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VARIATION IN MANAGERIALS' RELATIVE WAGE ACROSS U.S. INDUSTRIES: ITS IMPACT ON MANAGERIALS' EMPLOYMENT SHARE AND LABOR PRODUCTIVITY

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Abstract

Recent work in the economic development literature has established sizable variations across nations in the relative wage for management, defined as the average wage for managers divided by the average wage for other workers, and provided evidence that the high relative wage for managers in lower income nations depresses productivity in those nations. This research explores if the same relationships exist solely across industries within the United States using an annual data set of 228 industries for years 2002–2020. As in the development literature, more variation is found across industries in the earnings for all other workers than for management, along with sizable variation across industries in the relative wage for management. Across the 228 industries in any year, the relative wage for management at the 10th/90th percentiles is near 2.0 and 3.2 respectively. Also, a robust positive link is found between managerial employment share in an industry and the average wage of all other workers which is evidence of complementarity between management and the skill level of other workers in an industry. Lastly, evidence for nonlinearities over the sample period is found in the relationship between the growth rate of managerial share of employment and labor productivity growth. Industries with lower rates of growth in managerial share of employment exhibit a negative linkage with labor productivity growth, but this switches to a positive linkage with labor productivity growth for industries with higher growth rates for managerial share of employment. Potential factors driving this result are discussed.

Keywords: skill-biased management, management relative wage, performance, productivity, management effectiveness.

1. Introduction

Recent years have seen calls by well-regarded researchers for more economic analyses on the role of management in firm production (Roberts, 2018), with recent and ongoing work in this area.

One of the substantive research paths examines the impact of various management practices, and the utilization of management, upon firm performance via the collection of large cross-country firm-specific data sets such as The World Management Survey (Bloom and Van Reenen, 2007). This work has documented substantial variation across nations and industries in their use of high-quality management practices (Bloom et al, 2014) with a strong correlation between a nation's per capita GDP and its utilization of high-quality management practices. Two recent papers by Feng and Valero (2020) and Hjort, MalMBER, and Schoellman (2021) are the primary motivation for this research paper.

Contributing to the broader literature on complementarity in organizational effectiveness (Brynjolfsson and Milgrom, 2013), Feng and Valero (2020) combine World Management Survey data with firm-specific data on the distance from the firm to the nearest university for 19 nations. This distance measure is used as a proxy for the abundance of higher human capital and skilled workers from which the firm can recruit. They find strong evidence that management best practices and a skilled workforce are complementary. Firms operating in a labor market with higher human capital or higher skill workers more frequently utilize management best practices, likely because a more skilled workforce increases the marginal benefit obtained from improved management quality and utilization. Their findings are consistent with prior literature viewing management as an organizational technology choice (Bloom et al, 2016) which is complementary to higher-skill production processes and technology selections (Bender et al, 2018; Bloom and Van Reenan, 2010; Milgrom and Roberts, 1990; Roberts, 2007).

Hjort et al (2021) analyze a large private sector database on compensation for middle managers across 146 nations. When assessed across nations, they find real managerial compensation with respect to real GDP per worker to have an elasticity that is quite low. Middle management compensation varies much less across nations than does compensation to all other workers. This leads to a higher relative price for managers in nations with lower GDP per capita, a proxy for wages, which leads to lower usage of middle management. They estimate sizable efficiency losses for low-income nations from the underutilization of middle management, modelling a 31 percent rise in aggregate output if low-income nations faced the U.S. relative price for management instead of their actual much higher relative price.

More intensive use of managers, and utilizing higher quality management practices, can positively impact firm productivity through multiple channels. With more and better middle management, monitoring and coordinating of production processes improves and larger scale economies can be reached. Other mechanisms through which greater managerial intensity can positively impact firm productivity includes the ability for the firm to enhance labor specialization (Becker and Murphy, 1992) and to better

utilize the management hierarchy for knowledge transmission and decision-making (Garicano and Rossi-Hansberg, 2006).

