

Academic Entrepreneurship and Inequality: Evidence From Administrative Data

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Abstract: Over the past several decades, universities have increasingly emphasized knowledge and technology transfer. Faculty are key agents facilitating this transfer, engaging in commercial and entrepreneurial activities such as, consulting, student placement, patenting, and the founding of start-ups. This paper documents the prevalence of faculty commercial engagement as well as the extent to which it widens earnings inequality among faculty. In contrast to previous work that uses surveys with low response rates to measure the commercial engagement of university faculty, this paper uses detailed administrative data from universities (UMETRICS) linked to confidential earnings data at the Internal Revenue Service (IRS) and U.S. Census Bureau (including the universe of W2 and 1099 tax records) to analyse how often university faculty engage in the types of commercial and entrepreneurial activity that catalyse knowledge/technology transfer.

Keywords: academic commercial engagement, entrepreneurship, technology transfer, inequality

1. Introduction

As the links between universities and industry have grown tighter over the past several decades, opportunities for faculty entrepreneurship – that is commercial engagement – have flourished (Bozeman, 2000; Bozeman et al, 2015). These opportunities can take many forms, including patenting, start-ups, consulting, and contract research. Though academic commercial engagement has been heavily studied (Perkmann et al, 2013; Miller et al, 2018), an underexplored by-product is the effects it may have on faculty earnings inequality. In principle, it could reduce inequality if lower-earning faculty can use commercial engagement opportunities to reach parity with their more highly paid peers. However, inequality could increase if high-earning faculty are disproportionately privy to commercial engagement opportunities outside the university. This paper establishes basic facts about the commercial engagement of faculty that, for the first time, are based on high quality administrative payroll and tax data. These linked data are then used to present the first-ever analysis of how commercial engagement opportunities impact faculty earnings inequality.

The main contributions of this paper to the literature on academic entrepreneurship and faculty commercial engagement can be broken into three parts. First, this is the first work to measure engagement, such as participation and earnings, using high-quality linked administrative payroll and tax records. As noted, there already exists a large literature analysing the extent to which faculty engage in commercial activity. However, nearly all this work relies on cross-sectional survey data with low response rates. Surveys of US faculty, with response rates in brackets, include Bird and Allen (1989) [27%], Blumenthal et al (1996) [65%], Boardman (2008) [38%], Boardman and Corley (2008) [38%], Boardman and Ponomariov (2009) [38%], Boardman (2009) [38%], Bozeman and Gaughan (2007) [38%], Campbell and Slaughter (1999) [34%], Lee (1996) [43%], Lee (1998) [43%], Lee (2000) [64%], Lin and Bozeman (2006) [44%], Link et al (2017) [38%], Louis et al (2001) [64%], Ponomariov (2008) [38%], Ponomariov and Boardman (2008) [37%], and Renault (2006) [14%].

Thus, compared previous work, this paper can paint a more complete portrait of academic commercial engagement. Faculty are identified using administrative payroll data from UMETRICS (Lane et al., 2015). Faculty are then linked to the universe of W2 and 1099 tax records and unemployment insurance (UI) wage records. These linked data reveal each faculty member's entire US-based earnings and employment history (2005-2018). This includes earnings from both employers and self-employment, thus distinguishing between university and non-university income, and enabling the separation of earnings received from different types of employers, including older incumbent firms, younger or start-up firms, and high-tech/low-tech firms.

The second main contribution is the use of this new linked administrative data to establish basic facts about how often university faculty participate in various types of commercial engagement as well as the earnings they receive from these entrepreneurial activities. A substantial fraction of UMETRICS faculty, about 43%, receive non-university earnings each year. Further, while faculty receive earnings from both employers and self-employment, most faculty commercial engagement is driven by self-employment. Indeed, each year, approximately 32% receive earnings from self-employment while only 16% receive earnings from employers. It

is notable that only 3% of UMETRICS faculty receive earnings from a young/start-up firm (5 years old or less) each year, which is quite striking given the perception that these firms are disproportionately innovative (Haltiwanger et al, 2013). In sum, a large fraction of faculty is entrepreneurial in the sense of participating in some type of commercial activity outside the academy, but there is considerable variation in the extent to which they receive earnings from different sources.

