Information Sharing and Individual Performance: Evidence from a Japanese Bank

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Abstract

How do information sharing and communication within an organization affect employee performance? Answers have proven elusive due to problems obtaining precise measures of white collar output and of the information individuals consume. We address this question using an original panel data set that includes all accesses to an information sharing platform together with performance measures of all loan officers at a Japanese bank. This paper makes three main contributions. First, we document that low skill agents benefit the most from acquiring information from others. After controlling for unobserved heterogeneity over time, between branches, and officers, a standard deviation increase in information access increases performance by almost ten percent. Second, restricting attention to officers who switched branches, we show that they perform on average significantly worse than before the switch. Job rotation appears to destroy specialized human capital while significantly increasing demand for information. Third, our findings are robust to using exogenous variation in information sharing arising from cultural differences between branches. We conclude that there exists substitution between officers' ability and the amount of information they access from one another.

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1   Introduction

A key economic problem in organizations is to use available knowledge optimally. Information, however, is often dispersed among agents, which prevents implementation of efficient decisions if communication is not allowed. This can have severe consequences, especially when the organization operates in markets characterized by the need for specialized knowledge. Credit markets as well as insurance markets and more generally financial markets are only a few examples. The agents might, in fact, decline a loan to a reliable client or fail to identify the appropriate class of risk for a new costumer. When communication is available, instead, agents may acquire information from somebody else in the organization. As Hayek (1945) pointed out: "it is a problem of the utilization of knowledge which is not given to anyone in its totality."

The effects of improved communication, however, on productivity are not obvious. On the one hand, low skill agents may ask others for directions, thus communication might improve performance through a *learning channel*. On the other hand, high skill agents might spend a larger fraction of their time helping others, which might negatively affects their performance within the organization. Furthermore, even when the production and usage of information is not explicitly incentivized, a strategic motive might drive the agents' away from efficiency. Consider a high skill worker who has now the possibility to share with others his knowledge. He might use this as an instrument to signal his ability, in order to increase the probability of being rewarded within the organization. Then, he might substitute his ordinary tasks with the possibility to provide information to others. Similarly, even if communication does not directly affect the incentive scheme in place, a low skill worker might be reluctant to ask others for required information to complete his tasks, being afraid to signal his low ability.

This paper analyzes empirically these issues within the corporate division of a major worldwide bank primarily located in Japan. Starting in 2003, the bank implemented an online platform to allow employees to be constantly informed by the headquarters and to share their information with their colleagues. In particular, each

employee has now access to the documents made available by the headquarters, or may ask questions to other employees and provide answers to others' questions. This new technological adoption allowed a more efficient communication, both vertically, between headquarter and the lower layers of the organization, and horizontally, that is, between workers. This provides us with a natural environment in which to understand how communication, and information sharing in general, affects productivity.

We exploit two unique properties of our dataset. First, we have very detailed data on the performance of each loan officer inside the bank for the two-year period 2006-2008. We observe the targets set by the headquarters and the results achieved by each manager in a number of different dimensions such as gross profits, loan volume and revenues. The performance of the agents in these dimensions constitutes our *objective* performance measure. However, we also collected the head of the branch evaluations of each loan officer performance in more informal and softer dimensions, such as contribution to branch operations and customer-oriented processes. These evaluations can be interpreted as *subjective* performance measures because they are not directly related to the attainment of a pre-determined target.

Second, we are able to exploit a source of exogenous variation coming from an anti-corruption law which requires the agents to switch branch every two years. This allows us to use an instrumental variable procedure, in order to assess the causal effect of information sharing on employees' productivity. Moreover, our results are not contaminated by incentive considerations, in fact, there is no material incentive to use the new technology. Furthermore, the banking sector in Japan is very different from the one in the United States. In particular, while the incentive system implemented by this bank does not provide loan officers with end-of-the-year bonuses, incentives are exclusively constituted by the possibility of being promoted.

Our paper provides evidence that low skill agents benefit the most from the possibility to acquire information from others. The magnitude of the effect is quite significant. In fact, controlling for unobserved heterogeneity over time, between branches and managers, a standard deviation increase in information access increases performance by more than ten percent. This supports the idea that agents might under-perform because they are not aware of more successful management practices

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implemented elsewhere or lack the necessary information to fill the gap.

We also restricted attention to agents who switched branches and we have found that they tend to increase their demand for information right after the switch, but this effect declines over time. This supports the hypothesis that learning is a major factor affecting performance. Intuitively, when a loan officer is forced to switch branch, he does not possess, for example, the knowledge of the local market conditions to assess the reliability of new clients. Without the possibility of communication with more experienced officers, he would not be able to assess clients' reliability, which would negatively affect his results.

The possibility to restrict attention to switchers, offers us the opportunity to investigate their performance in the new branch. We find strong evidence that switching negatively affect their performance, in particular, after the switch they perform on average significantly worse than before. This result is of independent interest, in fact, it suggests that specialized human capital is destroyed when they move to a different branch. This is surprising because we are considering the same worker within the same organization, controlling for regional and branch differences. This finding contributes to the labor literature on the accumulation and destruction of specialized human capital.

Finally, we further exploit the mandatory switching of loan officers across branches in order to assess the causal effect of communication and information sharing on performance. Since there is variation in the usage of the information sharing platform across branches, we are able to construct an instrument based upon the attitudes of a branch towards the new technology. For each manager i, our instrument is the amount of information accessed in the previous branch excluding manager i. That is, if manager A worked in a branch in which problems are usually resolved within the branch, without attempting to find the solutions elsewhere in the organization, even when manager A moves to a different branch, he will be more unwilling to communicate with other loan officers. On the contrary, if manager A worked for a branch in which the access to information provided by others is encouraged, he will have the same attitude in the new branch.

We find even stronger results than those found with the estimation of the longi-

tudinal model. This provides further evidence in favor of the hypothesis that there exists substitution between the loan officers' ability and the amount of information they have access to.

The paper is organized as follows. Next section discusses the relationship with the existing literature. Section II discusses the institutional background, and describes the data. Section III explains our approach and the methodology we employ to estimate the effect of information sharing on performance. Section IV presents the main results on the effect of communication on performance, promotions and the effect of switching on information demand and productivity. Section V presents the results of our instrumental variable estimates. Section VI summarizes the results and concludes.

