Gallman Revisited: Blacksmithing and American Manufacturing, 1850-1870

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Abstract

In nineteenth century America, blacksmiths were a fixture in every village, town and city, producing a diverse range of products from axes to wheels and services from repairs to horse-shoeing. In constructing his historical GNP accounts Robert Gallman opted to exclude these "jacks-of-all-trades" from the manufacturing sector, classifying them instead as part of the service sector. However, using establishment-level data for blacksmiths from the federal censuses of manufactures for 1850, 1860 and 1870, we re-examine that choice and show that blacksmiths were an important, if declining, source of manufactured goods. Moreover, as quintessential artisan shops, a close analysis of their structure and operation helps resolve several key puzzles regarding industrialization in the nineteenth century. As "jacks-of-all-trades," they were generally masters of none (except for their service activities). Moreover, the historical record reveals that several of those who managed to achieve mastery moved on to become specialized manufacturers of that specific product. Such specialized producers had higher productivity levels than those calling themselves blacksmiths producing the same goods, explaining changes in industry mix and the decline of the blacksmith in manufacturing.

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“Under a spreading chestnut tree

The village smithy stands;

The smith, a mighty man is he,

With large and sinewy hands;

And the muscles of his brawny arms

Are strong as iron bands”

-Henry Wadsworth Longfellow

1. Introduction

This paper re-examines the role of the blacksmith in nineteenth-century U.S. manufacturing using establishment-level data from the decennial censuses of manufacturing for 1850, 1860, and 1870, in order to resolve important questions raised decades ago by Robert Gallman and others regarding commodity production and services during that period (Gallman 1960, 1966; Gallman and Weiss 1969).[1] It also provides important new evidence on the relationship between scale, specialization and productivity in nineteenth century manufacturing. While often overlooked by students of early industrialization, we argue that the blacksmith was a central character in the transition of manufacturing activity from small scale activity by generalists serving very local markets to more specialized and productive operations serving a dispersed clientele.

Blacksmiths produced a wide range of products and supplied important services to the nineteenth century economy. In particular, they produced horseshoes and often acted as farriers,

[1] Blacksmiths also appear in our establishment level data from 1880 census but changes in the census questions at that census prevent these later data being useful for the primary analyses in this paper; see the text.

shoeing horses, mules and oxen. This was a crucial service in an economy where these animals provided the most of the draft power on the farm and in transportation and carriage. They also produced a wide range of goods from agricultural implements to pots and pans, grilles, weapons, tools, and carriage wheels among many other items familiar and unfamiliar to a modern audience—a range of activities largely hidden behind their generic occupational title.

Blacksmithing was a sufficiently important activity to qualify as a separate industrial category in the nineteenth century US manufacturing censuses, alongside more familiar industries as boots and shoes, flour milling, textiles, and clock making. The 1860 manufacturing census, for example, enumerated 7,504 blacksmith shops employing 15,720 workers, producing an aggregate gross product of $11,641,213 (current dollars, see United States. Census Office. 1872, p. 399)—in terms of the number of establishments, the fourth most common activity behind lumber milling, flour milling and shoemaking. Although the absolute number of blacksmith shops would continue to increase for some time after the Civil War, their number declined relative to manufacturing as a whole and, more importantly, relative to industries such as agricultural implements and carriage-making whose goods competed with those produced by traditional blacksmiths. By the early 1900s, blacksmiths were no longer listed as a separate industry in the Census of Manufactures.[2]

This paper uses the Atack and Bateman (1999) plant-level samples from the surviving manuscript schedules of the census of manufacturing for 1850, 1860, and 1870 to study three aspects of historical blacksmithing.[3] The first concerns the distribution of the gross output of

[2] The 1900 census combined blacksmithing with wheelwrighting.
[3] Collection of sample data from the extant manuscripts of the nineteenth century censuses of manufacturing was begun by Bateman and Weiss (see 1981) and completed by Atack and Bateman. We do not use the Atack-Bateman sample from the 1880 census because, as explained

blacksmiths between manufactured goods and services such as repair work and horse shoeing. This exercise, using enumerated but un-tabulated census information on inputs and outputs, raises questions regarding decisions made by Robert Gallman (1960) to exclude "hand-trades", including blacksmithing, from his estimates of manufacturing value-added over the period 1839 to 1899. Second, we study the relationship between the product mix, shop size, and labor productivity among blacksmiths. We show that the correlation between the manufactures share and establishment size, as measured by the number of workers, was positive – or, to put it another way, the smallest blacksmith shops had a product mix that favored services like repairs and horse shoeing. Third, we use the product codes to study the differences in gross output per worker between those blacksmith shops that produced, for example, plows versus those establishments that also produced plows but reported their industry to be "agricultural implements" rather than blacksmithing. We find that, holding the type of good produced constant, the self-identified specialized producer of the good – agricultural implements, for example – had higher productivity, on average, than blacksmiths making ostensibly the same product.

2. Blacksmithing and Nineteenth Century Manufacturing: Background

The village blacksmith was a common sight in early nineteenth century American communities, along with cobblers, shoemakers, grist mill operators, and other artisans. Blacksmiths made goods from wrought iron or steel. This metal was heated in a forge until

in the text, we rely heavily on census information regarding the specific products that blacksmith shops produced—information which was not collected by the 1880 census. The basic sample data are available for download from https://my.vanderbilt.edu/jeremyatack/data-downloads/. This paper also uses additional information on business organization (e.g. partnership, corporation) culled from the original Atack-Bateman data worksheets; see Atack (2014).

pliant enough to be worked with hand tools, such as a hammer, chisel, and an anvil. Others also worked with metal but what distinguished blacksmiths was their abilities to fashion a wide range of products from start to finish and even change the properties of the metal by activities such as tempering, as well as repair broken objects. Over time, blacksmithing went into decline, displaced by manufacturing establishments that specialized in individual products once produced by blacksmiths.

Given what blacksmiths did with their hands for a living, one might think that blacksmithing was a natural activity to categorize as "manufacturing". Indeed, as noted in section 1, all of the nineteenth-century manufacturing censuses listed blacksmithing as a separate industry. Later on, however, economic historians have had other ideas.

In particular, in two celebrated articles Robert Gallman (1960, 1966) provided the first credible estimates of GNP and its structure for the nineteenth-century United States. In the first article, Gallman (1960) presented series of value added, employment, and labor productivity in the "commodity-producing" sectors, namely agriculture, mining and manufacturing, and construction. The time series covered the period from 1839 to 1899, with benchmark estimates at five-year intervals (e.g. 1854, 1859).[4] In the course of fashioning these estimates, Gallman made various adjustments to the published census data, one of which was to exclude industries that the Census had deemed to be "manufacturing" but which he did not. These excluded industries eventually would appear elsewhere in his national accounts, just not in manufacturing. For example, the Census considered carpentry to be a manufacturing activity, but Gallman

[4] Gallman's (1960) appendix gives the details of his estimation procedure. In the case of manufacturing, the basic sources are the federal censuses, starting in 1839. These were supplemented by various state censuses, which were used to interpolate to mid-points (e.g. 1854) between federal census dates.

disagreed, and re-classified it as construction. The point of departure for this paper was Gallman's (1960, p. 58) decision to exclude the so-called "independent hand trades" from manufacturing, of which there were six.[5] By far the most important quantitatively of these was blacksmithing.