In addition to documenting faculty participation in various commercial activities, this paper provides information on the fraction of a typical faculty member's earnings that comes from different sources, revealing the extent to which faculty augment their university salary with other sources of income. On average, UMETRICS faculty earn about \$151,400 per year, of which, about \$128,800 (85%) comes from a university and about \$22,600 (15%) comes from a non-university. Thus, while university earnings constitute the bulk of earnings for the typical faculty member, a substantial fraction of total earnings is derived from non-university sources. In addition, though faculty participation in commercial activity is dominated by self-employment, the typical faculty member only receives about a third of their non-university earnings (\$8,000) from self-employment with the remaining two-thirds coming from an employer (\$14,600).

Finally, the third main contribution is the first-ever analysis of how academic commercial engagement impacts faculty earnings inequality. In contrast to the large literature on faculty participation in commercial activities, there has been little work examining faculty earnings inequality generally (e.g., Monk, 2003) and there is no work (of which the author is aware) that specifically studies the relationship between faculty commercial engagement and faculty earnings inequality. However, the 15% of earnings that the typical faculty member receives from non-university sources is large enough to meaningfully contribute to (or dampen) the overall inequality in faculty earnings.

As noted, the existence of commercial engagement opportunities could, in principle, increase or decrease *total earnings* (university plus non-university earnings) inequality beyond inequality in university earnings. In fact, a decomposition of total earnings inequality suggests that non-university earnings exacerbate inequality, proportionately accounting for nearly half of total inequality (university earnings accounts for the other half). In other words, if commercial activities outside the university were unavailable to faculty, earnings inequality would be much lower – in fact, it would be cut in half. Thus, it appears that more highly paid faculty can take advantage of commercial opportunities that further increase their earnings relative to their lower paid peers.

The rest of this paper is organized as follows. Section 2 discusses the data, including administrative data from the UMETRICS program and tax/UI wage records from the IRS and the US Census Bureau. Section 3 presents results, establishing basic facts about faculty commercial engagement and exploring the contribution of this entrepreneurial activity to faculty earnings inequality. Finally, Section 4 concludes.

2. Data

As mentioned, most work measuring the entrepreneurial activity of university faculty relies on surveys with low response rates. This section discusses an alternative and more comprehensive way to measure faculty commercial engagement: linked administrative data. Indeed, establishing these data linkages is one of the main contributions of the paper. Though administrative data has limitations (see conclusion for a discussion), the linked data allow for tracking the same individual through time and can more decisively answer questions about various economic activities undertaken by faculty.

2.1 UMETRICS

UMETRICS is transaction-level data on all payments made by university grants to employees and vendors and is directly captured through university payroll and human resources records (Lane et al, 2015). These data include information on the occupations of individuals paid by a grant, which are used to identify faculty. The data also include information on the timing of payments which is important because some individuals transition, over time, from graduate students or post-docs into faculty. However, this paper focuses on the commercial engagement of faculty *while they are faculty*, not before or after.

2.2 Employment and earnings history

UMETRICS faculty are linked to three sources of administrative earnings data: 1) W2 tax records, 2) unemployment insurance (UI) wage records from the Longitudinal Employer-Household Dynamics (LEHD) program, and 3) 1099 tax records from the Integrated Longitudinal Business Database (ILBD). Taken together, these three sources provide a complete picture of the entire US-based earnings history of every UMETRICS faculty member between 2005 and 2018. This includes earnings from universities, private firms, government, and self-employment.

The W2 tax records are maintained by the Internal Revenue Service (IRS) and provide annual information on individual earnings. The LEHD-UI wage records provide quarterly information on jobs for most U.S. workers (Vilhuber et al, 2014). Both the W2 and LEHD-UI earnings records have tax identification numbers that allow distinguishing between university and non-university earnings and to link firm-level information, such as firm age or industry. These firm-level characteristics identify whether earnings come from various firm types, such as incumbent firms (over five years old), young/start-up firms (five years old or younger), high-tech firms, or low-tech firms (definitions from Goldschlag and Miranda (2020)).

The ILBD is the universe of non-employer firms in the US and is derived from 1040 tax forms with attached schedule C(s) (Goetz et al, 2021). The ILBD is used to measure earnings from self-employment. Overall, non-employer businesses account for about 75% of businesses in the United States (Jarmin, 2007), and, as documented below, incorporating self-employment income is crucial to properly measuring faculty commercial engagement.