Both Feng and Valero (2020) and Hjort et al (2021) utilize large firm-specific data sets and focus upon comparisons across nations at different stages of per capita income and development. Their findings motivate the starting point for this paper which investigates if their general findings hold up when the analysis is done using aggregated industry data across U.S. industries. The specific research questions examined in this paper are:

1. Similar to the comparisons across nations, is there sizable variation in the relative wage for managers across U.S. industries?
2. Similar to the comparisons across nations, is there less dispersion of wages for managers than for wages of all other workers across U.S. industries?
3. Is there evidence of complementarity between management and the skill level of all other workers in the industry?
4. Is there evidence that higher levels of management utilization in an industry associate with improved industry productivity growth?

The rest of this article presents the data in Section 2, the results in Section 3, and the discussion and conclusion in Section 4.

2. Data

Annual U.S. employment and wage estimates are produced by the U.S. Bureau of Labor Statistics, Occupational Employment and Wage Statistics program (OEWS, 2022) for nearly 800 occupations. Occupation data reported by the four-digit North American Industrial Classification (NAIC) system is available from 2002–2020. This study includes the 228 four-digit NAIC industries which have data for each of the 19 years. When aggregated the sample has total employment of 88.1 million in 2002 and 98.5 million in 2020 which covers much of the U.S. economy. For comparison, the study's sample employment captures 67.4% of total U.S. nonfarm employment in 2002 and 69.2% of total U.S. nonfarm employment in 2020 given total U.S. nonfarm employment of 88.1 million and 98.5 million in 2002 and 2020 respectively (CES, 2022). Thus, findings from this study will be reflective of a wide cross-section of the U.S. economy.

To investigate the first two research questions, for each year and each of the 228 industries, the average earnings across all management occupations in the industry, hereafter MgtEarn, is computed along with the average earnings across all other occupations, hereafter AllOthEarn. Next, the relative wage for managers, hereafter EarnRatio, is computed as the ratio $\text{MgtEarn} / \text{AllOthEarn}$. Table One contains

information on the dispersion of MgtEarn and AllOthEarn across the 228 industries in each year using the coefficient of variation as the dispersion measure. In addition, the distribution of EarnRatio across all industries is reported for each year.

Table 1: Distribution of Average Management Earnings and All Other Worker Earnings

Year	Coefficient Variation			Distribution of EarnRatio					
	MgtEarn	AllOthEarn	CV Ratio	Avg	Min	10th	50th	90th	Max
2002	0.195	0.283	1.45	2.49	1.29	1.89	2.48	3.09	4.15
2003	0.191	0.285	1.49	2.58	1.35	1.94	2.55	3.20	4.22
2004	0.181	0.287	1.59	2.60	1.28	1.94	2.57	3.28	4.13
2005	0.172	0.290	1.69	2.62	1.47	1.94	2.57	3.31	4.28
2006	0.171	0.293	1.72	2.63	1.44	1.93	2.58	3.32	4.14
2007	0.174	0.297	1.71	2.64	1.48	1.96	2.63	3.32	4.16
2008	0.176	0.297	1.69	2.66	1.49	1.97	2.64	3.34	4.18
2009	0.178	0.301	1.69	2.67	1.48	1.99	2.63	3.35	4.26
2010	0.177	0.304	1.72	2.68	1.45	1.99	2.64	3.38	4.18
2011	0.181	0.309	1.71	2.67	1.39	2.01	2.62	3.37	4.29
2012	0.186	0.314	1.68	2.65	1.47	1.98	2.62	3.36	4.45
2013	0.186	0.317	1.70	2.66	1.51	1.98	2.63	3.39	4.76
2014	0.193	0.317	1.64	2.64	1.52	1.98	2.60	3.35	4.15
2015	0.201	0.319	1.59	2.61	1.47	1.97	2.60	3.29	3.92
2016	0.206	0.322	1.57	2.60	1.46	1.93	2.57	3.27	4.08
2017	0.200	0.318	1.59	2.59	1.45	1.94	2.59	3.21	4.22
2018	0.199	0.314	1.58	2.55	1.46	1.92	2.54	3.13	3.73
2019	0.201	0.312	1.55	2.48	1.36	1.86	2.48	3.07	3.67
2020	0.203	0.312	1.54	2.44	1.28	1.84	2.44	3.00	3.57

