Impacts of the Bar Code: NBER Innovation Policy Grant Proposal

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During the 1980s and 1990s, there was a dramatic shift in the U.S. retail landscape, illustrated by the rapid growth of chain stores, particularly in the "big-box" and "category-killer" store formats, in a number of segments. Because of these shifts, the retail sector is often used as a motivating example in economic studies of information technology, productivity and organizational change (e.g., Holmes 2001; Bresnahan, Bynjolfsson and Hitt 2002). These studies focused on complementarities inside the firm, and provide clear evidence that the benefits of IT adoption are linked to a host of related managerial initiatives. However, economists have collected less evidence on the role of between-firm complementarities (i.e., spillovers or network effects) in the productivity impact of retail IT adoption. We aim to address these questions by studying the diffusion, productivity impact and governance of the bar code.

The Uniform Product Code, or UPC (formerly the Uniform Grocery Product Code), started appearing on consumer packaging in the early 1970s and represented a major innovation in the distribution of consumer goods. This innovation was achieved through the cooperation of food manufacturers, supermarket chains, wholesalers, independent grocers, and equipment manufacturers. The first scanning cash register went online in June, 1974, at a Marsh supermarket in Troy, Ohio; ten years later, more than 10,000 supermarkets and grocery stores were scanning source-marked packages.

The proposed project has (at least) four components that vary in terms of methods and stage of completion.

1. Emek has already completed a study of the productivity impact of early scanner adoption in U.S. supermarkets. This paper using data hand-coded from a Food Marketing Institute publication, *Scanning Installation Up-Date*, linked to U.S. Census micro-data.

2. Our preliminary research into the early governance of the bar code suggests a number of parallels to the governance of the Internet domain name system. In particular, both ICANN and the UCC originally outsourced registration to a private firm, only to reclaim the activity after discovering that the business was more profitable than anticipated. Both organizations struggled with the challenge of expanding the number of codes/addresses to meet demand, since early adopters came to have a vested interest in prized "real estate" (e.g. a large block of IP addresses or a UPC prefix with many zeroes). We plan to study these parallels in more detail before writing a descriptive paper that frames "registry management" as a distinctive set of challenges that are part of the broader problem of "platform management" that is receiving considerable attention in the literature on multi-sided platforms.

3. We have recovered files made available to Professor John Dunlop of Harvard University in 1999, by an organization then called the Uniform Code Council (UCC; now called GS1US). These files include most or all UPC registrations (including company name and address, and the date of registration) from 1994-1999, as well as more than half of earlier registrations, from 1971 onward. We hope to use these micro-data to study the diffusion of the UPC symbol across retail segments and geography over time. Unfortunately the earlier file, which contains UPC prefixes, addresses and industry codes for approximately 230,000 firms, does not contain the registration dates, which are essential to conducting any economic analysis. As described below, we are working to recover the list of adoption dates.

4. Finally, assuming we can recover firm-level adoption dates to complete the UPC micro-data set described above, we hope to merge these data with the U.S. Census Longitudinal Business Database (LBD) in order to study the long-run productivity impact of the bar code as it diffused across both the retail and the manufacturing sectors of the economy.

Clearly, locating the firm-level dates of UPC adoption is critical to completing the more ambitious steps 3 and 4 of this proposal. The original research by John Dunlop and co-authors strongly suggest that these data exist. We are in conversations with several industry insiders, including current and former UCC officers and engineers, and have found several promising avenues that we might pursue using the funds from an NBER grant. For instance, several libraries maintain promising but poorly documented private collections that are likely to include some hard-copy records of early membership lists. Specifically, Stony Brook University's library contains a large collection of papers from Teddy and George Goldberg, collected during 20 years of publishing SCAN Newsletter, which was dedicated to the Automatic Identification Data Capture (AIDC). Duke University's library has papers from the private company Bill Communications, which includes the 1974 UGPCC, as it was then called, membership list. We are also currently in communication with several current and former officers of UCC/GS1US in the hopes of securing access to some of their earlier hard-copy and microfiche membership files.

While in some ways an archeology project, this data set promises to be a goldmine for future research on innovation and the evolution of compatibility standards. Key features of the barcode which apply more broadly to other industries and standards are:

- Entirely voluntary adoption of a standard that was not endorsed by any regulator;
- Initial support of several large companies, but uncertainty about the extent of adoption by the rest of the grocery industry;
- Unexpected expansion of the standard to other industries, including a merger with the an organization that assigned barcodes for industrial use, adoption by FDA for pharmaceuticals, and eventual adoption by a very wide range of industries from apparel to record labels and books;

- Unexpected hold-up issues, when Jerome Lemelson surfaced with a set of patents on key aspects of the underlying scanner technology;
- A competing European standard that was eventually merged with the U.S. system to form a single international code;
- Increased size of the code (added digits) as its coverage spread in product space and across geography.

We plan to use the funds to pay for travel to the various data sites (Stony Brook, NY; Durham, NC; Dayton, OH) and to provide summer pay and RA support for the data entry task.

References

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