To the extent that Gallman (1960) justified his exclusion restriction, the logic seems to have been that blacksmiths and the other hand trades were (mostly) employed in "independent shops" rather than the factories that already made up the bulk of employment in manufacturing in 1850 and which would grow to overwhelming importance by the end of the century.[6] In his comment on Gallman's article, Potter (1960, p. 67), however, pointed out that the hand trades did, in fact, make physical products which were, in principle, part of manufacturing and, hence, that Gallman's value-added estimates, by excluding these workers, were biased downwards. But in a nod to Gallman's logic, Potter also asserted that the hand trades "were in considerable part displaced by manufacturing during the period 1839-99[.]" As a result, the downward bias was greater earlier (e.g. 1839) in the period than later (1899), and therefore, the growth rate of manufacturing, as estimated by Gallman, was biased upwards. As we discuss later in the paper, our analysis of the product codes in the Atack-Bateman samples support Potter's conjecture, but also concludes that the upward bias in Gallman's estimates is very small (see section 3).

[5] The six are blacksmithing, locksmithing, coppersmithing, whitesmithing (tin), gunsmithing, and carriage-smithing; see Gallman (1960). As discussed in Appendix B of this paper, not every hand trade was enumerated separately in every census.

[6] As we discuss later in the paper, an obvious problem with this logic is that median establishment size in manufacturing in 1850 was two workers and approximately 80 percent of establishments had five workers or fewer (Margo 2015, p. 221). Moreover, a clear majority of all establishments through 1880 (and beyond) were sole proprietorships and corporations were rare—even if their products were not (Atack 2014, Tables 17.1 and 17.2). We return to this point later in the paper.

Nevertheless, blacksmiths were important in other ways to the evolution of nineteenth century manufacturing, as we will show.

About a decade after his initial work appeared, matters were clarified when Gallman published a co-authored paper with Thomas Weiss on the service sector (Gallman and Weiss 1969). Accepting Potter's point, Gallman and Weiss (Gallman and Weiss 1969, p. 347) recognized that workers in the hand trades could be "employees of manufacturing establishments" or they could have been laboring "in small, independent shops". Workers in "independent" shops might be crafting goods or they might be performing services, such as a blacksmith fixing a carriage wheel. Gallman and Weiss agreed that the former activity should be included in manufacturing while the latter was clearly a service. The published census, however, did not divide the gross value of output in the hand trades into physical goods versus services making it impossible to determine how much of blacksmithing output consisted of manufactures – plows, for example – versus services, such as repairing broken tools or shoeing horses. Therefore, because Gallman had previously excluded the hand trades from commodity output, the only practical solution at the time was to put them in the service sector "so that their contribution does not go unrecorded" (Gallman and Weiss 1969, p. 347).

After the publication of the Gallman and Weiss article, the issue lay dormant for three decades until the appearance of the paper by Jeremy Atack and Fred Bateman announcing their samples from the surviving manuscripts of the nineteenth century manufacturing censuses (Atack and Bateman 1999). In a brief discussion towards the end of the paper, Atack and Bateman (Atack and Bateman 1999, p. 187) used census information on establishment outputs to point out that that blacksmiths "produced a wide range of goods that fully deserve to be called 'manufactured products'" such as "pots and pans … plows, fanning mills, hoes, scythes, knives, and wagons[.]" thereby agreeing with Potter (1960)). Moreover, they used the product descriptions in the census manuscripts (see below) to provide illustrative calculations of the (sometimes substantial) contribution of blacksmiths to goods production.

Since most blacksmith shops were small and remained small, the historical evolution of that industry may also be helpful in assessing the role of economies of scale in nineteenth century manufacturing. There is now a long literature making use of establishment-level data from the manuscripts of the nineteenth century manufacturing censuses to estimate the parameters of production functions econometrically, from which the extent of economies of scale can be calculated. Early work, for example, Atack (1976, 1977) or Sokoloff (1984) found evidence of economies scale, based on production function estimates, but a recent re-evaluation of this earlier literature by Margo (2015) suggests that the finding of scale economies is not robust.

The fundamental problem is that very small manufacturing establishments have higher labor productivity in value-added terms than large establishments (Sokoloff 1984). As we show later in the paper, this same, but smaller, effect is clearly present among blacksmiths but, by using the product information collected by Census, we can make two points that have previously gone unremarked. First, we show that the very smallest blacksmith shops had very different product mixes from larger shops. This proves crucial for economies of scale estimation. Second, comparing output per worker exclusively producing specific products in blacksmith shops with that in establishments describing themselves as manufacturers of that particular product, we find that, ceteris paribus, labor productivity was lower in the blacksmith shops. Putting these two results together, we suggest that the small firm effect found in the census data may be due, in part, to selection bias.

In the case of blacksmiths, over the course of the nineteenth century, most of them either exited the industry (like John Deere), or those with the talent and strength to work metal ended up as employees ("mechanics") in factories that made iron and steel products. Those blacksmiths who remained in the "industry" either were engaged in high value services that required special skills – repairing a specific tool or product, for example – or else worked within remote isolated markets with limited "market access" to the specialized industries whose products were displacing blacksmithing elsewhere.

3. Data

Our empirical analysis makes use of the national samples of establishments collected by Atack and Bateman (1999) from the 1850-70 federal censuses of manufacturing. Panel A of Table 1 shows statistics on blacksmiths derived from the published 1850-70 censuses of manufacturing. Blacksmith shops were 8 percent of manufacturing establishments in 1850, 5 percent in 1860, and nearly 10 percent in 1870. This zig-zag pattern in the time series led Gallman and Weiss (1969) to argue that blacksmiths were under-enumerated in 1850 and 1860 which, in turn, led them to make upward adjustments in their estimates of service sector output before the Civil War. Allegedly, the under-enumeration was concentrated in the left tail – the smallest blacksmith shops whose annual gross output was close to the census cutoff of $500. The census certainly claimed to make a better effort at enumerating small manufacturing establishments in 1870 (United States. Census Office. 1872), which Gallman and Weiss argue accounts for the increase in the blacksmith share of total establishments between the 1860 and 1870 censuses. However, the census cutoff of $500 was never adjusted for changes in the price level and, because the Civil War inflation persisted into the late 1860s, we would expect that the blacksmith share would be higher in 1870, even if no changes in enumeration protocols had been made—which is to say the $500 cut-off was no longer the barrier that it once had been because of the Civil War inflation.