1.1   Related Literature

Researchers have long investigated the differences in productivity performance between firms and plants within sectors and across countries. The magnitudes involved are striking. For example, within the 4-digit SIC industries in the U.S. manufacturing sector, the average difference in productivity between the highest and lowest percentiles are around 1.92^1. These productivity differences across similar enterprises are also persistent over time. As shown in the literature, the autoregressive coefficients are on the order of 0.6 to 0.8^2.

Most of the applied economic research focused on documenting and explaining the main drivers of these performance differences. Existing works in different fields have linked productivity levels to a number of features of technology, demand, human capital and market structure. However, to create persistent performance differences the advantageous inner workings must be difficult to imitate, this suggests that part of the performance variation across similar enterprises might be due to other aspects

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[1]See Syverson (2004) for a in-depth analysis of the productivity dispersion in the U.S. manufacturing sector.

[2]Arpad Abraham and Kirk White (2006) and Foster, Haltiwanger and Syverson (2008) among others study the evolution of productivity over time. Bartelsman and Doms (2000) present an earlier survey on productivity while Syverson (2010) focuses on the recent contributions in this area that aim to explain why businesse differ in their measured productivity levels.

of organizations such as management practices, communication, and managerial talent, which are softer and more informal than others identified in the literature[3]. One related aspect, central to management literature, is whether internal organization can create competitive advantage; however, empirical economists have had relatively little to say about this issue. A major problem has been the absence of high-quality data on performance and managers' behaviors to allow for an assessment of what can explain the observed productivity differences.

Our work relates to a number of strands in the literature. First, Garicano (2000) presents a theoretical model of hierarchical organization of expertise[4]. Decisions involve solving problems and thus acquiring the relevant knowledge for the decision. There exists a trade-off between information acquisition costs and communication costs, because agents can directly acquire information at a cost or elicit the relevant information from others at higher level of the organization. The latter is costly because agents at the higher levels need to spend time solving problems faced by others. Bloom, Garicano, Sadun and Van Reenen (2009) employ an international data set in order to investigate the effect of information technology and communication on worker autonomy, plant manager autonomy, and span of control. We are, instead, the first paper that is able to empirically investigate the effect of communication and the possibility to share information among workers on their performance.

Second, recently Bloom and Van Reenen (2007, 2010) surveyed 732 medium-sized manufacturing firms from four countries, collecting data on their management practices regarding operations, monitoring, targets, and incentives. The implementation of these practices is highly correlated with its total factor productivity. On one hand, the nature of our data limits the analysis to one bank but, on the other, it allows us to employ the same fine-grained performance measures used by headquarters to assess managers' performance and to avoid problems related to survey data[5]. In con-

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[3]See Gibbons and Henderson (2010) and Gibbons (2009) for a survey of the literature on performance differences across similar enterprises.

[4]Another related paper in this strand of the literature is Garicano and Rossi-Hansberg (2006).

[5]Similarly fine-grained personnel data are employed by Bandiera, Barankay and Rasul (2009) to study the effect of social connections and incentives on productivity, within the fruit picking division of a UK producer of soft fruit.

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trast to Bloom and Van Reenen (2007), our main focus is the analysis of the effects of the information generated within the organization on white collar productivity.

Third, our paper is related to the strand of the literature looking at the importance of technological adoption in increasing productivity, such as Brynjolfsson, McAfee, Sorell and Zhu (2007), Faggio, Salvanes and Van Reenen (2009), and Aral, Brynjolfsson and Van Alstyne (2007). Brynjolfsson et al. (2007) document case studies where IT enhances the speed with which firms can replicate practices they find productive in one of their lines of business across the entire organization. Our paper addresses a different question since we can look at manager-level performance measure over time. Faggio, Salvanes and Van Reenen (2009) show that industries which experienced the greatest growth in productivity dispersion also saw the largest increase in IT capital intensity. Aral, Brynjolfsson and Van Alstyne (2007) found that information technology can support increased output via an increased ability to multitask.

Finally, this paper is related to the studies of the impact of human resource management on firm performance, such as Ichinowski, Shaw, and Prenushi (1997), Lazear (2000), Black and Lynch (2001), and Bartel, Ichinowski, and Shaw (2005). In particular, Ichniowski, Shaw, and Prennushi (1997) find that human resources practices are observed in bundles, rather than being independently distributed; and second, different bundles are associated with substantial differences in productivity. We find supportive evidence in favor of the hypothesis that being aware of different and more productive practices within the same organization may foster productivity.

2   Empirical models and results

The foregoing discussion suggests that the managers' performance will be a function of their access to the information and the branches characteristics. We address these predictions by estimating a panel regression model. Because the estimation strategy is affected by data availability, this section begins with a description of the institutional background and the data.

2.1 Institutional Background

We analyze the behavior of loan officers, also called "relationship managers", in the corporate banking division of a major Japanese bank (the Bank) during the two-year period 2006-2008. The managers' primary task is to grant loans to local enterprises located across more than two hundreds of branches in Japan. Their performance is assessed every six months and is measured by the percentage of the targets met during the same time. The officers' performance can be affected by two main factors. First, there exist regional differences between branches, such as the local demand for loans and the profitability of local enterprises. Second, there is some heterogeneity in the tasks, in fact, while some officers only deal with the public administration, others need to structure more profitable loans or solicit new clients. However, we shall take into account these sources of heterogeneity among managers.

As explained in the introduction, one of the main differences between a U.S. bank and the Japanese bank we are analyzing is the incentive system in place. While end-of-the-year bonuses are extensively adopted in the U.S. banking sector, the Bank rewards the loan officers by the mean of promotion. We observe about two hundred instances of promotion in our sample, and we can investigate the effect that information sharing has on the probability of being promoted. Moreover, seniority is by far one of the most important factors that increase the promotion probability.

The Bank implements a switching rule as a way to prevent bribes and capture of the loan officers. This regulation prescribes loan officers to switch branch every two years, which allows us to disentangle the effect of branch working environment from the officer's ability on productivity. We shall show that headquarters do not relocate officers based upon their past performance.

In this environment, information sharing among loan officers have several effects. First, allowing managers to share information allow them to better assess the riskiness of the enterprises, or work on more project at the same time. Second, it might allow the low ability workers to fill the gap with the most productive ones. Third, high skill workers may be required to devote a larger fraction of their time to help their colleagues, which might negatively impact their performance. Our main contribution

is to disentangle the different effects that communication has on productivity.

