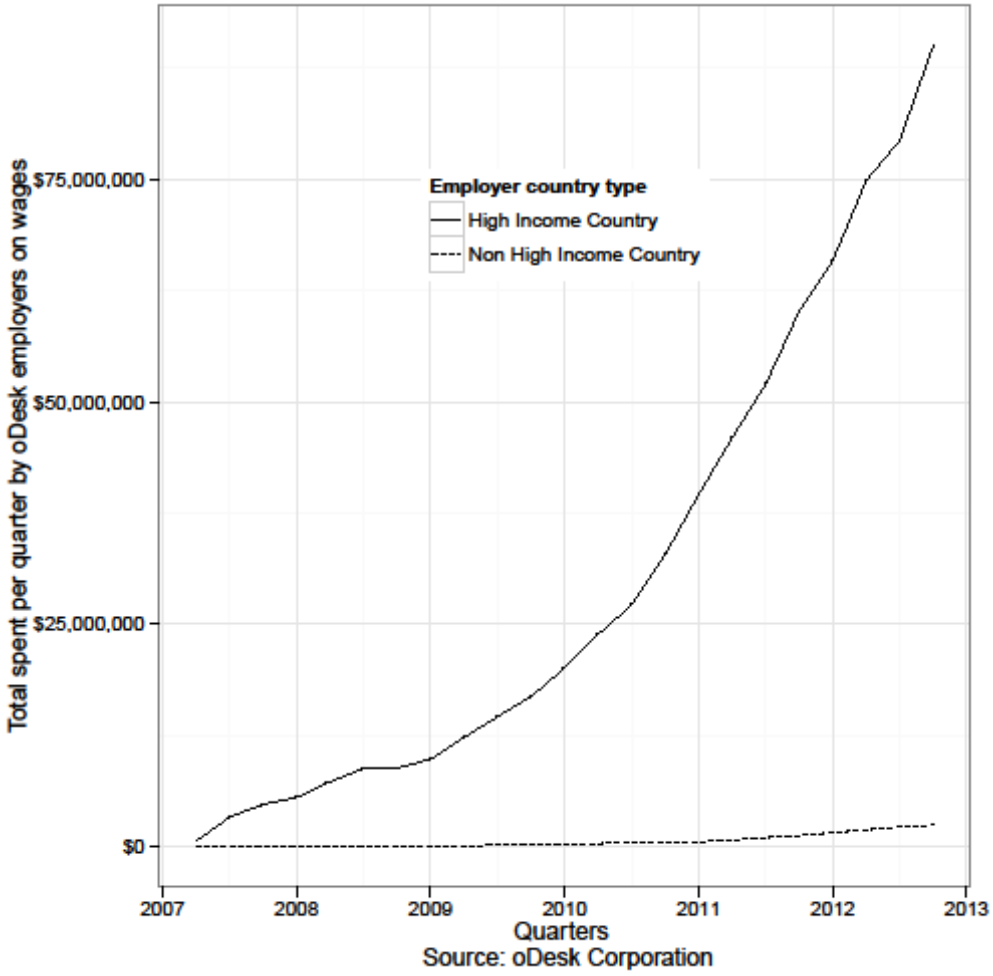

Figure 3: Contractors on oDesk Over Time and By High- vs Low-Country Income Level