The analogous statistics from the Atack-Bateman national samples are shown in Panel B for those observations meeting the standard sample screens that we use in our previous work (see, for example, Atack, Bateman, and Margo 2008).[7] Since the samples provide establishment level data, we can also determine the impact of imposing a real, as opposed to nominal, $500 cutoff. This drives the share of blacksmiths in 1870 below the level observed in 1850, consistent with the long-run (1850-1900) trend but there is still a rise in their share between 1860 and 1870. The rise between 1860 and 1870, however, was concentrated in the South, where it may reflect a temporary response to the various economic dislocations associated with the Civil War (Atack and Bateman 1999) that forced a return to more local self-sufficiency.

Although blacksmith shops made up a non-trivial share of all manufacturing establishments, they constituted a much smaller share of gross value, factor use (employment, capital, and raw materials), and value-added than their number would suggest. For example, in 1850, when blacksmith shops made up a little more than 8 percent of establishments reported in published census, their share of employment was far smaller, just 2.6 percent. Indeed, regardless of how size is measured, blacksmith shops were, on average, small and their size distribution was heavily skewed to the left. As we show in Panel C, where we compare the distribution of establishments by the number of workers, this was true relative to the overall distribution – in

[7] Specifically, we drop observations for which no labor, or capital, or inputs, or outputs were reported, if value-added (output value minus input value) was negative, if the business produced less than $500 worth of (nominal) annual output (such establishments were not supposed to be included in the census) and those whose estimated rate of return lay in the upper or lower one percent (on the grounds that these were outliers and must have suspect data).

each of the three census years. A far larger share of blacksmith shops had just 1 or 2 workers than in manufacturing as a whole.

Not only were blacksmith shops smaller than the norm in manufacturing, they were also less productive in revenue terms. This is apparent in both Panel A and B, by comparing the blacksmith share of total value-added, which is always less than the blacksmith share of employment, implying that output per worker was lower, on average, in blacksmith shops than the average in manufacturing.

Panel C illustrates a basic conceptual problem with Gallman's (1960) original decision to exclude the "independent" hand trades from manufacturing. If true "manufacturing" only took place in larger establishments as opposed to "independent shops" – defined as a sole proprietor, or a proprietor plus perhaps an assistant – then the vast majority of establishments should have been dropped, even in industries such as flour milling where there is no question whether the work force was providing a service or making a product for sale. However, the published census volumes for the earlier years in Gallman's analysis never included size distributions of establishments, so there was simply no way for him to exclude "independent" shops, except wholesale by industry (such as blacksmiths). But, as Panel C shows, size alone cannot be the criterion for exclusion.

On the census forms that the enumerators submitted to Washington DC, they reported the name of each manufacturing establishment that they visited. This information was not encoded in the original Atack-Bateman samples primarily because of technological constraints when the earliest data were collected.[8] It was, however, recorded on the original worksheets (in the

[8] Specifically, space was at a premium since the data had to be transferred to 80-column Hollerith punch cards after encoding for entry into the mainframe computer. Moreover, the

authors' possession) and contains useful and useable information. These "doing business as" names for each sample establishment has since been examined and categorized, although the names themselves are still not attached to each sample observation.[9] They were categorized as follows: an establishment doing business as, say, "John Smith" was deemed a sole proprietorship while "John Smith & Son(s)" or "John Smith and George Smith" was categorized as a family business. We classified businesses with names like "John Smith and Johan Schmidt" as partnerships, distinguishing between those businesses with just two individual's names and those with more than two. Businesses whose name was impersonal or included the word "mill," "factory" (or similar), or "Corporation" (or "Co.") were classified as incorporated, for example "The Ohio Iron Co." Virtually all such businesses were large. More challenging, were those businesses whose name included "& Co(mpany)" (note the ampersand). These were classified separately and are believed to represent partnerships with one or more "silent" partners. Most state laws provided that such individuals were not jointly or separately liable for the debts of the business beyond their initial investment provided that they remained silent on the day-to-day management of the business (Bates 1886; Burdick 1899; Hilt and O'Banion 2009; Howard 1934).

Dividing the establishments in the samples into these various organizational forms suggests that over 82 percent of all manufacturing establishments were organized as sole proprietorships in 1850, declining to 77 percent in 1860 and 73 percent in 1870 (Table 2, Panel

primary scientific programming language of the time (FORTRAN) was not well-suited to string manipulation.

[9] A few individual worksheets are missing from their worksheet folders—presumably these were removed at some point over the past fifty years or so to check information and not returned (or improperly filed). In these cases, the "doing business as" field has been coded as missing.

A).[10] These businesses engaged about 6 workers (Table 2, Panel B). Businesses that we believe were incorporated, however, made up only 1.7 percent of all manufacturing establishments in 1850, growing to just 3.9 percent by 1870 but they generally had ten times as many employees per establishment as the sole proprietorships.

If we restrict the sample to just those businesses identifying themselves as blacksmiths, sole proprietorships made up about 90 percent of the business population in that industry and these establishments had, on average, just two workers—likely the blacksmith and a helper (to work the forge bellows, hold the metal punch, or clip the softened iron, and so on). Moreover, the bulk of the remaining population of blacksmiths were organized either as family concerns or partnerships and differed little in size one from the other.

In collecting the manufacturing data, the census enumerators also quizzed respondents regarding the types of products that each establishment produced, as well as their quantity (if relevant) and value. This information was also never tabulated by the Census but most of it was encoded in the Atack-Bateman manufacturing samples and is central to our analysis.[11] The instructions to enumerators called for each establishment to be asked to list by name up to five products or services provided by the establishment and up to six physical inputs used to produce those outputs. Each was listed in order of importance and along with the name of the product or raw material, information was also collected on quantity (and the units of measurement) and their value.[12] These inputs and outputs were converted to numeric codes for type and units and

[10] These figures differ slightly from those reported in Atack (2014) because of the application of data screens here to eliminate observations with any missing or suspect data.

[11] See http://my.vanderbilt.edu/jeremyatack/files/2011/08/MFGDOC.pdf

[12] As previously noted, not all of this information made it into the original Atack-Bateman samples since the data were encoded on 80-column Hollerith punch cards—three cards per observation, one for labor, capital, power, location, etc., one for inputs, and one for outputs.

are identified in the codebook to the Atack and Bateman samples. When data collection was complete, the samples used a total of 1,395 separate product codes and 1,295 raw materials codes.[13] From census year to census year, these codes grew more numerous and specific, suggesting that manufacturers were increasingly particular and specific in describing the products that they used and made—for example, anthracite coal rather than just "coal" and "rakes" and "plows" rather than just "agricultural implements." We make extensive use of these final product codes in our analysis of blacksmithing activities that follows.

4. The Mix of Services and Manufacturing among Blacksmiths

There were 83 separate final product codes used for blacksmiths (see Appendix A), covering a wide range of products and activities. We have collapsed these into a set of six broad product categories – general blacksmithing (such as jobbing and including horse shoeing); hardware (harness fittings, nails, hinges, latches and the like); implements (such as hoes, plows, rakes and tools); iron work (like fencing and generic "iron work"); repair services; and carriages, wagons, and wheels. Many blacksmith shops still produced more than one of these broadly defined products.