Note. EarnRatio = MgtEarn / AllOthEarn with variables as defined in text

In any industry and any year, the lowest EarnRatio is 1.28. From 2002 to 2020 the median value for this ratio varies from 2.44 to 2.64, average values vary from 2.44 to 2.68, and 90th percentile values vary from 3.0 to 3.39. Clearly management wages are higher than the average for all other workers by a noticeable amount across these industries. In addition to having higher average wages, management occupations exhibit less wage dispersion across these industries than is found for the average wage for all other workers. In each year from 2002 to 2020, the coefficient of variation for MgtEarn is lower than the coefficient of variation for AllOthEarn. The coefficient of variation for AllOthEarn is between 45% and 72% higher than for MgtEarn in each year. In conclusion, for each year from 2002 to 2020 there is considerable variation across industries in the relative wage for managers, so Research Question 1 has an answer of yes. Research Question 2 also is answered in the affirmative as the dispersion across

industries in average wages for all other workers is notably larger than the dispersion in average earnings for managers.

In addition to the average earnings data, later analysis also will utilize employment data by industry to compute managements' share of total employment for each year and industry (OEWS, 2022). The final data used in this study is labor productivity data matched to the four-digit NAIC industries from 2002 to 2020 from the "Productivity Data by Sector, Industry, and State" database maintained by the U.S. Bureau of Labor Statistics (BLS, 2022). There are 111 industries with labor productivity data that can be matched to the original 228 industries. All 111 industries are used in the productivity related analysis presented below.

3. Results

The affirmative findings for the first two questions make Research Question 3 relevant. Since average management earnings always exceed average earnings for all other workers in an industry, and average earnings for all other workers are more dispersed across industries than average management earnings, this raises the likelihood that the same dynamic examined in comparing developed to less developed nations by Hjort et al (2021) and others also holds true when just comparing across industries within the United States. Namely, that a positive association exists across industries in the average wage for all other workers, AllOthEarn, and managements' share of total employment, hereafter MgtShar. Separately for each year from 2002 to 2020, this relationship was examined using Equation 1 below and examining the statistical significance of the coefficient on AllOthEarn.

$$\text{MgtShari} = b_0 + b_1 * \text{AllOthEarn}_i \quad (1)$$

where

MgtShari is management employment share in industry i

AllOthEarn_i is average wage of all other workers in industry i

for i = 1,228 four-digit NAIC industries

Regarding research question 3, the Equation (1) regression results can be summarized simply: yes, there is strong evidence of complementarity between management and the skill level of all other workers in the industry.

For each of the 19 years, b₁ in Equation (1) is positive and statistically significant (p-value always < .001): a robust finding of a positive association across these 228 industries between management employment share and the average wage for all other workers. Moreover, the strength of this association grows over the sample period. The standardized beta coefficient rises from 0.39 in 2002 to above 0.50 by 2005 and is above 0.55 from 2016 onward. Relatedly, the R² improves from 0.15 in 2002 to

above 0.30 from 2016 onward. As with the data for less developed nations (Hjort et al, 2021), there is clear positive association between the average wage for all other workers and management employment share. Lower wage industries, implying higher relative price for managers, have a lower share of total employment in management occupations.

Turning now to the fourth and final research question, recall that in the economic development literature there is concern that lower income nations are using inefficiently low levels of management employment, due to high relative wage for management, with adverse effects on long-run economic growth. Although the effect is unlikely to be as pronounced in the US, given it is a highly developed nation, there may still be an association across US industries between management employment share and long-run productivity growth. To investigate this issue, industry labor productivity data is matched to the study's 228 four-digit NAIC industries from 2002 to 2020 for which there are 111 industries with labor productivity data that can be matched to the original 228 industries. All 111 industries are used in the remaining analysis. The impact of management employment share upon labor productivity growth for an industry is investigated by testing for the association between the growth of management employment share and the growth in labor productivity from 2002 to 2020. First, the standard linear regression shown as Equation (2) is estimated.

$$\text{ProdGrow } i = b_0 + b_1 * \text{MgtGrow } i \quad (2)$$

Where

ProdGrow_i is % change in labor productivity (LP) from 2002 to 2020 for industry i ,
 $i, = (LP_{2020} - LP_{2002}) / LP_{2002}$

MgtGrow_i is % change in management's share of total employment (MgtShar) from 2002 to 2020 for industry i ,
 $= (\text{MgtShar}_{2020} - \text{MgtShar}_{2002}) / \text{MgtShar}_{2002}$

$i = 1, \dots, 111$ industries

Equation (2) finds evidence of a weak linear relationship between management growth and productivity growth as b_1 is statistically significant ($p = 0.04$), but the standardized coefficient β on MgtGrow is only 0.19 and the R^2 is only 0.04 for Equation (2).