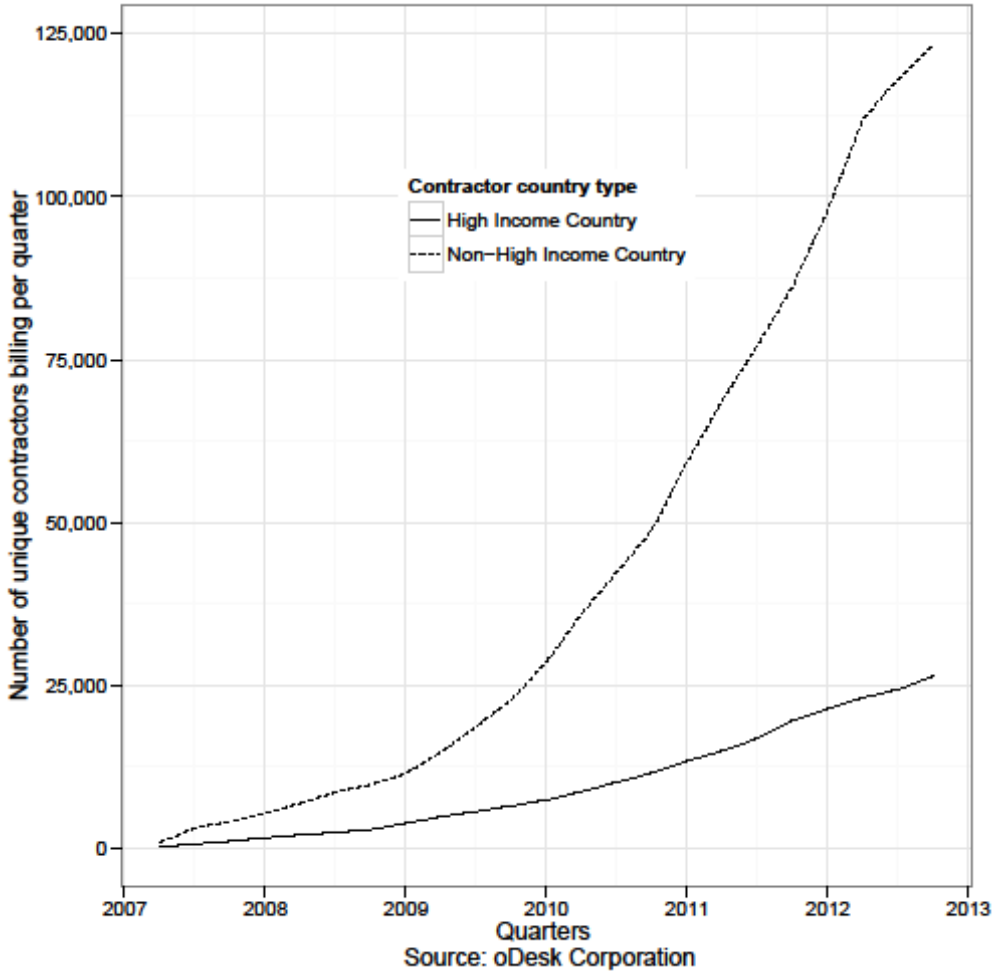

Figure 4: Contractor Earnings on oDesk Over Time and By High- vs Low-Country Income Level