Bateman and Weiss determined that no more than four inputs and output values, quantities and codes could be accommodated within the 80-column space of a single card. However, since few establishments reported more than four inputs or outputs, they opted to consolidate the additional data from those few observations rather than add more (mostly blank) input and output cards per observation. When there were more than four distinct inputs or outputs listed, the values of the least important raw material inputs and outputs were aggregated and coded as "miscellaneous" as the fourth input or output. A similar practice must also have been adopted by the enumerators as they sometimes listed a "miscellaneous" category as the last input or output in their enumeration.

[13] In the public code book accompanying the Atack-Bateman sample (http://my.vanderbilt.edu/jeremyatack/files/2011/08/MFGDOC.pdf), a few products have multiple codes that survived the data cleaning process so that the number of different products or raw materials is slightly less than reported in the text. The multiple codes are allowed for in assigning broad product categories.

Panel A of Table 3 shows the fraction of the gross value of the primary activity (the first product listed in the census enumerations per instructions) as distributed across the product category, along with the distribution of establishments. A solid majority – two-thirds, for example, in 1850 – of total blacksmith gross value (and, for that matter, of blacksmith shops themselves), were engaged in what we call "general blacksmithing" or repair services. Moreover, by 1870, the share of blacksmith gross value classified as general blacksmithing or repairs had increased to 85 percent, that is to say blacksmith shops became less specialized in specific product production and more service-oriented over time.

Our general blacksmithing category is an amalgam of various activities. Some of these were (mostly) quite specific services, such as shoeing horses, while others were vaguely worded, such as "jobbing," "custom work", or simply (but unrevealingly) "blacksmith". Because of this, we have constructed two estimates of the share of blacksmith gross value that can be attributed to manufacturing activity, a lower bound and (plausibly) an upper bound. The lower bound assumes that, unless a specific good is mentioned, such as a plow or an axe, the blacksmith was engaged entirely in supplying services. The upper bound excludes from the calculation any activities which are too vaguely worded to be plausibly and clearly allocated to either services or manufactures, such as "jobbing." We believe that these represent very conservative interpretations of the data and in calculating these lower and upper bounds, we use all of the activities listed in the samples, not just the first (and primary) one, as shown in Panel A.

These lower and upper bounds on the fraction of the gross value of blacksmith output that properly constituted manufacturing for the census years 1850-70 are reported in Panel B. The ranges are fairly large – for example, in 1850, the lower bound estimate of the manufactures share is about 29 percent whereas the upper bound is 65 percent – because many blacksmiths reported one of their activities as "blacksmith." However, both the lower bound and upper bounds are decreasing over time – robustly so, indicating that the blacksmith "industry" was shifting strongly away from the production of manufactured goods and towards services, consistent with Potter's (1960) conjecture. Moreover, the range is narrowing over time.

The sharp decline in the manufactures share implies that Potter's (1960) criticism of Gallman's (1960) decision to exclude the hand trades was conceptually correct. Gallman understated the size of the manufacturing sector in 1850 and, because the hand trades were declining over time, he therefore overstates the growth of manufacturing value added and productivity (output per worker). However, as we show in Appendix B, the resulting bias in Gallman's estimates is very small and can safely be ignored.

We previously noted that blacksmith shops, while always small on average, were also becoming even smaller over time, counter to the general trend in manufacturing (see, for example, Table 2, Panel B). The fact that the shrinking in size was occurring when blacksmiths were shifting towards services suggest that the two features of behavior – size and product mix – could be related. Regression analysis suggests that it was. Panel C of Table 3 reports the coefficient of the manufactures share of value added (lower bound estimate) and the probability that a blacksmith shop had at most two workers. The coefficient is negative and statistically significant, regardless of whether we control for geographic location – urban status and state – which might also matter for the size distribution. Larger blacksmith shops, in other words, had a product mix more tilted towards goods production, while those shops that specialized in services were smaller. The next section explores how size and product mix affected labor productivity in blacksmithing.

5. Labor Productivity in Blacksmithing: The Small Firm Effect, Product Mix, and Industry Endogeneity

A defining feature of nineteenth century industrialization in the United States was the growth of large scale production. At the start of the century, the vast majority of manufacturing took place in artisan shops but by century's end, output and factors of production had shifted towards factories (Atack 2014). The shifts toward large scale production was driven by improvements in internal transportation and changes in technology that created incentives for division of labor, and by greater access to financial markets which provided the monetary grease so that firms could grow in size.

It is a truism that economic historians believe that the shift towards large scale production contributed to the growth of labor productivity in manufacturing through the exploitation of economies of scale. But using the primary source of data on nineteenth century American manufacturing – the censuses of manufacturing – to document the existence of and measure the extent of economies of scale has proven to be problematic. The basic problem is a "small firm effect" on productivity – the smallest establishments, measured in terms of workers, have higher labor productivity than larger establishments (Sokoloff 1984). Moreover, in the economy as a whole, labor productivity was higher in services than in manufacturing (Gallman and Weiss 1969; Weiss 1967). Is it possible that variations in the product mix of businesses—especially if these establishments also produced services—might explain some of the "small firm effect" on labor productivity in manufacturing?

Sokoloff attributed the small firm effect to an alleged under-reporting of entrepreneurial labor in small firms which he "fixed" in the 1850 data by adding one person to each establishment's workforce. With the fix in place, Sokoloff was able to demonstrate the existence of fairly sizeable economies of scale based upon production function estimates, even in non-mechanized establishments which he attributed to pure division of labor—the specialization by individual workers in a specific task or group of tasks. More recent analysis by Margo (2015), however, finds no evidentiary basis for Sokoloff's specific adjustment and concluded that Sokoloff's conclusions were not robust.

However, even with the superior corrections proposed by Margo (2015), the small firm effect remains and it is clearly present among blacksmiths. Column 1 of Panel A of Table 4 reports the coefficients of a dummy variable equal to one if the number of workers was one or two (i.e. was a small firm) from a panel regression of the log of value-added per worker. The regression also includes fixed effects for census year (1860 and 1870), urban status, and the state in which the establishment was located. The coefficient of the dummy variable is positive and highly significant. Thus, even among blacksmiths, where there were relatively few large-scale establishments, the smallest shops were still significantly more productive than larger shops.

The product code information in the samples, however, provides a fresh insight into what may be going on here. Specifically, we test whether the product mix between services and goods manufacturing may explain the small firm effect. In the aggregate nineteenth century economy, we already know that output per worker was highest in services (Weiss 1967), and this differential may have carried over within industries. As we showed in the previous section, the smallest blacksmith shops had a product mix tilted towards services rather than towards good production.