The discussion and conclusion section of this paper develops arguments for why the impact of a change in managements' share of total employment in an U.S. industry upon its productivity growth may not be a linear relationship. Instead, the impact may vary depending upon whether the industry has relatively high or low growth in managements' share of total employment. To allow for the possibility of a structural break in the relationship between managements' employment share and productivity

growth, the model is tested for an unknown structural break using Equation (3) and the method popularized by Andrew (1993).

$$\text{ProdGrow}_i = a_0 + b_1 * \text{MgtGrow}_i + b_2 * \text{MgtGrow}_i * \text{Dum}_i(\text{MgtGrow}_i > \text{critval}) \quad (3)$$

Where

$\text{Dum}_i = 1$ if value $\text{MgtGrow}_i >$ selected critical value and 0 otherwise
Other variables as defined in Equation (2)

The test consists of multiple repetitions of Equation (3). The first iteration sets the critval so that 15% of the observations are in the "low" MgtGrow regime and 85% in the "high" regime. The regression is run and the Wald statistic that tests for significance allowing a change in parameter on MgtGrow is collected. Next, the critval is increased by a small amount, the regression is run, and the Wald statistic again is collected. This step is repeated until the critval has 85% observations in the "low" MgtGrow regime and 15% in the "high" regime. The maximum Wald statistic value across all of the regressions (Supremum Wald) is then identified and compared against Andrew's critical values in order to test the null hypothesis of no change in parameter value. If Andrews' Supremum Wald test finds a structural break, the model is then estimated using the identified structural breakpoint on MgtGrow.

Andrews (1993) Supremum Wald test finds strong evidence of a structural break in Equation (3) as the Supremum Wald Statistic is 25.2 (p -value $< .001$). The identified break places 66 of the 111 observations in the low regime of MgtGrow and 45 in the high regime. The identified breakpoint places industries in the MgtGrow low regime if their MgtGrow value is 1.2% or less, values above 1.2% place industries in the high regime.

Next, Equation (3) is estimated again with the critval = 1.2%. This version of Equation (3) is a much-improved fit over Equation (2) as the R^2 improves to 0.22 versus 0.04 for Equation (2). In Equation (3), the standardized coefficient associated with b_1 is $\beta_1 = -.78$ and the standardized coefficient associated with b_2 is $\beta_2 = 1.06$. Clearly, this version of Equation (3) is a much better fit to the data than Equation (2).

4. Discussion and Conclusion

The first three research questions motivating this paper are clearly answered in the affirmative. For the first two research questions, there is sizable variation across U.S. industries in the relative wage of management, and there is less dispersion across U.S. industries in earnings for management than for earnings of all other workers as seen Table 1. Regarding the third research question, there is evidence of complementarity between management and the skill level of all other workers in the

industry. First, Table 1 clarifies that management wages exceed the wages for all other workers in every industry in all years, and that there is considerable variation in this relative wage for management across industries.

In addition, Equation (1) regression results establish a robust positive association between the average wage for all other workers in an industry and management's employment share in the industry, consistent with complementarity between management usage and more skilled labor in an industry. Moreover, the strength of this relationship grew from 2002 to 2020. In sum, results for the first three research questions are quite consistent with the economic development literature which motivated this work.

More subtleties arise, however, for fourth research question regarding the link between growth in managements' employment share and labor productive growth across U.S. industries. To make sense of the Equation (3) results finding a negative association between growth in managements' employment share and labor productivity growth for "low management growth" industries, but a positive association for "high management growth" industries, we need to consider other factors that may be impacting this relationship.