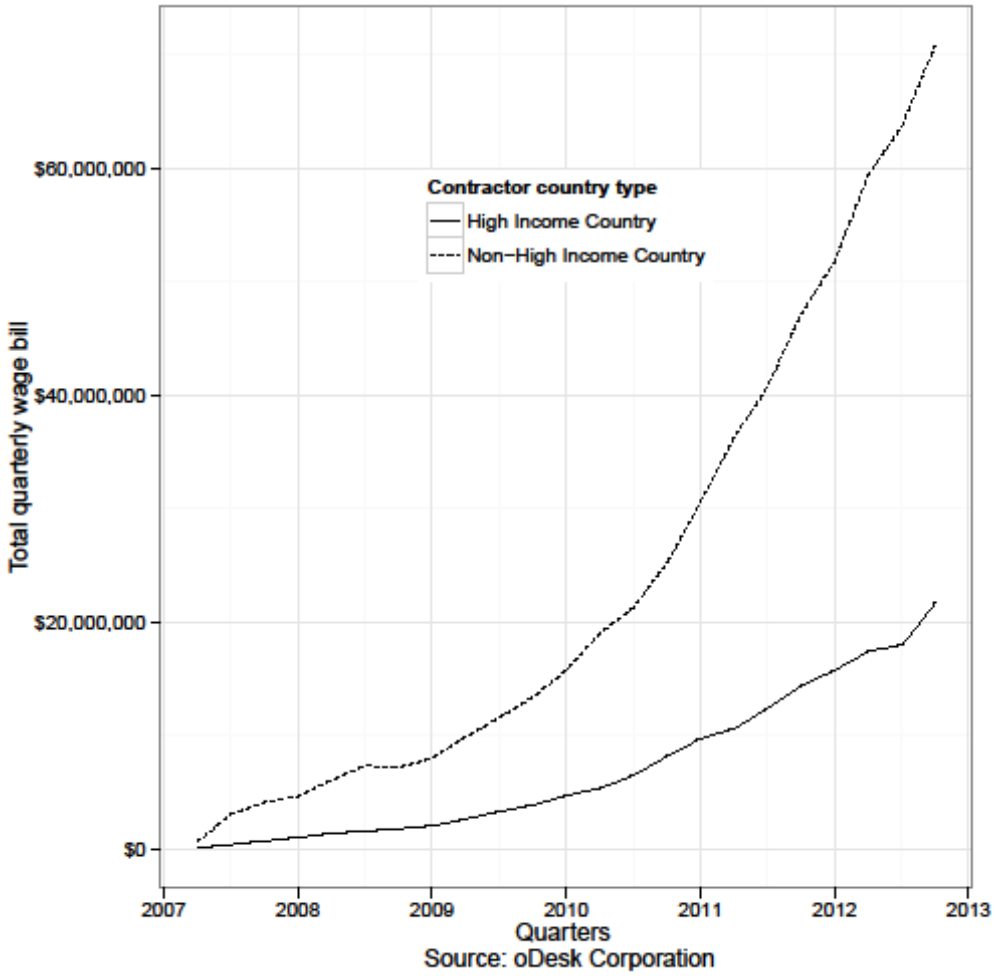

Figure 5: Contractor Country Representation on oDesk

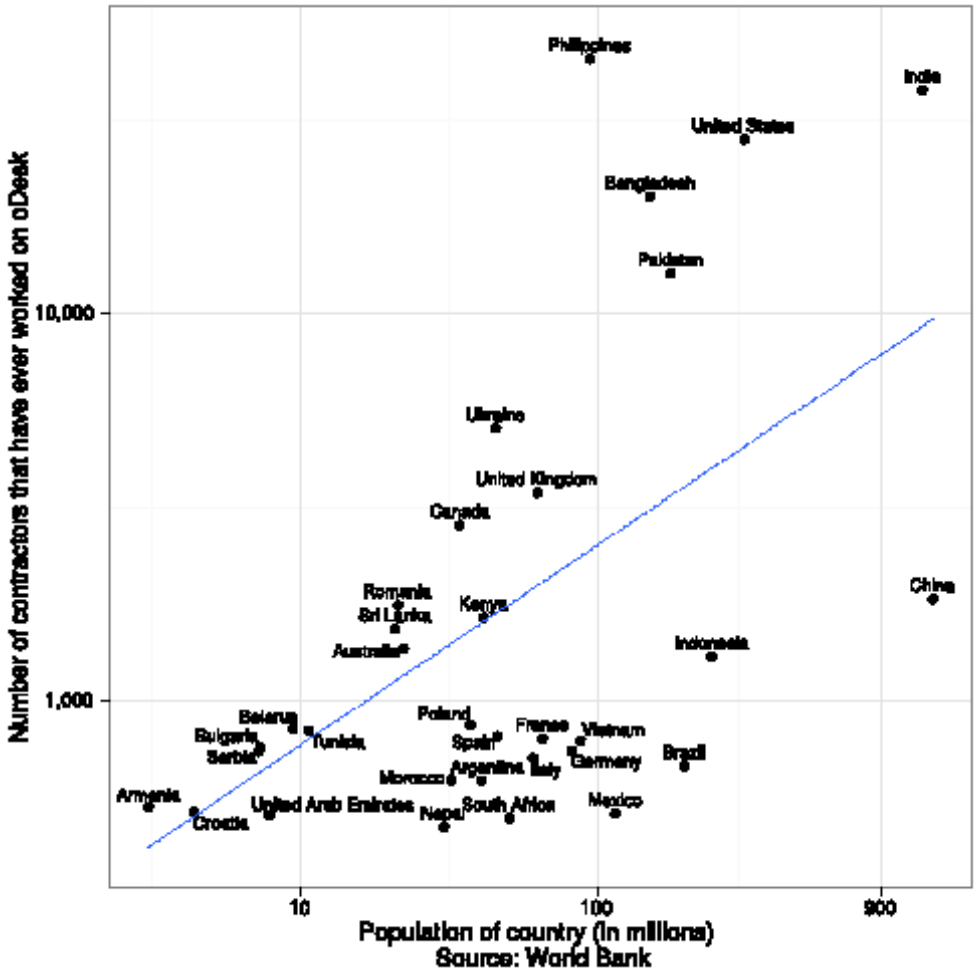