We now discuss the features of this work environment that allow us to assess whether information sharing shapes managerial performance.

2.2 Data Characteristics

We collected data on performance, communication and information sharing from the corporate banking division of one of the major Japanese banks. Our primary data source is the bank's personnel records. They include all loan officers, approximately 2800 people, located across hundreds of branches in Japan. Branches vary in size and primary type of business, mainly due to location. In general, metropolitan branches have more relationship managers, between 30 and 100, and more large enterprises as costumers, while those located in suburban areas have fewer managers, about 10, and smaller businesses as customers. Our data span October 2006 through September 2008. Since the Bank had a major merger in October 2005, we focus our attention on the stable second year of the new bank to avoid having merger activity influence results via changes in managerial performance. The strengths of the data lie in their fine-grained level of detail and the possibility to track each manager's performance over time.

Dependent Variable. Relationship managers are reviewed semi-annually to assess their performance. In order to account for branch location and task differences, there exist six main groups to which each manager may belong. These groups are: large existing account, small existing account, restructuring group, public sector, new strategic account, and new account. Bank headquarters set the targets for each manager in these groups and to each relationship manager the head of the branch assigns a score of up to 80 points based on his performance in the relevant category: bank gross profit, revenue, loan profit, liquid deposit profit, loan volume, reduced disclosed debt, and reduced estimated loss. The performance of loan officers in these dimensions constitutes our objective performance measure.

For increased accuracy, the branch manager may, at his discretion, assign a qualitative score up to 60 for performance in the following categories: customer-oriented

process, contribution to branch operations, contribution to organization operations, and loan reinforcement. As reported by executives of the bank, the branch managers often assign this score to reward high effort that did not yield results or discount low effort that did. Our data include all targets, objective results, and subjective scores for each relationship manager in each group for every branch. That is, we have all performance assessments between 2006 and 2008 for the corporate division of the bank. We believe that the richness of our data and the fact that we need not rely on survey data to extrapolate observed productivity make it highly suitable for study of productivity differences across officers.

In most of the analysis below, we focus our investigation on one dependent variable: total performance. This is the total score assigned to officers, representing the sum of performance in each of the different categories and including the individual subjective score. We also checked our results using only the objective performance measure, which does not include the subjective score assigned by the branch manager, and the results are unaffected.

Independent Variables. The main variables of interest capture how relationship managers use the internal platform to share and gather information. We collected data on all accesses to the information platform by each manager during the period of interest. Our data include (i) the number of documents consulted by each manager, (ii) the number of questions posted, and (iii) the number of answers provided, down to the second of access and across each term.

We also have information on the number of years the manager has worked for the Bank, captured by the variable "tenure," and whether he came directly from school with no prior experience or transferred from another bank, captured by the dummy "college."

2.3   Descriptives

Table 1 reports descriptive statistics for our variables of interest, and two things are worth noting. First, loan officers perform significantly differently, in fact, the mean of our main measure of performance is 52, but the standard deviation is 21.

Table 1: Summary Statistics

	Mean	Median	Min	Max	Std. Dev.
Total Performance	52	48	8	110	21
Number Documents	569	522	102	1618	282
Number Questions	77	45	4	585	123
Number Answers	250	238	4	813	164
Tenure	10	11	0	32	5

Then, even if we focus on the employees of the same bank, within the same country and with homogeneous tasks, we still find that their performance is heterogeneous. Second, loan officers seem to make great use of the available information within the organization. On average they have access to 569 documents, post 77 questions and provide 250 answers during a six-month period. Moreover, the standard deviation of all these three variables is quite high, ranging from 164 to 282. This will be relevant to interpreting model coefficients for our results.

Our main hypothesis is that officers may access the information generated within the bank in order to improve their performance. In particular, we expect low performers to ask more questions and provide fewer answers.

Figure 1 shows that the kernel density of our total performance measure for below median number of answers (above median number of questions) is on the left of the above median number of answers (below median number of questions). The loan officers who help others more often, answering their questions, on average perform better than the others. In contrast, the loan officers that ask more questions are associated with lower performance. Table 2 confirms this intuition showing the officers' performance for those who have shared information more or less than the median officer. The first column shows that there is no significant difference in performance between officers who had access to greater or fewer numbers of documents than the median. The second column, instead, shows that there exists a positive correlation between the number of answer provided and performance. The loan officers who provide a higher number of answers perform significantly better than the others. The third column confirms this result showing that those who ask more questions, above
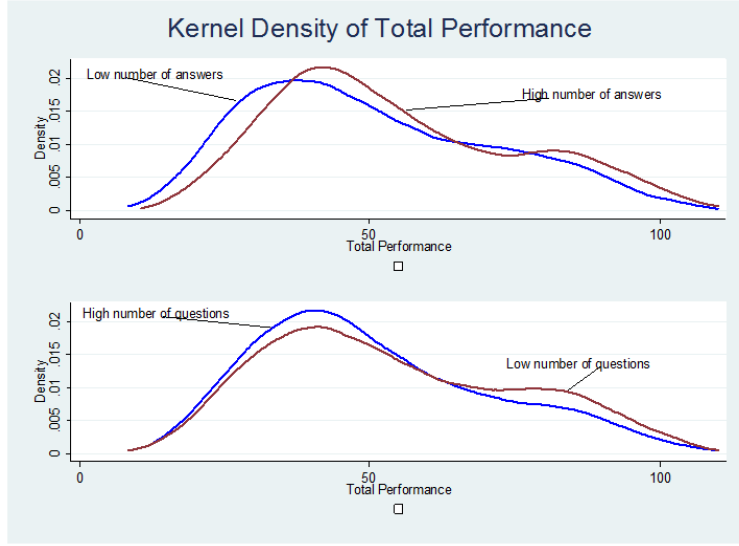
Figure 1: Kernel Density Estimation by Number of Questions and Answers.

the median, performs significantly worse than the others. These results suggest that information sharing is correlated with performance and with the managers' innate ability.

In the remainder of the paper, we present formal evidence to shed light on whether these descriptive results are robust to controlling for other determinants of performance. In doing so, we make precise the underlying identifying assumptions required to interpret this evidence as causal and present evidence in support of these identifying assumptions.