We can explore if this was the case by adding the product mix to the regression specification.[14] The variable is measured such that larger values represent a higher share of manufactures in the total. As can be seen in column 2 of Panel A, the manufactures share is negatively related to output per worker, consistent with the hypothesis that establishments that emphasized services had higher measured productivity. Relative to larger establishments, the smallest blacksmith shops had a product mix that favored services; and that, other factors held constant, the higher the share of services in the product mix, the higher was output per worker. That said, controlling for the product mix explains only a small portion of the small firm effect. The "small firm" dummy is still positive and highly significant.[15] The last column of Table 4,

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[14] For this purpose, we use the lower bound measure because this is defined for all blacksmith shops whereas the upper bound measure excludes observations for which the product code is too vaguely worded ("blacksmithing") to assign precisely to manufactures or services (see the previous discussion).

[15] At the suggestion of a referee, we conducted a sensitivity analysis in which we narrowed the sample in Panel A, Table 4, to blacksmiths that reported producing a specific agricultural good, whether this was the first, second, third, or fourth product listed. This is a narrower test of the small firm effect because it substantially restricts the product mix by construction, unlike the regressions in Panel A of Table 4.

There is only one good for which there are sufficient observations in the samples to estimate such a regression– plows. Specifically, we compute a variable, PLOWVAL, which is the sum of the total value of plows produced (first through fourth products listed), and restrict the sample to blacksmith shops for which PLOWVAL was positive (in any census year). There are 89 observations in this sample. The dependent variable is the log of the value of plows, and the critical independent variable is the small firm dummy (=1 if one or two; the regression also includes dummies for urban status, state, year, and linear terms in the log of the number of workers, the log of capital invested, and the log of the value of raw materials. The coefficient of the small firm dummy is positive ($\beta = 0.147$) which, consistent with the argument in the text, could be attributed to selection bias; however, the standard error is large (s.e. = 0.476) so the coefficient is (very) imprecisely estimated, and we cannot reject the hypothesis that it is statistically zero.

We also conducted a similar exercise focusing on blacksmith shops that derived at least 50 percent of their gross revenue from the production of wagons; in this regression, the dependent variable is log of value added per worker, and the regression includes the small firm dummy, urban status, state, and linear terms in the log of the capital-labor ratio and the share of gross value derived from wagons. There are 50 observations in this sample. The coefficient on the small firm dummy is positive and the coefficient of the share of gross value from wagons is

Panel A adds the log of the capital-labor ratio to the regression. This further reduces the effect of the small firm dummy as well, but the coefficient remains positive and highly significant.

The product codes can also be used to compare the productivity of blacksmith shops with establishments other industries that produced the same good. One of the most important examples involves agricultural implements. In the first half of the nineteenth century blacksmiths in rural areas everywhere made hoes, rakes, plows and many other tools for use on farms. By the end of the century, however, the vast majority of this production took place in factories whose owners considered themselves to be in the "agricultural implements" industry. In the Atack-Bateman sample, such establishments are given the (modern) SIC code 352 (United States. Office of Management and Budget. 1987).

To make this productivity comparison, we limit the sample to those blacksmith shops (SIC 769) whose primary activity was the production of a specific agricultural implement, such as plows, as well as agricultural implements establishments (SIC 352) who did the same. Thus, in effect, we are holding constant what the establishments in both industries considered to be their primary economic activity. We have two dependent variables, the log of the gross value of the primary product, and the log of the gross value of total output. Our interest is in the coefficient of a dummy variable taking the value one if the observation was a blacksmith shop (SIC 769). All of the regressions include fixed effects for the census year and the product code of the primary activity, and continuous variables in factor inputs (see the notes to Panel B of Table 4).

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negative, again consistent with the patterns observed in Panel A of Table 4; like the "plows" regression above, however, both coefficients have large standard errors, and we cannot reject the hypothesis that they are statistically zero.

In part, our choice of comparing blacksmiths producing agricultural implements with "pure" agricultural implements manufacturers was guided by sample size. But, we are also cognizant of the case of John Deere, who operated as an independent blacksmith until in the late 1830s when he invented a plow that proved remarkably useful to Midwestern pioneer farmers. He subsequently formed a partnership with Leonard Andrus in 1843 to build enough plows to meet robust demand for his plows, effectively abandoning his "jack-of-all-trades" blacksmithing to specialize on producing his plows. That partnership was dissolved in 1848 and Deere moved his company to Moline, Illinois where it prospered and grew in size (Broehl 1984), eventually broadening its offerings of agricultural implements beyond the plow.[16]

Our narrative of change over time in agricultural implements production implies that the coefficient of the dummy variable for blacksmith shops should be negative – that is, blacksmith shops were less productive than establishments in the specialized industry. As can be seen in columns 1 and 2 of Table 4, the hypothesis is strongly borne out, whether or not we include fixed effects for urban status and state in the regression. We are calling this the "John Deere effect": holding the type of good produced constant, the self-identified specialized producer of the good – agricultural implements, in this instance - had higher productivity, on average, than blacksmiths making ostensibly the same product.

Although the regressions in columns 1 and 2 control for factor inputs, these controls are not specific to the goods in question. Thus, it may be that blacksmith shops that were

[16] There are other examples of well-known industrial firms that started as independent blacksmith shops, for example, Studebaker Brothers, which began as a blacksmith shop in the early 1850s, but soon specialized in wagons and carriages. The company grew dramatically during the Civil War as a consequence of military contracts with the Union Army (Erskine 1918), a couple of decades after Deere made the same kind of transition to specialist product producer.

specialized in agricultural implements production allocated less labor, capital, and raw materials to producing such implements, relative to other activities. In columns 3 and 4, the dependent variable is the total value of gross output; the difference between the columns is that the regression in column 4 includes our estimate of the overall share of manufactures while column 3 does not. The coefficient of the dummy variable for blacksmith shops is negative in column 3, but not statistically significant. However, once we control for the manufactures good share, the blacksmith shop coefficient is negative, larger in magnitude, and significant at the 5 percent level.

We believe that these results for blacksmiths suggest a plausible hypothesis for why it has been so difficult for economic historians to generate robust estimates of economies of scale from the nineteenth century census data. Consider the goods produced historically by blacksmiths, such as plows. Over time, blacksmiths produced fewer and fewer of these, concentrating instead on services like shoeing horses or repairs. But even controlling for this, only the most productive of blacksmiths (or else those whose market was protected from competition in some way) survived – a selection effect. On the goods side of the market, production shifted towards establishments that were sufficiently productive that they could specialize in a particular "industry," such as John Deere in the agricultural implements industry. As this industry grew, it drew in workers—some of whom in an earlier era might have opened their own blacksmith shops but most of whom now worked on the factory floor, perhaps doing some of the same tasks by hand that blacksmiths had done earlier but otherwise performing entirely novel tasks, because production process was increasingly mechanized. On average, such workers in the specialized industry were more productive than the "jack-of-all-trades," the blacksmith, had been formerly.

The village smithy could and did produce rakes and hoes, but the village smithy eventually and increasingly gave way to businesses like (John) Deere & Company who did it better.