Figure 6: Contractor Earnings on oDesk by Country Relative to Local Minimum Wage

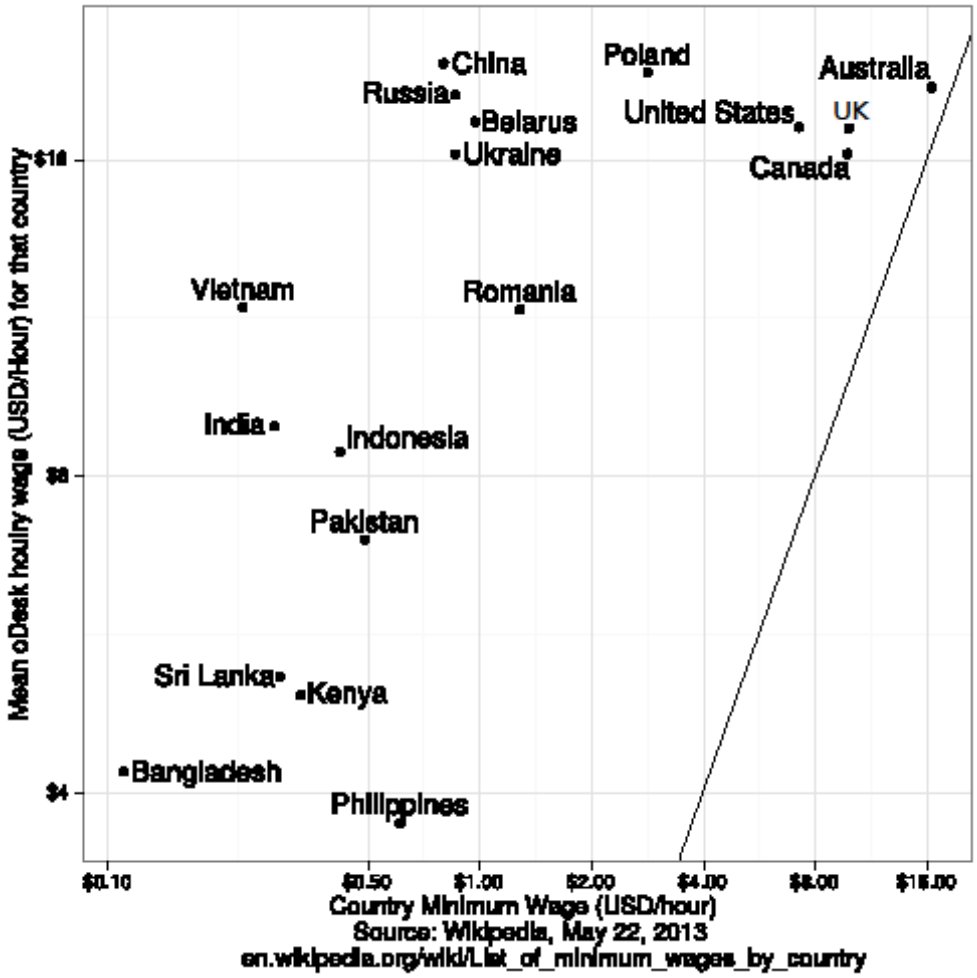

Figure 7: Contractor Earnings