3   Information Sharing and Worker Performance

3.1   Methodology

The analysis proceeds in two stages. First, we estimate the effect of information sharing on loan officers employing a longitudinal model that allows us to control for unobserved heterogeneity between branches and workers. Next, we take advantage

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Table 2: Managers Performance by Information Sharing

	Number Documents	Number Answers	Number Questions
Below the Median	52.603	50.356	53.919
	(0.291)	(0.294)	(0.308)
Above the Median	52.025	54.438	50.727
	(0.306)	(0.306)	(0.287)
Difference	0.577	4.085***	-3.192***
	(0.422)	(0.420)	(0.421)

of an anti-corruption law that requires officers to switch every two years to identify the causal effect of information sharing on performance.

To identify whether information sharing affects manager performance, we estimate the panel data regression

$$y_{ijkt} = \alpha_1 I^a_{ijkt} + \alpha_2 I^g_{ijkt} + \alpha_3 I^p_{ijkt} + \lambda_t + \eta_k + \gamma_j + \delta_i + \beta_1 T_i + \beta_2 C_i + \varepsilon_{ijkt} \qquad (1)$$

where y_{ijkt} is manager i's log performance in branch j in group k and during term t. The time fixed effects λ_t account for unobserved shocks that might have affected both the managers' performance and their demand for information, such as those arising during a financial crisis. The group fixed effects η_k capture permanent productivity differences across regions and tasks, such as those arising from the different clientele and heterogeneity across tasks. The branch fixed effects γ_j allows us to control for permanent productivity differences across branches, such as those arising from a more profitable location or a better head manager of the branch. Finally, individual fixed effects δ_i provides the possibility of controlling for innate ability or motivation. We also include the tenure of the loan officer T_i, when we don't include managers' fixed effects and the dummy C_i which is equal to 1 if the manager joined the bank right after college and equal to 0 if he had previous experience in the banking sector.

We also note that information sharing and performance is unlikely to be identi-

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cally and independently distributed within a branch. We therefore adopt a conservative strategy in estimating standard errors and allow the disturbance ε_{ijkt} to be clustered by branch throughout[6].

To better assess the causal effect of communication and information sharing on performance, we exploit the mandatory switching of loan officers across branches. Since there is variation in usage of the information sharing platform across branches, we can construct an instrument based upon the attitude of a given branch toward the new technology. For each loan officer i, we construct an instrument Z_{-i} which is the amount of information accessed in the previous branch excluding officer i. The choice of this instrument is motivated by the idea that if officer A worked in a branch in which problems are usually resolved within the branch, without attempting to find the solutions elsewhere in the organization, even when officer A moves to a different branch, he will be less willing to communicate with other loan officers. In contrast, if officer A worked for a branch in which the access to information provided by others is encouraged, he will have a similar attitude in the new branch. We construct similar instruments for each of our three endogenous variable of interests: the number of documents accessed, the number of questions posted, and the number of answers provided.

Formally, the first stage for each endogenous variable $u \in \{a, g, p\}$ is represented by:

$$I^u_{ijkt} = \alpha_1 Z^a_{-ijkt} + \alpha_2 Z^g_{-ijkt} + \alpha_3 Z^p_{-ijkt} + \lambda_t + \eta_k + \gamma_j + \beta_1 T_i + \beta_2 C_i + \eta_{ijkt}$$

while the second stage is

$$y_{ijkt} = \alpha_1 \widehat{I}^a_{ijkt} + \alpha_2 \widehat{I}^g_{ijkt} + \alpha_3 \widehat{I}^p_{ijkt} + \lambda_t + \eta_k + \gamma_j + \beta_1 T_i + \beta_2 C_i + \varepsilon_{ijkt}$$

where we have employed three instruments for the three endogenous variables. The validity of this instrumental variable procedure relies on the relevance of our instruments, and their exogeneity. First, we shall show that our methodology is not

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[6]Clustering the disturbance terms by manager leads to the standard errors on the parameters of interest being considerably smaller than those we report.

affected by the "weak instrument" problem, in fact, the coefficients in the first stage regressions for each endogenous variable are highly significant and the F-Test is always above 10, which is the commonly used threshold for weak instruments. Second, we have constructed our instruments for manager i, excluding manager i from the computation of the information accessed in his branch. This should reduce the correlation between the instrument and manager $i's$ innate ability. However, since our instruments relies on cultural variations across branches we are afraid that manager i might have been contributing to the branch's culture in the past, which would bias our estimates. We address this concern restricting attention to larger branches (with more than 50 officers), for which this possibility is, at least, less likely.

4 Baseline Results

Table 3 presents estimates of our baseline specification (1). The results show that the pattern of unconditional differences in worker performance by information sharing is robust to conditioning on a rich set of determinants of manager performance. It presents estimates for the main parameter of interest showing that the number of document and the number of answers are positively correlated with managerial performance, while the number of questions is instead negatively correlated with their performance.

Furthermore, tenure significantly affects performance, which can be the result of a longer experience within the Bank. At the same time, joining the bank right after college, without any previous experience, is positively correlated with performance. This result can be interpreted as a result of greater effort exerted by new employees.

The main concern with these results is that information sharing and the effect on performance might be driven by other factors, such as a market turndown, a greater need of information for a specific local market or a result of a better performing branch. In order to control for all this unobserved heterogeneity, as shown by column (4), we control for time, group and branch fixed effects. Except for the effect of the number of answers, the other coefficients are still economically and statistically significant.

Table 3: Panel Model – Fixed Effects Estimates

Log(Tot. Performance)	(1)	(2)	(3)	(4)	(5)
Log(Number Documents)	0.0493***	0.0562***	0.0226**	0.0300***	0.0216**
	(0.010)	(0.011)	(0.010)	(0.011)	(0.011)
Log(Number Questions)	-0.0505***	-0.0335***	-0.0246***	-0.0217***	-0.0195***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Log(Number Answers)	0.0508***	0.00848	0.00533	0.00337	0.00475
	(0.003)	(0.006)	(0.006)	(0.006)	(0.007)
Log(Tenure)	0.0632***	0.0674***	0.105***	0.100***	0.1000***
	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)
College	0.108***	0.113***	0.105***	0.0924***	0.0891***
	(0.028)	(0.028)	(0.026)	(0.026)	(0.025)
Time Fixed Effects		YES	YES	YES	YES
Group Fixed Effects			YES	YES	YES
Branch Fixed Effects				YES	YES
Time * Branch Fixed Effects					YES
Observations	9,805	9,805	9,805	9,805	9,805
R-squared	0.0629	0.0582	0.1567	0.3049	0.467

In column (5) we further control for the interaction of time and branch fixed effects, which shows that the results are robust to this more restrictive specification. These results suggest that when managers increase the number of documents accessed, this has a positive and significant effect on the productivity of the average worker, whereas increasing the number of questions has a negative impact on his performance. The magnitude of these effects implies that when managers increase their information access by one standard deviation it increases their performance by eleven percent. Similarly, an increase in the number of questions is associated with a reduction in performance of about five percent.