If we divide the employment in an industry into two groups, management and all other workers, we can consider two different reasons for why the average wage for all other workers in "Industry X" is rising. One potential reason is that the underlying productivity of these workers has not changed, but that rising demand for workers in other industries is forcing firms in Industry X to increase wages to retain many of these workers. The second reason why the average wage for workers in Industry X is rising is that the human capital or skills of workers in Industry X is rising. These two potential reasons for the rising wage for all other workers in Industry X have different implications regarding the impact from changes in the management employment share in an industry upon its productivity growth.

If we envision U.S. industries as being in either the comparative advantage or comparative disadvantage groupings, then it is likely that the industries paying lower average wages for all other workers are in the comparative disadvantage group. This result is based on the well-established positive link overall between wages and human capital or skills, so higher human capital or skill labor earns higher wages, along with the recognition that the U.S. economy's comparative advantage frequently lies in higher skill intensity production items and not in low skill intensity production items (Fort, et al, 2018; Kamal and Lovely, 2017; Kemeny, et al, 2015; Mandelman and Zlate, 2022).

For the firms in a comparative disadvantage industry, being forced to pay higher wages to prevent their workforce from moving to other industries creates additional

financial stress. Effectively, the higher-wage options for workers elsewhere present firms in the comparative disadvantage sectors with a fall in supply of all other workers. As a result, while the average wage for these workers rises, the total number employed will decline, all else the same. If the industry's adjustments to the size of its management employment are slower than the declines in employment of all other workers, then the industry will have a rising management employment share. This rising management employment share, however, is not because the industry is gaining materially in productivity. Instead, the rising management employment share is associated with an increasingly stressed industry which is less likely to undertake spending that will have positive longer-term impacts on firm productivity as the firms focus on short-term survival. In this scenario, we would expect a negative association between changes in an industry's management employment share and changes in its productivity growth. The potential channels for a negative impact from firm's downsizing includes disruptions to the firm's prior processes (Miller, Pentland, and Choi, 2012), impaired flexibility (Fisher and White, 2000), the need to substantially modify routines (Brauer and Laaman, 2014), less innovation (Lawson, 2001) damage to the psychological contract with remaining workers (Arshad, 2016), inadvertently lost human capital (Schmitt, Borzillo, and Probst, 2012), and lost social capital which impairs social networks and organizational memory (Schenkel and Teigland, 2017), all of which can contribute to reduced efficiency and higher risk of bankruptcy (Holtom and Burch, 2016; Zorn et al, 2017).

As we observe ever higher average wages for all other workers, however, it becomes increasingly likely that the reason for the higher wages is that the workers in the industry have higher levels of human capital and skill. If management is complementary to worker skills, in the economic sense of substitutes versus complements, then there would be an expected positive association between an industry's average wage for all other workers and its management employment share. Higher wages mean more highly skilled workers which means greater demand for managers and a higher ratio of managers to workers. See Feng and Valero (2020) for evidence that management is complementary with all other workers' skills. In this scenario, a higher management employment share in the industry implies a higher skilled and more productive workforce so we would expect a positive association between changes in an industry's management employment share and changes in its productivity growth.

By using Andrews (1993) methodology for testing for unknown structural breaks, the Equation (3) results allow for the possibility of these differential impacts. The results are consistent with the above narrative. Estimation of Equation (3) finds a negative association between growth in managements' share of total employment and labor productivity growth for industries in the lower regime, defined as cumulative

growth of less than 1.2% from 2002 to 2020 in managements' share of total employment, but a positive association in the higher regime ($> 1.2\%$).

Moreover, this structural break model is a substantively improved fit to the data compared to the simple linear model. To conclude, the answer to the fourth research question is a qualified yes, higher growth rates of managements' share of employment do associate with higher productivity growth rates across U.S. industries once the observed growth rates of managements' share of employment are in approximately the top 40% (45/111) of observed industries growth rates of managements' share of employment.

Overall, the findings in the paper are broadly consistent with results from the economic development literature which focused on comparisons across lower and higher income nations, suggesting the linkage between management employment share and wages for all other workers may be quite robust. Potentially valuable future work can focus on increasing the number of industries available for comparison and using alternative measures of productivity growth. Another potentially fruitful extension would be to replicate the analysis for nations with per capita incomes similar to the U.S. to see if a breakpoint also exists in those nations in linkage between managements' employment share and productivity growth rates across industries.

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