on oDesk by Country

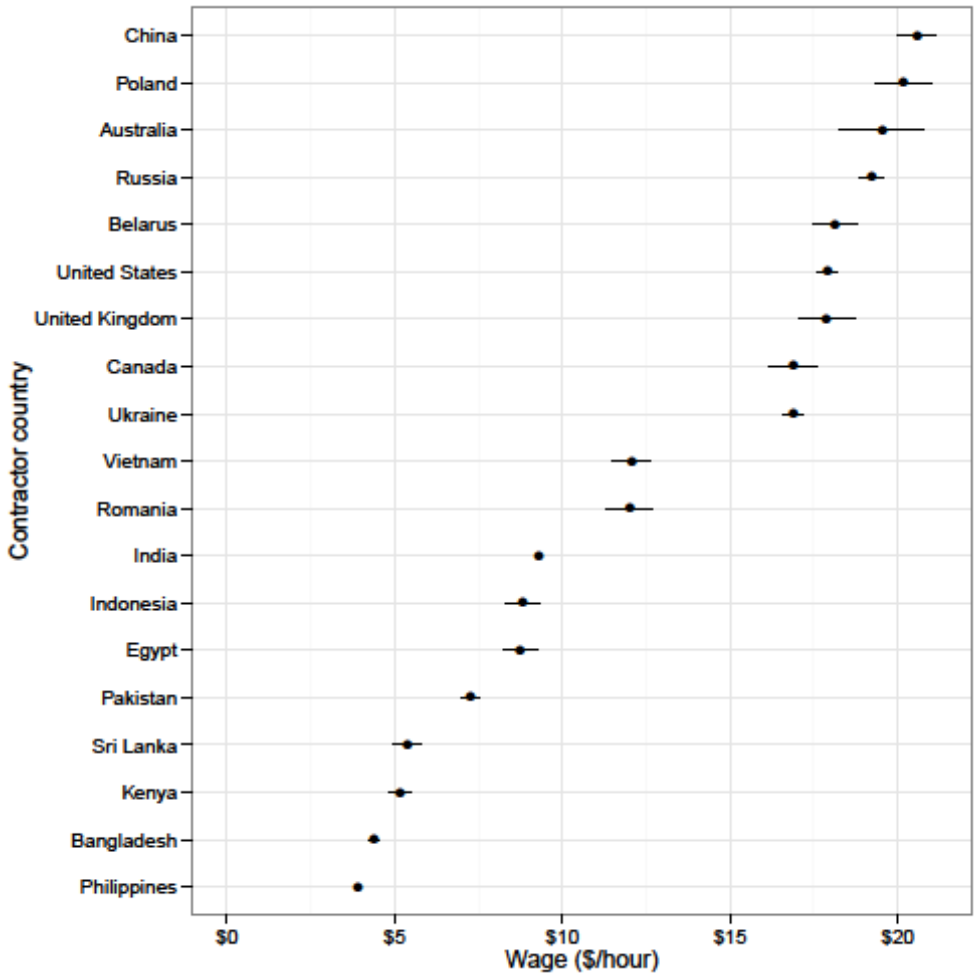

Figure 8: Average Wage on oDesk by Job category

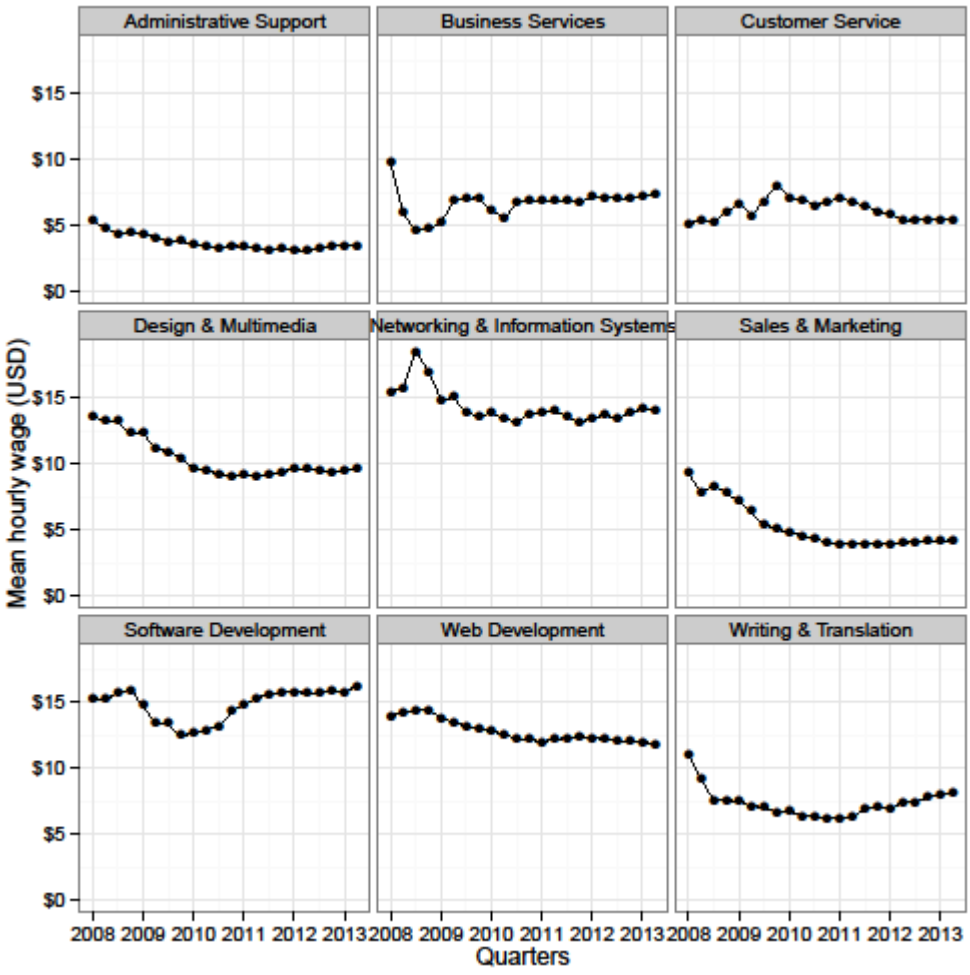