A concern with these results is that the estimation might be picking up heterogeneous effects that are unrelated to information sharing, in particular one of the main factors for which we cannot directly control is manager's ability. It is plausible that innate ability has a significant effect, which would create a spurious correla-

Table 4: Panel Model – Individual FE Estimates

Log(Tot. Performance)	(1)	(2)	(3)	(4)	(5)
Log(Number Documents)	0.0480***	0.0430***	0.0467***	0.0292*	0.0374**
	(0.010)	(0.016)	(0.017)	(0.017)	(0.018)
Log(Number Questions)	-0.0543***	-0.0408***	-0.0176**	-0.0153**	-0.0104
	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
Log(Number Answers)	0.0511***	0.0519***	-0.00604	-0.00668	-0.0062
	(0.003)	(0.003)	(0.007)	(0.007)	(0.007)
Managers Fixed Effects		YES	YES	YES	YES
Time Fixed Effects			YES	YES	YES
Group Fixed Effects				YES	YES
Branch Fixed Effects					YES
Observations	9,806	9,806	9,806	9,806	9,806
R-squared	0.032	0.048	0.059	0.081	0.157

tion between information sharing and performance. For example, it is likely that a loan officer, who is able to close a higher number of deal and identify the most profitable ones, will post fewer questions. Then, observing a negative correlation between the number of questions and the officers' performance might just be driven by heterogeneous innate ability or differences in training.

Table 4 provides evidence on the effects of communication and information sharing on the productivity of the *same* worker. We exploit the longitudinal nature of our data and control for individual fixed effects. In accord with the descriptive evidence presented in the previous section, once we control for the individual fixed effects as in column (5), the number of questions is not significant anymore. However, we find an even stronger effect for the number of documents. This suggests that performance is significantly affected by the number of documents consulted by the loan officers, even controlling for managerial ability. As highlighted in the introduction, we interpret this as evidence for the possibility for loan officers to know more successful management practices implemented elsewhere in the bank.

4.1 Quantile Regression Estimates

To explore whether the effects of information sharing are heterogeneous across loan officers, we use quantile regression methods to estimate the conditional distribution of the log of performance of loan officer i in branch j, and group k during the term t, y_{ijkt}, at different quantiles, θ. We therefore estimate the following specification

$$Quant_\theta\left(y_{ijkt}|\cdot\right) = \alpha_{1\theta}I^a_{ijkt} + \alpha_{2\theta}I^g_{ijkt} + \alpha_{3\theta}I^p_{ijkt} + \beta_\theta X_{ijkt} + \varepsilon_{ijkt} \qquad (2)$$

where all variables are as previously defined, and bootstrapped standard errors based on 1000 replications are calculated throughout. The effect of information access, gathering and production on officers' performance at the θth conditional quantile of log performance is measured by the vector α_θ.

Table ?? reports the estimates of α_θ from the specification above at various quantiles, controlling for tenure and experience as well as time, group and branch fixed effects. Two points are of note. First, the effect of information access is zero for the top two quantiles, and is positive and significant at the bottom three quantiles. Second, the effect of information gathering as measured by the log of the number of questions posted is negative and significant for all the quantiles. In particular, a ten percent increase in the number of documents increases performance by at least twenty percents, whereas the same increase in the number of questions posted decreases the log of officer productivity by more than twenty-five percent.

The data suggests that information access increases the performance of loan officers in the left tail of the productivity distribution, while it has no significant effect on the right tail of the distribution. These results provide evidence in favor of the interpretation that information provides the possibility for the low performance officers to learn and try to fill the gap with the most productive officers.

4.2 Promotion Probability

As pointed out before, the Bank's incentive system is mainly based upon promotion, then it is natural to check if the communication among the loan officers, and its effect

Table 5: Quantile Regression Estimates

Log(Total Performance)	10th	25th	50th	75th	90th
Log(Number Documents)	0.0391**	0.0409***	0.0250*	0.002	-0.012
	(0.017)	(0.012)	(0.014)	(0.013)	(0.010)
Log(Number Questions)	-0.0207***	-0.0251***	-0.0372***	-0.0361***	-0.0164***
	(0.007)	(0.008)	(0.007)	(0.006)	(0.006)
Log(Number Answers)	0.004	0.008	0.013	0.0209**	0.006
	(0.010)	(0.012)	(0.012)	(0.009)	(0.007)
Observations	9,805	9,805	9,805	9,805	9,805

on their productivity, is reflected in the probability of being promoted. Although the Bank does not directly incentivize the loan officers to share their information with their colleagues, the bank headquarter may recognize, for example, that a loan officer has developed valuable expertise in one particular field, and then he should be rewarded for the positive externality on others. At the same time, the headquarter might infer from the amount of questions posted the ability of the manager, this signaling effect should affect his probability of getting promoted.

Although the headquarters might not directly observe the amount of information demanded and produced by each loan officer, this data can still be reflected in the promotion probability. In fact, the head manager of each branch, who has a better knowledge of the information generated within the branch, recommends to the headquarters the loan officers that deserve to be promoted.

Table 6 presents evidence to support these hypothesis. Specifically, we observe about two hundreds promotions in our sample, then we can investigate the effect of communication on the probability of being promoted. The estimates show that, as expected given the institutional background, tenure has a positive and significant effect on the probability of being promoted, and it is by far the greatest predictor of promotions.

Column (1) shows that the coefficients on the first lag of productivity, as captured by the officers' performance in the previous term, is positive but insignificant.