Taken together, these administrative earnings data completely characterize the entire US-based earnings history of UMETRICS faculty between 2005 and 2018. Further, they identify the different sources from which earnings is received. The author is unaware of any other work that has tracked the employment and earnings history of faculty so comprehensively and reliably.

2.3 Final sample

For every year between 2005 and 2018, the final analysis sample is comprised of UMETRICS faculty with positive W2/LEHD earnings from a university. Since the paper focuses on *faculty* commercial engagement, the only years included are those after the individual has been identified as a faculty member at their UMETRICS university. For instance, if an individual is classified in UMETRICS as a post-doc in 2005-2007 and as a faculty member in 2008-2018, only the 2008-2018 period is kept for this individual. In all, the sample contains approximately 59,500 faculty across 25 universities (which account for about 20% of all research funding in the US). Faculty are tracked over time, so all analyses take place at the faculty-year level. Since not all faculty appear in every year, the panel is unbalanced.

3. Results

3.1 Faculty commercial engagement: Basic facts

The paper first establishes how common it is for UMETRICS faculty to engage in commercial activities outside of the university. Figure 1 displays participation rates – specifically, the fraction of UMETRICS faculty that receive positive wages from university and non-university sources. First note that, as discussed in Section 2, the sample is defined so that only faculty with positive university earnings in a given year are included. Thus, by definition, the fraction of faculty receiving positive university wages is 1. Nevertheless, the university bar is included to emphasize this sample restriction.

The first substantive finding is that a large minority of UMETRICS faculty engage in some form of entrepreneurial activity outside the university. Indeed, the yearly fraction of faculty receiving positive non-university earnings is about 43%. Thus, though the majority of faculty each year rely exclusively on university earnings, a sizable fraction is commercially engaged.

Separating commercial engagement into its component parts, it is clear that self-employment is much more common than working at an employer firm. Indeed, the yearly fraction of faculty with positive earnings from self-employment and an employer firm is, respectively, about 32% and 16%. Thus, faculty are about twice as

likely to engage in self-employment as they are to work at an employer firm. It is important to emphasize that these engagement activities are not mutually exclusive – the same individual can receive earnings from both self-employment and an employer firm each year. In other words, faculty can engage in multiple commercial activities simultaneously.

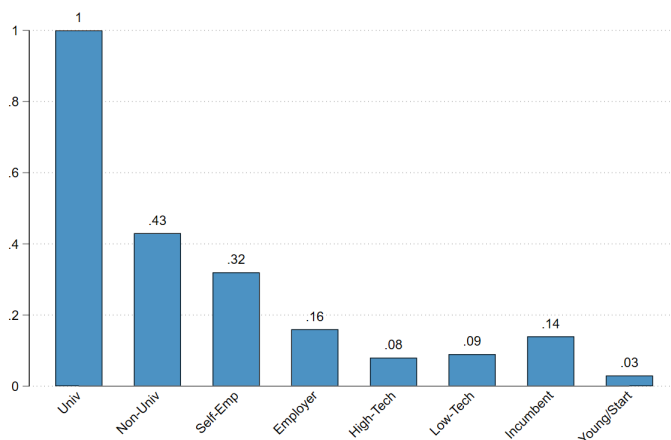


Figure 1: This figure shows the fractions of UMETRICS faculty that receive positive earnings from the following sources: University, non-university, self-employment, an employer firm, an incumbent firm, a young/start-up firm, a high-tech firm, and a low-tech firm. By definition, all UMETRICS faculty in my sample receive positive university earnings

Separating engagement at employer firms by industry, Figure 1 shows that faculty are about equally likely to receive positive earnings from high-tech and low-tech firms: about 8% and 9%, respectively. Thus, perhaps surprisingly, it appears that faculty do not disproportionately engage with the high-tech sectors of the economy. This may be driven by different faculty commercially engaging for different reasons: for instance, some may have opportunities to work at high-tech firms to advance a collaborative research agenda, while others (perhaps adjuncts) need to supplement low university pay by working at low-tech firms.