Figure 9: Monthly Spending on oDesk by Job category

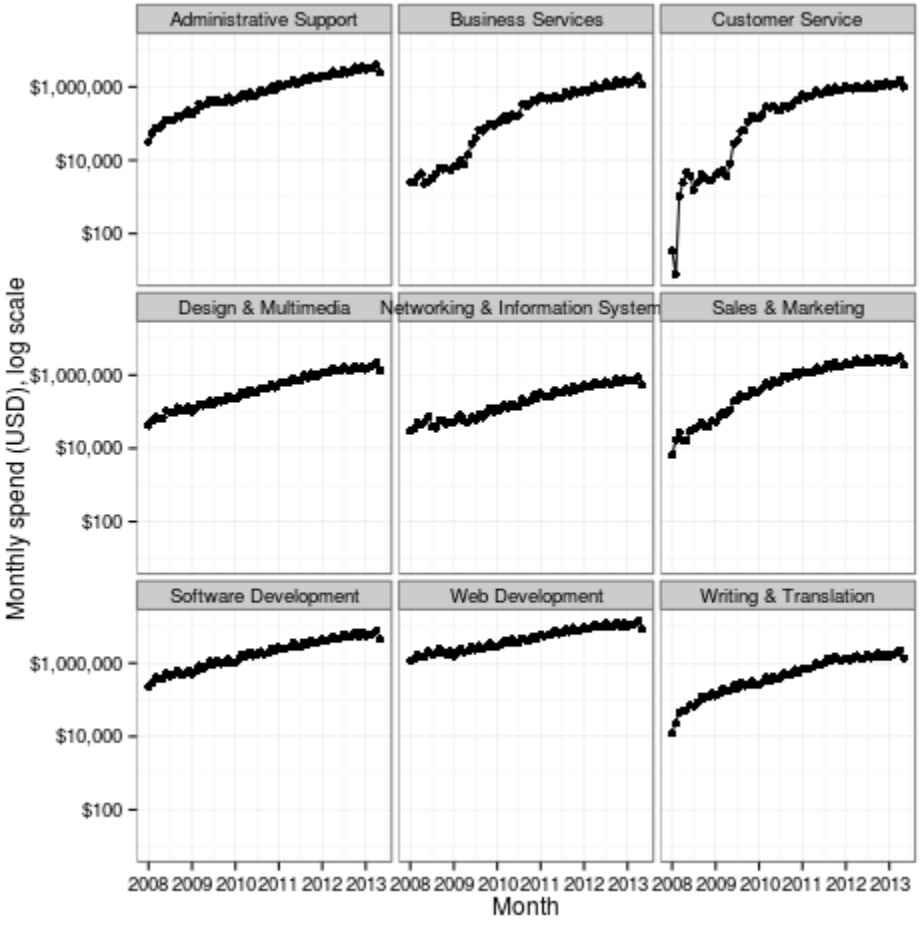

Figure 10: Contractor Job Category