Table 6: Effect on Promotion Probability

Promotion (Probit)	(1)	(2)	(3)	(4)	(5)
Number Questions		-0.00172**	-0.00174**	-0.00154**	-0.00245**
		(0.001)	(0.001)	(0.001)	(0.001)
Number Answers		0.00106***	0.00107***	0.00106***	0.00153***
		(2.88E-04)	(2.87E-04)	(0.001)	(0.001)
Lag Productivity	0.00067	0.00194	0.00177	0.00152	0.00146
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Tenure	0.096***	0.107***	0.107***	0.108***	0.148***
	(0.007)	(0.010)	(0.009)	(0.009)	(0.016)
College	0.1608	-0.227	-0.229	-0.22	-0.294
	(0.294)	(0.254)	(0.254)	(0.258)	(0.267)
Time Fixed Effects			YES	YES	YES
Group Fixed Effects				YES	YES
Branch Fixed Effects					YES
Observations	6,971	6,971	6,971	6,971	6,971

This means that variations in the number of questions or answers posted do not pick up effects driven by lagged performance. Even controlling for the lag productivity and our set of time, group and branch fixed effects, there exists a positive correlation between the number of answers and the probability of being promoted, while the correlation with the number of questions is negative. These results, even if they cannot be interpreted as causal and definitive, confirm our interpretation. In particular, column (5) shows that there might be an element of signaling when managers decide to share their information with others or to ask for information. Providing others with relevant information increases, in fact, the probability of being promoted, even if it has no significant and direct effect on performance, as described in the previous section.
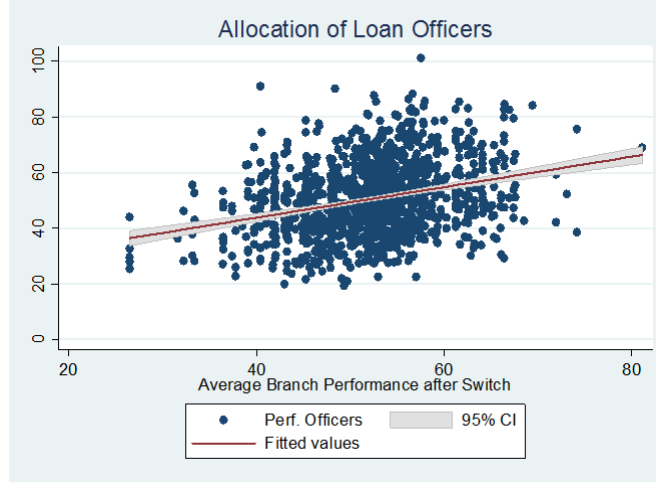
Figure 2: Officers' and Branches' Productivity

4.3   Effect of Switching

Up to now, in fact, we have found evidence that communication and information
sharing might help the low performance managers acquire the necessary knowledge
to improve their performance. If this is true, we should then expect managers to sig-
nificantly increase their access to the available information when they switch branch.
A loan officer might, for example, start working in a different environment, with
different existing costumers, and a different local credit market, which should have
a significant impact on his demand for information. The switchers might then re-
quire information about the reliability of the costumers and the conditions offered
by competitors. We observe 618 loan officers who switch branch, as prescribed by
the anti-corruption law described above, after two years of experience in the same
branch.

As a first step, we investigate if the headquarters locate officers to different
branches based upon their performance. On the one hand, it might be that in
order to improve the productivity of a branch with below-average productivity, the
Bank might find optimal to allocate the best officers to the branches that need to
improve their productivity. On the other hand, the high performance officers might

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Table 7: Effect of Switching on Information Access

Log(Number Documents)	(1)	(2)	(3)	(4)
Switch	0.0199**	0.0218**		
	(0.009)	(0.009)		
After Switch			0.0125	0.0150*
			(0.008)	(0.008)
Log(Tenure)	-0.0218		-0.0217	
	(0.014)		(0.014)	
College	0.278***		0.279***	
	(0.042)		(0.042)	
Time Fixed Effects	YES	YES	YES	YES
Group Fixed Effects	YES	YES	YES	YES
Branch Fixed Effects	YES	YES	YES	YES
Individual Fixed Effects		YES		YES
R-squared	0.3342	0.347	0.334	0.346
Observations	10,055	10,055	10,055	10,055

be rewarded by being allocated to the best branches. Figure 2 shows that this is indeed the case. It displays the slightly positive relation between the mean officers' performance before the switch and the productivity of the branch where they work after the switch. This means that the Bank does not employ the switching rule to strategically locate officers across branches.

Table 7 reports the estimate of the coefficients on an indicator variable, "switch", which is equal to one when the loan officer moves from one branch to another one, on the number of documents accessed. As highlighted by column (1) and (2) the results are consistent with the learning hypothesis. Even controlling for time, group, branch and individual fixed effects the coefficient is positive and both statistically and economically significant. This suggests that switching might be an important determinant of the demand for information. Intuitively, the less experienced managers would try to acquire a greater amount of information, as shown by the coefficients on tenure, negative but insignificant, and the coefficient on college, which is instead positive and significant.

Table 8: Effect of Switching on Performance

Log(Total Performance)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Switch	-0.111***	-0.0317	-0.118***	-0.0461*		-0.108***	
	(0.012)	(0.027)	(0.012)	(0.027)		(0.013)	
Switch*Tenure		-0.00778***		-0.00726***			
		(0.002)		(0.002)			
After Switch					-0.0889***		-0.0915***
					(0.010)		(0.012)
Log(Number Documents)	0.0470***	0.0469***	0.0287***	0.0283***	0.0274**	0.0387**	0.0348**
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.018)	(0.018)
Log(Number Questions)	-0.0515***	-0.0516***	-0.0210***	-0.0210***	-0.0205***	-0.00851	-0.0078
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)
Log(Number Answers)	0.0569***	0.0571***	0.0059	0.00618	0.00476	-0.00394	-0.0052
	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
Log(Tenure)	0.0636***	0.0700***	0.0994***	0.105***	0.0994***		
	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)		
College	0.106***	0.104***	0.0915***	0.0907***	0.0897***		
	(0.027)	(0.028)	(0.026)	(0.026)	(0.026)		
Time Fixed Effects			YES	YES	YES	YES	YES
Group Fixed Effects			YES	YES	YES	YES	YES
Branch Fixed Effects			YES	YES	YES	YES	YES
Manager Fixed Effects						YES	YES
Observations	9,805	9,805	9,805	9,805	9,805	9,805	9,805
R-squared	0.0698	0.0701	0.3078	0.308	0.3054	0.166	0.165

However, if the demand for information is driven by a temporary need due to the new environment, we should observe a diminishing effect of switching over time. Column (3) and (4) investigate this issue, presenting the estimate for another indicator variable - after switch- which equals one for all terms after the switch. The effect is still positive, but not significant anymore. This confirms the hypothesis that switching has only a short-run impact on the demand for information.