6. Concluding Remarks

During the first half of the nineteenth century blacksmiths were ubiquitous in the United States but by the end of the century they were no longer sufficiently numerous or important goods producers to qualify as a separate industry in the manufacturing census. Blacksmiths are interesting to study because they were "jacks-of-all-trades," capable of producing manufactured goods like pots and pans, hoes and rakes, from scratch at an affordable price and of adequate quality and functionality but also capable of repairing a broken tool or carriage wheel. They were "gateways" to more specialized (and highly skilled) activities. In a famous paper, Robert Gallman (1960) treated blacksmiths as a precursor to modern manufacturing—proto-industry—and therefore excluded them and their output from his estimates of manufacturing value added. While even at the time this was recognized as incorrect because blacksmiths did produce manufactured goods, there was no way for Gallman to measure the importance of manufacturing in blacksmith activity.

This paper has used the product codes in the Atack, Bateman and Weiss (2004) samples of the manuscript censuses of manufacturing to measure the share of manufactures in blacksmith gross output for the census years 1850 to 1870. We also explore the relationship of the product mix to labor productivity. Over time the product mix among blacksmiths shifted towards services and the typical blacksmith shop became smaller, counter to the general trend in establishment size in manufacturing as a whole. The product mix and size were also related in cross-section – the smaller the blacksmith shop, the higher was the share of output devoted to services. The product mix also helps to explain some of the "small firm effect" present in nineteenth century US manufacturing census data, the tendency for the smallest establishments to have the highest value added per worker. However, much of the small firm effect remains even after controlling for the product mix.

We also compare labor productivity of blacksmiths and in establishments in a related industry, agricultural implements, controlling for the specific type of implement that the establishment considered to be its primary output. We show that blacksmiths were less productive the specialized establishments, even if we control for the overall product mix. Taken together, these two results on productivity help explain why blacksmith production of manufactured goods was displaced over time, but also why some shops were able to survive.

7. **Appendix A**

As indicated in the text, enumerators at the censuses of manufactures in 1850, 1860 and 1870 were instructed to list up to six raw materials used in the production of up to four individually identified final products. Specifically, the instructions stipulated that:

> "Under the general heading, entitled "*Annual products*" is to be inserted the *quantity, kind*, and *value* of *each* produced during the whole year. It will require great care to fill this column properly. When several articles are manufactured, the first four only need be particularly specified, and the remainder classed under a general heading of "Other articles," and the aggregate value of such articles carried out, the quantity being omitted; or, where otherwise impracticable in any case, the aggregate value, without the specific quantity or kind. In stating the value of the products, the value of the articles *at the place of manufacture* is to be given, exclusive of the cost of transportation to any market." [emphasis in original] (Wright, 1900, p. 314)

The Bateman-Weiss coding scheme kept the spirit of these instructions within the space constraints imposed by an 80-column Hollerith punch card. To achieve this, they reduced the number of individually identified raw materials and final products to a maximum of the four most important (by value). In those cases where more than four inputs or outputs were identified, only the three most important by value were identified by specific codes and the value of the remaining inputs or outputs were aggregated, reporting that value under a code for "Miscellaneous."

Collectively, the products made by the blacksmiths in the individual Bateman-Weiss state samples were classified under 83 different final product codes, 82 of which were unique (in the sense of different descriptions or units of measurement – including none). The duplicate code is for "miscellaneous." [17] In analyzing the activities of blacksmiths, we grouped these 83 final products (disregarding the units of measurement) into six broad groups (some of which represent judgment calls about what was meant by the product description).[18] Specifically:

"General blacksmithing work": Blacksmithing, custom work, horseshoes, jobbing, joiner work (presumably welding, etc.), miscellaneous, (horse)shoeing/shoeing etc./shoes, and stove fitting.

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[17] Almost fifty years has passed since collection of these data began and it has been about 45 years since Atack did any product coding on them. No one remembers what the distinction was between the two "miscellaneous" codes but they were assigned consecutively and very early in the project: 45 and 46. Initially, sequential numerical codes were assigned, began with "1." After the 99th code had been assigned, subsequent codes were alphanumeric beginning with A0 (Azero) through A9, then B0 through B9, etc. as the coding sheets and punch cards allowed for only two characters for each code. Once the 80-column Hollerith punchcard constraint vanished (in the late 1970s with the switchover to terminals and eventually personal computers), all codes were translated into 4-digit numerical codes as entering only numerical data was faster, more accurate, and more consistent than a mix of numbers and characters. Atack's best guess for the initial distinction between the two "miscellaneous" codes is that "45" was used where the census enumerator had classified the product as "Other articles" (aka, miscellaneous) while "46" was used where Bateman and Weiss (and their student helpers) had done the aggregation but this distinction was lost at some point. Certainly, Atack only remembers using "46" for "miscellaneous" (or not specified).

[18] The following final product codes were used for establishments describing themselves as blacksmiths (SIC 769): 1, 7, 10, 11, 13, 16, 27, 28, 29, 32, 45, 46, 47, 52, 53, 54, 55, 57, 63, 64, 68, 74, 83, 94, 96, 124, 130, 152, 164, 165, 168, 191, 192, 199, 203, 228, 257, 310, 346, 350, 351, 358, 366, 367, 370, 422, 446, 519, 533, 537, 564, 611, 628, 629, 630, 640, 649, 650, 651, 655, 703, 789, 822, 829, 852, 854, 935, 982, 985, 991, 1040, 1079, 1105, 1109, 1148, 1161, 1215, 1233, 1246, 1265, 1292, 1297, and 1308.

“Hardware”: Copper, harnesses (presumably fittings thereof like bits, buckles, hame clips and rosettes), hinges, iron cast, ironware, locks, locks etc., millwork, nails, screws, shipwrighting (presumably fittings like oarlocks), spikes, springs, tableware, tinware, and wagon irons.

“Implements”: agricultural implements, axes, corn planters, cradles, cultivators, edge tools etc., farm/plantation, hoes, machinery, mining, planers, plows, reapers, scythes, steel work, threshing machines, tools, and wheat drills.

“Iron work”: iron railings/rails, iron/ironwork, and wrought iron.

“Repairs”: guns/rifles (almost certainly confined to repairing items such as trigger guard, sight, etc.), repair work, and wagon work.

“Wagons and Carriages”: buggies, carriages, carts, coaches, wheel hubs, sleighs, wagons, wheels.