Separating by age, Figure 1 reveals that it is quite rare for UMETRICS faculty to receive earnings from a young/start-up firm – only about 3% do so each year. Given widespread perceptions about the innovativeness of young firms and the closeness of universities to innovative sectors of the economy, this low level of participation is quite surprising. In contrast, a much larger fraction of faculty receives earnings from an incumbent firm – approximately 14% each year. Of course, older firms account for a disproportionate fraction of employment generally, so this higher level of participation is unsurprising. Overall, faculty are about 5 times more likely to receive earnings from an incumbent firm than they are from a young/start-up firm. Again, note that none of these categories are mutually exclusive – it is possible for faculty to work at a high-tech, low-tech, incumbent, and young/start-up firms (or any combination) in the same year.

In sum, in any given year, most faculty rely exclusively on universities for their earnings, but a large minority engage in entrepreneurial activities outside the university. Self-employment is the most common source of non-university earnings, which is about twice as common as working at an employer firm. Working at a young/start-up firm is quite rare and faculty are about equally likely to work at high-tech and low-tech firms.

In addition to measuring faculty participation in various entrepreneurial activities, this paper also measures the extent to which these outside activities supplement the university earnings of faculty. Specifically, the fraction of total earnings that a typical UMETRICS faculty member receives from non-university earnings is measured. Table 1 sheds light on this by providing summary statistics for the various components of earnings.

Table 1 show that the typical UMETRICS faculty member earns about \$151,400 per year. Of this total, about \$128,800 (85.1%) comes from a university and about \$22,630 (14.9%) comes from a non-university source. Thus, the typical faculty member relies on universities for the bulk of their earnings, but also derives a non-trivial fraction though commercial engagement.

Of the \$22,630 earned from non-university sources, \$14,580 (64.4%) comes from employer firms and \$8,056 (35.6%) comes from self-employment. This difference is stark because faculty are twice as likely to be self-employed as they are to work at an employer firm, which means a much larger fraction of faculty earn nothing from employer firms. Thus, conditional on positive earnings from an employer firm, faculty likely receive an even higher percentage of non-university earnings from employer firms.

Of the \$14,580 earned from employer firms, the typical faculty member receives much more from incumbents (\$13,280, or 91.1%) than from young/start-up firms (\$1,299, or 8.9%). This is unsurprising, given the much higher probability working at an incumbent firm. Alternatively, about \$9,294 (63.7%) comes from high-tech firms and \$5,284 (36.2%) comes from low-tech firms. Given the equal probability of working at high-tech and low-tech firms, this suggests a high-tech wage premium for faculty.

Table 1 also reveals a striking feature of the distributions of faculty wages: a very high degree of variation. For total wages, the standard deviation is \$161,800, which is a bit above 100% of the mean. University earnings are less variable, with a standard deviation that is about 88% of the mean. In contrast, the non-university wage components have extremely high variability relative to their means. For instance, total non-university earnings have a standard deviation of \$110,700, which is nearly 5 times higher than the mean. The standard deviations of the sub-components of non-university earnings range from 6 (incumbent earnings) to 20 (start-up earnings) times higher than the mean. As will be shown in the next section, this extreme variability has important implications for the contribution of non-university earnings to overall faculty earnings inequality.

Table 1: This table shows summary statistics of earnings for UMETRICS faculty. The unit of observation is a person-year, but only the person (faculty) counts are reported.

	Mean	SD	Coef. of Variation
Total Wages	\$151,400	\$161,800	1.069
University Wages	\$128,800	\$112,900	0.877
Non-University Wages	\$22,630	\$110,700	4.892
Self-Employment Wages	\$8,056	\$59,610	7.399
Employer Wages	\$14,580	\$92,040	6.313
Incumbent Wages	\$13,280	\$81,630	6.147
Young/Start-up Wages	\$1,299	\$26,010	20.023
High-Tech Wages	\$9,294	\$83,500	8.984
Low-Tech Wages	\$5,284	\$37,790	7.152
Faculty Count: 59,500			

3.2 Commercial engagement and inequality

The means and standard deviations from Table 1 can be used to decompose the inequality of total earnings into contributions from each constituent source using methods discussed in Shorrocks (1982, 1983). This decomposition is displayed, along with associated statistics, in Table 2. Column (1) shows the correlations between total wages and each wage component, which are used (in combination with the standard deviations from Table 1) to determine the contribution of each component to total inequality. All earnings components are positively correlated with total earnings, and obviously the correlation of total wages with itself is 1. The largest coefficients are for university and non-university earnings, which are quite similar at 0.73 and 0.72, respectively.

