

Naomi Hausman
Department of Economics, Hebrew University of Jerusalem
Information Technology and Innovation in Firms
NBER Economics of Digitization Research Grant Proposal

Please note that the following proposal draws on work produced for a joint application with Kristina McElheran and Chris Forman to the U.S. Census for use of confidential data. The overarching project is large in scope and will take several years to complete; this proposal aims to describe the larger context of the project while also highlighting my central interest: the interactions of IT use with local area characteristics in generating innovation and productivity growth.

Information technology (IT) is generally considered to be an important driver of economic growth in the United States, and understanding its diffusion and efficacy across firms and places is crucial for understanding this growth (Syverson 2011). IT is credited with dramatically improving productivity (Atrostic and Nguyen 2005; Bloom et al. forthcoming), promoting innovative goods and services (Bartel et al. 2007; Brynjolfsson and Saunders 2010), transforming internal firm processes (Davenport 1993; McElheran 2012a), and restructuring value chains (Baker and Hubbard 2003; Clemons and Row 1992).

But IT alone cannot explain differences in growth across firms and places. Similar investments have been shown to have vastly different effects on labor productivity across regions, for example (Forman, Goldfarb, and Greenstein 2012), and complementary technological and organizational investments, as well as appropriate use of human capital and choice of firm location, are considered to play important roles in mediating the productivity of IT adoption. Nevertheless, systematic evidence on these complementarities remains scarce (Brynjolfsson and Saunders 2010), and the variance in productivity of IT remains largely a puzzle. This project employs a wealth of confidential US Census data on firms, supplemented with rich proprietary external data, to measure the importance of various organizational, research and development, and geographic factors in determining the productivity of a variety of IT investments.

The proposal consists of a series of closely related studies on these questions. The full project is expected to take four to five years and will have access to confidential US Census data on firms; this grant would provide first-year funding for my summer work, travel to use the Census data, and some research assistant time.¹ The project can be categorized into four main sets of analyses:

- Margins of IT use and data quality assessment
- Reduced form analyses of complementarities (in generating productivity and innovative outputs) between
 - IT and organizational characteristics
 - IT and innovative inputs
 - IT and local area characteristics

¹ Because I am at a non-US university, all of my research funding and summer funding must come from external grants.

- Instrumental Variables (IV) analyses of complementarities between the above pairs of inputs
- Structural production function estimation

The first group of analyses focuses on understanding the IT information in the Census and in our external data, first in terms of reliability and second to know which firms adopt IT when, where, and along which margins. With this knowledge as a base, we will begin measuring the complementarities of these various types of IT with three other groups of inputs that are likely to play an important role in IT's ultimate effectiveness in augmenting productivity and innovation: organizational characteristics (e.g. allocation of decision rights, use of key performance indicators, incentives), innovative inputs (e.g. R&D expenditures, human capital usage), and local area characteristics (e.g. education of population, industry agglomeration, IT usage rates, urban status).

My focal interest lies in the geography of IT use and effectiveness. Cities are generally thought to provide firms and residents advantages that justify the high cost of locating there; these advantages likely stem from the face-to-face interactions and knowledge sharing that are facilitated by urban proximity. It's easier to transmit certain information and to conduct certain transactions with people you can meet in person. Even information technology, which often improves communication and coordination over great distances, has been shown to be more productively used in cities – where distances are short – than elsewhere. But how a place's education, income, industry structure, firm size distribution, technology adoption, etc., interact with an individual establishment's IT use is not well understood. This research agenda aims to understand the factors that make IT so much more productive in some places than in others.

We start with reduced form analyses to understand the relationships that exist between IT, these other types of inputs, and outcomes like productivity and patenting in the raw data. Of course, the main challenge is to measure the causal effect of IT adoption in various contexts on productivity; IT adoption is not random, so we worry that firms adopting IT are doing so for some unobserved reason that is correlated with their productivity. Thus we hesitate to interpret the raw relationships in the data as causal, though they do give us new information about how IT is used and what is likely to contribute to its productivity.

We use several strategies to get at the causal effects of IT. The third group of analyses, from above, uses instrumental variables (IV) to isolate what random variation may exist in IT adoption and uses only that variation to measure the effect. We propose multiple instruments and produce multiple IV estimates, each using different variation, rather than relying on one. Finally, in the fourth set of analyses we take a more structural approach to dealing with the endogeneity of IT investment. Following Olley and Pakes (1996), we estimate production functions to recover estimates of the firm-year (or establishment-year) specific productivity shock as a function of IT investment and other inputs. These firm-year productivity shocks can then be related to all sorts of other characteristics of the firm and its location. One can further endogenize the productivity shocks, allowing them to evolve according to, say, R&D inputs (Doraszelski and Jaumandreu 2012) such that the complementarities between other inputs and specific IT investments can be measured. The goal is that, together, these multiple strategies and our rich data will provide a more comprehensive understanding of IT use and productivity in the US than we have ever had before.