Empirical Study on Productivity When Agents Have Discretionary Powers

Introduction

Productivity is a key performance metric for service businesses. The study of productivity has a long tradition in the operations management literature, and has extended to numerous avenues. In this paper, by utilizing a detailed time-stamped dataset, we study agents’ productivity with time-varying factors and explore the effect of scheduled interruptions on productivity when agents have high autonomy. The goal of this paper is to provide managerial insights on granting reasonable levels of autonomy to agents, and optimal scheduling of planned interruptions.

Our study is related to three streams of work in the productivity literature: worker discretion over operational decisions, the factors that impact agents’ productivity (with workload being the main focus), and the mechanisms by which workload affects productivity.

Prior work has studied discretion over various operational variables, including task routing, processing time, and speed-quality tradeoff. It has been shown that worker discretion has important implications (Tan and Netessine 2014; Berry Jaeker and Tucker 2016). However, few studies explicitly models agents’ discretionary decisions as a dependent variable and in turn studies its impact on productivity. Properly handling agents’ decisions is critical for casual inference as they endogenously affect the end results – agents’ productivity. A recent paper by Ibanez et al. (2016) is closely related to our work. They specifically study the implication of discretionary task ordering deviation on workers’ productivity. We complement and extend their work since in our case, we study the implications of not only workers’ task ordering decisions, but also any other discretionary decisions made by workers including mid-way task switching, multitasking, and break, as well as planned interruptions imposed by the management team. We manage to do so with a granular time-stamped dataset that tracks every single decision/activity of all workers. Having a set of decisions made by agents rather than a binary one (as in Ibanez et al., 2016) also imposes additional estimation challenges. Extensive research has also been done to explore the factors that affect productivity, and the mechanisms behind it. For example, the size and structure of a team can affect its efficiency and performance. A vast majority of studies in this stream focus on the effect of workload, and the corresponding mechanisms.

To summarize, existing literature has studied discretionary decisions, the effect of coordination/communication requirement, and the implications of workload on productivity in relatively isolated contexts. The following questions still lack rigorous empirical analysis and satisfactory answers. Does planned interruptions (scheduled meetings, lunch break, etc.) affect productivity, and how? How do agents make discretionary decisions along their workflows (that
is, these decisions are time dependent), and how do these decisions in turn affect their productivity? This study aims to answer these questions by leveraging a granular time-stamped dataset at an IT service delivery system, and provide managerial insights on such issues.

**Background and Dataset**

We investigate a time-stamped productivity dataset at an IT service delivery system (SDS). The SDS consists of a number of agents, and is responsible for handling service requests brought up by its customers. The SDS is managed centrally only at the first stage where a dispatcher receives requests and assigns them to agents following established processing standards. Then each agent independently controls the sequence and the way he processes the assigned requests. The management team also imposes regular group meetings and we consider these as planned interruptions. We focus on the agents and not the dispatcher by treating each agent’s personal queue as exogenously created by the dispatcher.

Agents have high autonomy when managing their personal task queue in the sense that they get to choose the order in which he processes his assigned requests. They are also allowed to process their requests in whatever way they prefer as long as requests are finished within its deadline (which, as observed in the dataset, is hardly a binding constraint). For example, agents need not to work on request one by one, and they can switch between single-tasking and multi-tasking at their will. They could also switch to other requests while leaving the current unfinished request open. This is sometimes viewed as a preferred approach since it enables the agent to make full use of the down time of the current request.

Each agent’s activities are recorded in the dataset with detailed time stamps. Such activities include start time of requests, suspension of requests, switching between requests, request related communication, completion of requests, lunch and breaks, and group meetings imposed by the management team. With such detailed timing data, we can easily infer each agent’s complete workflow. The time-stamped data, combined with a separate dataset of agents’ demographics, allowing us to study factors that affect their time-dependent discretionary decisions, and how such decisions in turn affect their productivity.

**Econometric Models and Preliminary Results**

We construct and estimate a simultaneous equations model (SEM) that consists of two equations for our analysis. The first-stage choice model explicitly estimates agents’ time-dependent discretionary decisions using time-varying covariates. The estimated choice model then serves as a control function in the second-stage Cox proportional hazard rate model to
address the time-dependency nature of the dependent variable (productivity), as well as the endogeneity raised by agents’ discretionary decisions.

We first justify our choice of the second-stage Cox proportional hazard model as the ultimate goal is to study productivity. Our granular time-stamped dataset grants us the ability to track almost everything along agents’ workflow. That is, we are able to obtain a complete snapshot of the status of all the relevant factors at any given time point. Under such setting, all the variables are time-dependent by nature. We propose measuring productivity as a hazard rate to fully utilize the granularity of our dataset. Modeling productivity as a hazard rates allows productivity to fluctuate during the lifetime of a request, thus leveraging the time-dependency feature of our data. To address the endogeneity issue caused by agents’ discretionary decisions, we estimate a first-stage nested choice model that explicitly models agents’ discretionary decisions. We categorize agents’ decisions into a number of cases based on two key factors – whether they are single-tasking or multi-tasking, and whether they maintain or switch the workload they are currently undertaking. Our second stage model is still under development so we only present the preliminary results from the first stage choice model:

(i) As time approaches a scheduled meeting, agents on average are less likely to take a break, but on the other hand, are more likely to scale down their workload.
(ii) Surprisingly, the time till the end of an agent’s shift has little impact on their decisions.
(iii) When agents have many open requests (started but not completed yet), on average, they are much more likely to either, ramp up their current workload, or take a break, rather than to maintain the current workload or scale down.
(iv) Scheduled interruptions have a larger impact on agents’ productivity than their cumulative working time in both statistics significance and magnitude

These findings provide some interesting insights. Presumably, results from the completed SEM could generate further insights on agents’ behavior and productivity, which in turn might be used to better design agents’ autonomy level and the scheduling of planned meetings.

References