8. Appendix B

We use our estimates of the share of blacksmiths’ gross value-added represented by their manufacturing (as opposed to services) output to explore the bias in Gallman’s estimates of nominal value added in manufacturing for the census years 1850-70.. Gallman’s estimates of nominal value-added (in hundreds of millions of current dollars) can be found in Table A-1 of his 1960 article (Gallman 1960, p. 43). In his discussion of the construction of the estimates Gallman (1960, p. 57) notes that “[c]ensus manufacturing totals were adjusted to exclude nonmanufacturing industries … included in the census of manufactures of [1850] through [1870]”.[19] Among these were six industries that Gallman (p. 58) collectively referred to as the

[19] For example, Gallman considered “carpentering” to be a nonmanufacturing industry, putting it into construction instead. It is important to keep in mind that none of the nonmanufacturing

"hand trades": blacksmithing and locksmithing (1850-1880), coppersmithing (1860-1880), whitesmithing (1850-50), gunsmithing (1870-80), and carraigesmithing (1860). For example, the 1860 census of manufactures includes a row pertaining to "carraigesmithing"; Gallman adjusts by excluding figures for this industry from his totals. The overwhelming majority of the totals for the hand trades pertain to blacksmithing.[20]

In column 2 of Appendix Table B-1, we reproduce Gallman's estimates of nominal value added in manufacturing for 1850-70. In column 3, we report total value added ("value of products" minus "value of raw materials") for the six hand trades; and, in column 4, the ratio of value added in the hand trades to Gallman's aggregates. Note that these ratios are absolutely small overall but smaller in 1870 than in 1850. This would indicate a modest upward bias in the aggregate growth rate of manufacturing value added in Gallman's estimates, if we were to assume that all of the value added in the hand trades pertained to manufacturing. We know that this is not the case for blacksmithing, but we lack data on the manufactures share for the other hand trades. However, this does not matter, because as noted above, blacksmithing accounted for the vast majority of economic activity in the hand trades. As a practical matter, therefore, we can adjust value added in the hand trades downward by multiplying by the manufactures shares from Panel A of Table 3; for this purpose, we use the upper bound shares. In effect, we are assuming that, proportionately, manufacturing in the other hand trades was the same as in blacksmithing. These adjusted totals are shown in column 4, Appendix Table B-1. The exclusion of manufacturing value added from the hand trades does bias upward Gallman's

totals were "lost" – they were simply put elsewhere in Gallman's national accounts. In the case of the hand trades, these went into services, as we pointed out in the text of our paper.

[20] For example, in 1850, blacksmithing accounted for 97.8 percent of total value of products in the six hand trades.

estimates of the size of the manufacturing sector, more at the beginning of the period (1850) than at the end (1870). While this supports Potter's (1960) conceptual criticism, the magnitude of the bias is trivial.[21]

Appendix Table B-1: Gallman's Estimates of Aggregate Value Added in Manufacturing, 1850-70: the Bias from Excluding Manufacturing Output in the Hand Trades

Year	Gallman, Value Added in Manufacturing	Hand Trades, Census Value Added	Ratio, Hand Trades/Gallman (percent)	Atack-Margo, Adjusted Estimates, Manufactures Value Added, Hand Trades	Ratio, Atack-Margo/Gallman (percent)
1850	$447,000,000	$11,182,130	2.50%	$7,313,113	1.64%
1860	815,000,000	9,017.689	1.11	4,860,534	0.60
1870	1,631,000,000	31,283,699	1.92	9,416,393	0.58

Notes to Appendix Table B-1: Gallman, Value Added: from Gallman (1960, Table A-1). Hand Trades, Census Value Added: 1850, sum of "value of product" less "cost of raw material" for "Blacksmiths" (p. 406) and "White and locksmiths" (p. 408); 1860, same, for "Blacksmiths" (p. 399), "Carriagesmithing" (p. 400), "Coppersmithing" (p. 400), "Locksmithing and bell-hanging" (p. 402), and "Whitesmithing" (p. 405); 1870, same, for "Blacksmithing" (p. 394), "Coppersmithing" (p. 394), "Gunsmithing" (p. 395), and "Locksmithing and bellhanging" (p. 396). Atack-Margo: column 3 multiplied by upper bound share of manufactures in gross value of blacksmithing, from Panel B of Table 3.

We can also use our results to explore the size of the bias in Gallman's estimates of output per worker. To this end we use the following equation, which pertains to the hand trades:

$$(V_M/L_M)/(V_S/L_S) = \beta$$

[21] The bias figures in column 6 of Appendix Table B-1 are still too large because we are using the upper bound shares of gross value, rather than, say the average of the upper and lower bounds. Further, it is likely that the share of manufactures in value added in the hand trades is lower still, because manufacturing used more raw materials per dollar of gross value than services.

In this equation, V refers to value added, L to gainful workers, M to manufacturing, and S to services; β is the ratio of labor productivity in manufactures as opposed to services.[22] For the hand trades, we can estimate the V's from Appendix Table B-1; we know the total L (= $L_M + L_S$) from the census of manufactures; and we can estimate β from the regression in Panel A of Table 4, assuming a manufactures share of 1 (we use the regression coefficient of the manufactures share from last column in Panel A of Table 4: β = exp (-0.132) = 0.876). By rearranging the equation, we can estimate the ratio L_M/L_S, and because we know the total L, we can recover estimates of L_M.

In Appendix Table B-2 we report Gallman's estimates of gainful workers in manufacturing (column 2); our estimates of L_M in the hand trades (column 3); the ratio of our estimates of L_M in the hand trades to Gallman's estimates of gainful workers in manufacturing (column 4); Gallman's estimates of nominal value added per worker (column 5); our adjusted estimates of output per worker, which include manufacturing output and estimated gainful workers (L_M) from the hand trades (column 6); and the ratio of our estimates of output per worker to Gallman's (column 7). [23] There is a slight upward bias to Gallman's estimates of labor productivity, more so in 1850 than in 1870 – again, consistent with Potter (1960) – but the magnitude of the bias is trivial (and literally zero in 1860).

[22] We recognize that the typical blacksmith spent part of his time making manufactures and part of his time performing services; in effect, we are assuming that if the blacksmith spent half of his time making manufactures, this is the equivalent of 0.5 of a gainful worker.

[23] Gallman's estimates of gainful workers and of value added per worker in mining as well as manufacturing (i.e. value added per gainful workers in manufacturing and mining).

Appendix Table B-2: Gallman's Estimates of Nominal Output Per Worker in Manufacturing: the Bias from Excluding Manufacturing Output and Labor in the Hand Trades

Year	Gallman, Gainful Workers in Manufacturing	Atack and Margo, Estimates of L_M, Hand Trades	Ratio, Atack-Margo/Gallman	Gallman, Nominal Value of Output Per Worker in Manufacturing	Atack-Margo, Adjusted Estimates, Output Per Worker	Ratio, Atack-Margo/Gallman, Output Per Worker
1850	932,000	17,368	1.86%	$480	$479	0.998
1860	1,474.000	9,454	0.64	553	553	1.000
1870	2,187,500	21,804	1.00	746	743	0.996

Source: Gallman, gainful workers: Gallman (1960, Table 6, p. 30). Gallman, Nominal Value of Output per worker: Column 2, Appendix Table B-1/Column 2, Appendix Table B-2.

Table 1

Blacksmiths in American Manufacturing, 1850-1870

A. Published Census

Year	Number of Blacksmith Shops	Blacksmith Percent of: Total Establishments	% Gross Value of Output	% Employment	% Capital	% Raw Materials	% Value Added
1850	10,373	8.4	1.0	2.6	1.1	0.9	1.1
1860	7,504	5.3	0.6	1.2	0.5	0.3	1.0
1870	26,364	10.5%	1.0	2.6	0.8	0.5	1.6

Source: (United States. Census Office. 1872, pp. 394, 399 and 406).