Since we have identified a significant effect of switching on communication, it is now natural to investigate what are the costs associated with the application of this anti-corruption regulation. In particular, we can investigate if switching has a positive or negative effect on the managers' performance. On the one hand, switching

might result in the managers exerting more effort during the first few months of the new appointment to signal their ability. On the other, loan officers might have acquired some specific knowledge about the type of firms and market conditions in the previous branch, which suggests that after the switching they would need more time to learn to work in the new environment.

Table 8 presents evidence that strongly supports the latter hypothesis. As shown by column (3) and (4) switching has a negative and significant effect on performance. Moreover, this effect is even stronger for longer tenured officers, as suggested by the negative coefficient on the interaction term between the indicator variable and the managers' tenure. This means that even if loan officers might tend to work more when they are forced to change branch, the overall impact on their performance is negative. As in the case of the demand for information we should expect a decreasing effect of switching on the managers' performance over time. Column (5) shows the coefficient estimates on the indicator variable that accounts for all the time after the change of branch. Although still significantly negative, its magnitude is decreased.

The last two columns (6) and (7) assure that these results are robust to the inclusion of individual fixed effects. Overall this evidence suggest that implementing a switching rule as a way to prevent bribes and capture of the loan officers can have a high cost. In particular our estimates suggest that some specialized human capital is destroyed when loan officer switch from one branch to another.

One problem with the interpretation of these results might come from the possibility of endogenous adjustment of the targets after the switch. This would be a problem if our performance measures were the results achieved by the loan officers, instead, our performance measure is the score assigned to the loan officers based upon the percentage of the targets met during the last six months and aggregated across all the relevant dimensions. Then, even an endogenous change in targets is reflected in our dependent variable without biasing our results.

However, it is of independet interest the analysis of how targets vary over time and between officers. Table 9 considers the targets set for the Bank's profit, which is the one for which we have the highest number of observations. Three things are worth noting. First, targets significantly increase with the tenure of the officers, then,

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Table 9: Effect of Switching on Profit Target

Bank Profit Target	(1)	(2)	(3)	(4)	(5)
Switch	11.15***	9.866***	7.289***	8.850***	10.34***
	(1.766)	(1.814)	(1.769)	(1.726)	(1.802)
Tenure	4.994***	5.041***	5.862***	6.665***	
	(0.346)	(0.345)	(0.297)	(0.289)	
College	10.76	9.514	8.083	8.366	
	(8.455)	(8.453)	(7.07)	(6.837)	
Time Fixed Effects		YES	YES	YES	YES
Group Fixed Effects			YES	YES	YES
Branch Fixed Effects				YES	YES
Individual Fixed Effects					YES
Observations	10,055	10,055	10,055	10,055	10,055
R Squared overall	0.0092	0.0161	0.0676	0.1908	0.2359

not only the officers' performance increases with their experience, but the Bank also requires more experienced officers to achieve higher targets. Second, loan officers after the switch are required to meet higher targets than before. Third, the branch and the individuals' fixed effects explain the greatest variations in targets.

5 Instrumental Variable Estimates

Up to now the evidence presented strongly suggest the existence of a significant effect of communication on managers' performance. Specifically, there is substitution between the demand for information and the innate ability of managers. Moreover, low performers or officers who just switched to a new branch significantly increase their demand for information. We can now address a natural endogeneity problem that can arise in our context. The loan officer who is facing a market contraction, for example, can *decide* to acquire more information in order to improve his performance. Although in the previous estimates we have accounted for a variety of unobserved shocks, with the inclusion of a set of fixed effects, we now try to address this endogeneity issue in order to understand if we can interpret the results as causal

Table 10: First Stages

	Documents	Answers	Questions
Documents Prev Branch	7.398***	-0.654*	-0.214
	(0.744)	(0.362)	(0.248)
Answers Prev Branch	-14.439***	4.190***	-1.637**
	(2.282)	(1.112)	(0.757)
Questions Prev Branch	8.420***	2.271**	7.437***
	(2.157)	(1.052)	(0.718)
Tenure	-10.419***	-4.132***	-2.688***
	(2.622)	(1.278)	(0.873)
College	54.021	19.242	-2.409
	(69.580)	(33.915)	(23.161)
F-Test	50.289	16.774	49.343
Time Fixed effects	YES	YES	YES
Group Fixed Effects	YES	YES	YES
Observations	618	618	618

or not.

Since we do not have data before the adoption of the new technology, which allowed for information to be shared, we are not able to run a natural experiment to understand the effect of information sharing on managers' performance. Neverthless, we are able to address this issue employing the anti-corruption law as a source of exogenous variation. For each manager i who switched from branch j at time t to branch j' at time t', we use the number of documents (as well as questions and answers) in the branch j as an instrument for the number of documents (and the number of questions and answers) that manager i had access to in branch j' at time t'. That is, we exploit the variation in branch attitudes toward information sharing to determine the effect of communication on performance.

Table 10 presents the first stage estimate for each one of the endogenous variables. The first column reports the coefficient estimates of our instrument for the

Table 11: IV Estimates

Total Performance	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
Number Documents	-0.00123	0.0197**	-0.00138	0.0225***	-0.00347	0.0194**
	(0.003)	(0.008)	(0.003)	(0.008)	(0.003)	(0.008)
Number Questions	-0.0306***	-0.133**	-0.0287***	-0.104***	-0.0169**	-0.0908***
	(0.008)	(0.061)	(0.008)	(0.034)	(0.008)	(0.033)
Number Answers	0.0175***	0.112	0.0148**	0.0727**	0.0114*	0.0674**
	(0.007)	(0.080)	(0.007)	(0.036)	(0.007)	(0.034)
Tenure	0.387**	0.871**	0.385**	0.689***	0.603***	0.819***
	(0.172)	(0.382)	(0.174)	(0.242)	(0.183)	(0.223)
College	-3.736	-7.538	-3.714	-6.748	-3.414	-6.015
	(4.809)	(6.436)	(4.806)	(5.74)	(4.839)	(5.544)
Time Fixed Effects			YES	YES	YES	YES
Group Fixed Effects					YES	YES
Observations	618	618	618	618	618	618

number of documents, which shows that both the coefficient, positive and statistically significant at one percent level, and the F-test, above 50, strongly suggest that our instruments are not weak. Column (2) and (3) presents the first stage of the number of questions and the number of answers. As for the documents, our instruments seem to significantly affect the demand for information. Intuitively, for all three variables of interest tenure has a negative and significant effect, which confirm that even restricting attention only to the switchers, the more experienced people demand less information. Given the small sample of switchers we are not able to control for branch fixed effects, but we include both time and group fixed effects.