Column (2) displays the proportionate contribution of each component to total inequality, which is equivalent to the slope coefficient from a bivariate regression of the component on total earnings (multiplied by 100). This exercise reveals that university earnings account for about 50.9% of total inequality and that non-university earnings account for the remaining 49.1%. Thus, even though non-university earnings make up only 15% of total earnings, they account for nearly half of total inequality. This is possible because, though the mean of non-university earnings is much lower than the mean of university earnings (\$22,630 vs. \$128,800), these two earnings components have quite similar standard deviations (\$110,700 vs. \$112,00) and correlations with total earnings (0.72 vs. 0.73). As noted, the coefficient of variation (ratio of the standard deviation to the mean) is about 4.9 for non-university earnings and only about 0.88 for university earnings. Thus, since non-

university earnings are far more variable relative to their mean than university earnings, they contribute to total inequality far beyond what their much lower mean might initially suggest.

Table 2: This table shows the proportionate contribution of each earnings component to total earnings inequality. The unit of observation is a person-year, but only the person (faculty) counts are reported

	Correlation with Total Wages	Proportionate Contribution to Inequality
Total Wages	1.00	100.00
University Wages	0.73	50.94
Non-University Wages	0.72	49.07
Self-Employment Wages	0.45	16.70
Employer Wages	0.57	32.36
Incumbent Wages	0.55	27.70
Young/Start-up Wages	0.29	4.66
High-Tech Wages	0.51	26.28
Low-Tech Wages	0.26	6.08
Faculty Count: 59,500		

Table 2 also shows that, of the 49.1% contribution of non-university earnings to total inequality, about 32.4 percentage points are attributable to earnings from an employer and the other 16.7 percentage points are attributable to earnings from self-employment. Thus, earnings from an employer contribute about twice as much to total inequality as do earnings from self-employment. Breaking out the 32.4% contribution of employer earnings by firm age, 27.7 percentage points are attributable to earnings from incumbent firms and 4.7 percentage points are attributable to earnings from a young/start-up firm. Similarly, breaking out the contribution of employer earnings by industry, 26.3 and 6.1 percentage points are attributable to earnings from high-tech and low-tech firms, respectively. Thus, earnings from incumbent and high-tech firms contribute far more to total inequality than do earnings from young/start-up and low-tech firms.

In sum, while the existence of academic commercial engagement could, in principle, decrease faculty earnings inequality, it in fact increases it dramatically. Indeed, despite accounting for only 15% of total earnings for the typical faculty member, non-university earnings, because it has a very large standard deviation relative to its mean, accounts for about half of total earnings inequality. Put another way, if commercial activities outside the university were unavailable to faculty, earnings inequality would be much lower – indeed, they would be about half as large.

4. Discussion and conclusion

Overall, this paper finds that a large fraction of UMETRICS faculty is commercially engaged – around 43% each year. The most common form of commercial engagement is self-employment, in which about 32% of faculty participate. A lower fraction, about 16%, receive positive earnings from employer firms. Though the typical faculty member relies on university earnings for the bulk of their salary, around 15% comes from non-university sources. Thus, there is significant scope for commercial engagement to either exacerbate or mitigate overall earnings inequality among faculty.

Turning to inequality, this paper reveals that non-university earnings account for nearly half of total earnings inequality among UMETRICS faculty. This is possible despite non-university earnings only accounting for 15% of total income because non-university earnings are substantially more variable relative to the mean than is university earnings, allowing for a disproportionate contribution to total earnings inequality. Overall, the decomposition suggests that, in the absence of commercial engagement, total earnings inequality would be cut in half (though this ignores possible general equilibrium effects).

Using surveys to measure faculty commercial engagement, as has been the norm in this literature, certainly offers some benefits. For instance, they typically allow for a more detailed set of questions to be examined. However, surveys also have well-known limitations, especially non-response bias. Indeed, it is common for surveys attempting to measure faculty commercial engagement to have response rates of 30-40%. In contrast, the linked administrative data used in this paper allows for a full and accurate characterization of the entire

US-based earnings history (between 2005 and 2018) of every UMETRICS faculty member, a feat that, until now, had not yet been accomplished in the faculty commercial engagement literature.

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