B. Atack-Bateman National Samples: With Sample Screens

Year	Number of Blacksmith Shops	Blacksmith Percent of: Total Establishments	% Gross Value of Output	% Employment	% Capital	% Raw Materials	% Value Added
1850	430	8.7%	1.5%	2.6%	1.0%	0.9%	2.1%
1860	339 [336]	6.8 [6.7]	1.1 [1.1]	2.0 [2.0]	1.0 [1.0]	0.7 [0.7]	1.8 [1.7]
1870	346 [290]	9.0 [8.0]	0.7 [0.6]	1.6 [1.4]	0.5 [0.5]	0.4 [0.4]	1.1 [1.1]

Source: Atack, Bateman and Weiss (2004). Establishments must be in the national samples to be included in the table. One blacksmith observation in the 1850 national sample is dropped as an outlier. All establishments have positive values of reported employment, capital, inputs, and value added, and $500 in gross output measured in current dollars; in addition, establishments with very high or low estimated rates of return are dropped. [ ]: to be included observations must have $500 of real gross output, measured in 1850 dollars; 1860 cutoff is $518; 1870 cutoff, $826.

Table 1 (continued)

C. Distribution of Establishments by Reported Employment: Blacksmith Shops, Atack-Bateman National Samples with Sample Screens

	1-2 workers	3-5	6-15	16 or more
1850				
Blacksmiths	67.5%	28.8%	3.5%	0.2%
All	45.6	28.4	16.5	9.5
1860				
Blacksmiths	77.1	18.2	3.9	0.8
All	45.6	27.4	16.8	10.3
1870				
Blacksmiths	77.2	21.0	1.7	0
All	37.2	28.9	19.5	14.4

Source: see Panel B. Sample screens are the same as in Panel B.

Table 2
Business Organization and Average Employment of All Manufacturing Businesses and Blacksmithing Establishments

Panel A Share of establishments:

	Sole Proprietorships	Blacksmiths organized as sole proprietorships	Familial	Partnership	Silent Partnership	Corporation
1850	82.6	91.6	3.6	7.8	4.3	1.7
1860	76.8	90.3	4.3	9.2	7.0	2.7
1870	73.0	89.6	4.9	10.7	7.5	3.9

Panel B Average Employment in:

	Sole Proprietorships	Blacksmiths organized as sole proprietorships	Familial	Partnership	Silent Partnership	Corporation
1850	6.0	2.3	10.4	9.3	25.0	69.3
1860	6.0	2.2	17.1	12.7	23.3	50.1
1870	7.4	2.0	16.6	12.9	23.4	79.5

Source: (Atack, Bateman, and Weiss 2004) augmented by worksheet data.

Table 3

The Product Mix in Blacksmith Shops

Panel A: Distribution of Primary Product Code by Product Category: Blacksmith Shops, 1850-70

	General Blacksmithing	Hardware	Implements	Iron Work	Repair Services	Carriages, Wagons, and Wheels	Number of Observations
1850	63.1% [63.3]	11.9% [2.3]	11.5% [16.9]	1.7% [1.8]	2.9% [2.3]	9.0% [13.5]	444 {84.2%}
1860	66.2 [66.2]	2.4 [1.8]	11.8 [13.2]	0 [0]	4.2 [3.0]	14.5 [25.5]	333 {54.3}
1870	62.5 [63.3]	0 [0]	3.6 [5.1]	1.0 [1.5]	21.4 [15.6]	11.6 [14.6]	275 {74.4}

Source: computed from Atack, Bateman and Weiss (2004) national samples, 1850-70 manuscript censuses of manufacturing. To be included in the table an establishment must be a blacksmith shop (SIC code 769) and also meet standard sample screens (see chapter 3). Columns 2-6, outside parentheses: fraction of gross value of output of primary product; [ ]: fraction of blacksmith shops listing the good or service as primary product. { }: fraction of total gross value of output accounted for by primary product.

Panel B: Blacksmith Value of Gross Output Attributable to Goods Manufacturing: Lower and Upper Bound Estimates, 1850-70

Year	Lower	Upper
1850	28.9%	65.4%
1860	24.1	53.9
1870	15.4	30.1

Based on classification of primary, secondary, etc. output. Lower bound assumes that if the output is “jobbing”, “miscellaneous”, or “blacksmithing” that the blacksmith produced no manufactured goods. Upper bound assumes that if the listed good is one of these three, the blacksmith produced manufactured goods in the same proportion of gross value of the other blacksmiths in the sample who identified specific products (e.g. plows) or services (e.g. repair). Horseshoeing is treated as a service in both columns.

Table 3 (continued)

Panel C: Regression Estimates, Probability that Blacksmith Shop Has 1 or 2 workers

Dependent variable	= 1 if one or two workers	=1 if one or two workers
% manufactures of gross value	-0.110 (0.039)	-0.099 (0.043)
Year dummies	Yes	Yes
Urban status and state dummies	No	Yes
Adjusted R-2	0.014	0.047

Source: see text. Standard errors in parentheses. N = 1,052 establishments.

Table 4

Productivity Analysis: Blacksmiths, 1850-70

Panel A: Regression: Log of value added per worker: Blacksmith Shops, Atack-Bateman samples, 1850-70

Dependent variable	Log (value added per worker)	Log (value added per worker)	Log (value added per worker)
% manufactures of gross value		-0.127 (0.047)	-0.132 (0.048)
1 or 2 workers?	0.111 (0.036)	0.105 (0.036)	0.097 (0.035)
Log K/L included?	No	No	Yes
Urban and state dummies included	Yes	Yes	Yes
Year dummies included	Yes	Yes	Yes
Adjusted R-2	0.295	0.300	0.365

Source: see text. N = 1,052 establishments.

Panel B: Regressions of Ln (Gross Value of Output): Blacksmith Shops vs. Agricultural Implements Establishments

Dependent Variable	Ln (Gross Value of Output, Primary Activity)	Ln (Gross Value of Output, Primary Activity)	Ln (Gross Value of Output, Aggregate)	Ln (Gross Value of Output, Aggregate)
Blacksmith = 1	-0.589 (0.139)	-0.605 (0.154)	-0.120 (0.083)	-0.151 (0.083)
Urban status and state dummies?	No	Yes	Yes	Yes
Manufactures share of gross value of output included?	NA	NA	No	Yes
Adjusted R-Square	0.758	0.767	0.915	0.916

To be included in the regressions, an establishment must be either a blacksmith shop (SIC code 969) or agricultural implements establishment (SIC code 352) producing an identifiable agricultural implement(s) as the primary activity. Standard sample criteria also apply. All regressions include fixed effects for year, product code of primary activity, and the following continuous variables: ln (workers), ln (capital), ln (value of raw materials). Factor inputs (e.g. ln (capital)) are aggregate, not specific to primary activity. N = 225. Standard errors in parentheses. NA: not applicable.

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