Concentration on oDesk by Country

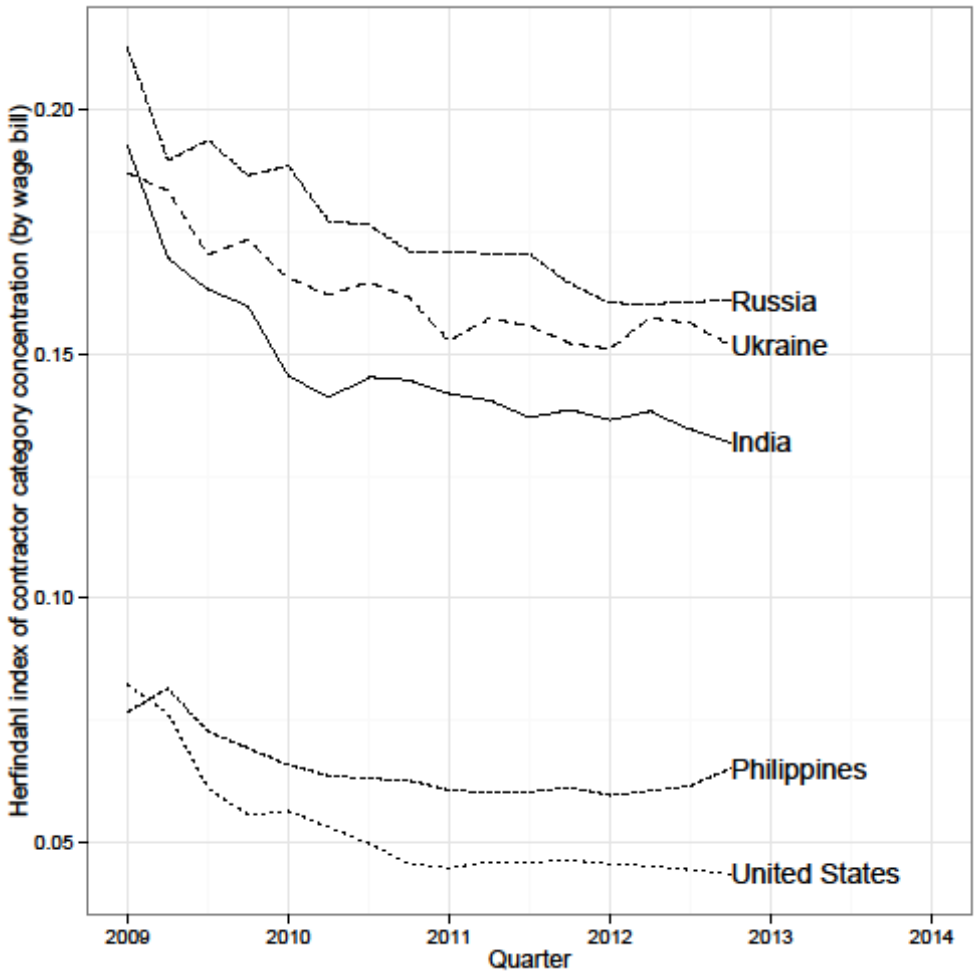

Figure 11: Job Category Concentration on oDesk by Country of Hires