Table 11 presents the ordinary least square estimate restricted to the switchers sample and the instrumental variable estimates. The coefficient on the number of documents is negative and non significant for all the OLS estimates while positive and highly significant for the IV estimates. This can be interpreted as evidence in favor of our substitution hypothesis, that is, high ability managers tend to demand less information than their colleagues. The magnitude is also interesting, in fact,

Table 12: IV Estimates: Large Branches (> 50)

Total Performance	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
Number Documents	0.007	0.026	0.006	0.0129*	0.004	0.0156**
	(0.005)	(0.042)	(0.005)	(0.007)	(0.005)	(0.007)
Number Questions	-0.0455***	0.224	-0.0384***	-0.0422**	-0.0199**	-0.0377*
	(0.009)	(0.683)	(0.009)	(0.019)	(0.010)	(0.021)
Number Answers	0.0316***	-0.387	0.019	0.020	0.011	0.0392*
	(0.011)	(1.049)	(0.013)	(0.025)	(0.013)	(0.021)
Tenure	0.243	-0.039	0.211	0.269	0.603**	0.695**
	(0.272)	(1.100)	(0.278)	(0.269)	(0.282)	(0.286)
College	-25.25***	-13.650	-22.65***	-24.11***	-19.94***	-23.44***
	(7.129)	(33.150)	(6.421)	(6.669)	(7.420)	(8.608)
Time Fixed Effects			YES	YES	YES	YES
Group Fixed Effects					YES	YES
Observations	240	240	240	240	240	240

the most conservative specification in column (6) suggests an effect of about ten percent on performance. This means that incentivizing the usage of the information produced by others within the same organization might actually result in a significant improvement in productivity.

Our second variable of interest, the number of questions, has a negative effect on performance in both the OLS and IV estimates. This is consistent with the previous results, and confirms that even the exogenous variation in the number of questions negatively affect performance. The magnitude is higher for our IV estimates then in the OLS results, ranging from five percent to almost twenty percent. This confirms the substitution between managers' ability and the number of questions posted.

Finally, in contrast to the panel estimates presented above, the number of answers has a significant positive effect on performance, then this estimates show that the exogenous variation in the number of answers has an impact on performance. However, the coefficients on the number of questions and answers should be inter-

preted carefully, because from the panel analysis of the previous section, we know that these might not be robust to the inclusion of individual fixed effects.

The main concern with our instrument is that it might fail the exogeneity restriction. In particular, one might imagine that even if we do not include manager i's demand for information in the construction of our instrument, he may have had an effect on the cultural attitude of the branch about information sharing. However, this effect should be more pronounced for small branches than for larger branches.

Table 12 shows that even when we restrict attention to the subsample of branches with more than the average number of employees, we find the same results. That is, the number of documents consulted and the number of answers provided positively affect performance, while the impact of the number of questions is negative. As expected given the lower number of observations, the estimates are significant only at the five and ten percent level in the most conservative specification of column (6). However, both the magnitude and the signs are consistent with the previous results.

6 Discussion & Conclusions

To address the question of whether access to the information produced and gathered within the same organization affects the performance of information workers, we examined two years of micro data from a major Japanese bank. Data include all accesses to an information sharing platform, objective and subjective performance measures, and all promotions and job rotations among more than 2,800 loan officers. Exogenous legal requirements, aimed at curbing corruption by compulsory office rotation, permit analysis of loan officer performance in different settings.

We find that a standard deviation increase in the number of shared documents predicts an 11% rise in output, in specifications with time, location and individual fixed effects. Quantile regressions estimates suggest that communication and information sharing greatly benefits the low-performance officers. In fact, questions are used more by workers of lesser ability, and when productivity gains exist, they appear strongly on the left tail of the distribution, at the 10th and 25th percentiles, but do not appear on the right tail, at the 75th and 90th percentiles.

We observe over 200 instances of job promotion. Tenure within the bank is by far the strongest predictor, while lagged productivity is not significant. Loan officer answers are associated with faster promotion while loan officer questions are associated with slower promotion. These findings are consistent with a signaling hypothesis on the part of high ability workers, who distinguish themselves from low ability workers providing lots of answers in order to signal their expertise and higher ability.

We also observe 618 instances of loan officers switching branches, as a result of an anti-corruption law. Controlling for unobserved heterogeneity over time and branch, a standard deviation increase in shared document consumption boosts productivity by at least 10%. These results appear to be causal.

The difference in OLS and IV specifications provides evidence of the substitution hypothesis: high ability officers demand less information than low ability officers, while low ability officers can compensate for low independent performance by consuming information provided by others. We also find that switching jobs significantly reduces overall performance, possibly indicating destruction of job specific human capital. The anti-corruption law should therefore avoid economic losses from graft of at least this much value. Interestingly, officers of all abilities increase their demand for information on switching jobs.

A range of potential extensions of this work is in progress. It is important to understand how information sharing and communication are related to the incentive system in place. We are trying to address this question by developing a similar analysis on micro data from a major U.S. bank, which should clarify if end-of-the-year bonuses and an incentive system heavily based upon performance affects the information shared between white collar workers. We are also running an experiment, on the same set of loan officers considered in this paper, in order to understand whether it is possible to increase the flow of information within the organization by explicitly relate information consumption with monetary incentives. Moreover, we are also interested in the possibility of anonymously provide information. On one hand, this would eliminate any signaling motives in the usage and production of information. On the other hand, the quality of information can dramatically decrease

due to a lower reputation-building effect. This will allow us to test how incentives and reputation may interact with organizational theories of the firm.

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