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Routine-biased technical change: Panel evidence of task orientation and wage effects



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ABSTRACT

This analysis explores changes in the premium for abstract relative to routine tasks both across and within occupations over time. Previous theoretical and empirical work has linked growth in the relative task premium to changes in production technology that complement abstract but substitute for routine tasks, i.e. the Routine-Biased Technical Change hypothesis. The supporting empirical literature has relied almost exclusively on repeated cross-sections of workers and single cross-sections of task content. Thus, these studies have been unable to examine the evolution of wages in response to changes in task content within occupations over time and unable to control for unobserved individual and occupational heterogeneity. In this paper, I construct a new panel of occupational task content using incumbent-updated survey data from archived releases of the *O*NET* database. Estimating wage effects in a model with individual and occupation fixed-effects, I find that an increase of ten percentiles in the routine task distribution corresponds with a wage penalty of -0.09 to -0.35 percent in 2004 and declining to between -0.42 and -2.43 percent by 2013. In contrast, an increase of ten percentiles in the abstract task distribution corresponds with a wage penalty of 0.42 – 2.27 percent in 2004 and declining to between 0.42 and 2.43 percent by 2013. In contrasting estimates with and without individual fixed-effects, I also find evidence patterns of self-selection over time that are also consistent with the Routine-Biased Technical Change hypothesis.

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1. Introduction

This analysis fills a significant gap in the empirical literature on Routine-Biased Technical Change (RBTC) by directly examining wage dynamics using a combined panel of occupational task content and individual workers. In examining wage and employment polarization, the existing literature on RBTC has relied exclusively on cross-sectional measures of occupational task content. In this paper, I exploit variation in task content within occupations over time and develop a natural extension to Autor and Handel (2013) using panel data. Panel data on occupational tasks allows for a more rigorous examination of changes to task premiums predicted by the RBTC hypothesis as well as the consequent sorting of workers based on comparative advantage. Panel data also allows me to fully control for time invariant unobserved heterogeneity by estimating models that include individual, occupation, and employer fixed-effects. Using this novel empirical framework and panel data on occupational tasks, I find new and compelling evidence in support

of the RBTC hypothesis. Specifically, I find that the wage premium for routine tasks has declined from 2004 to 2013 while that for abstract tasks has increased markedly. Further, I find evidence suggesting that patterns of self-selection are consistent with prediction that technical change creates stronger selection into routine occupations and weaker selection into abstract occupations.

In describing why RBTC has resulted in some occupations becoming more automated than others, recent papers by Autor (2013; 2014) outlines a compelling mechanism for observed changes in the labor market. In this paper, Autor refers to tasks that follow explicit rules as routine and suggests that they are more easily codified by technology. Codification of these tasks allows for them to be more easily substituted for capital in the production process. In contrast, tasks that are rich in tacit knowledge are characterized as non-routine or abstract. Abstract tasks serve as complements to technology in production because they are less easily codified and require frequent cognitive judgments as well as high levels of social interaction.

Acemoglu and Autor (2011) provide a detailed theoretical exposition of RBTC that captures the interconnectedness of technology, tasks, skills, and wages. A key feature of their model is the distinction

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they make between employers' demand for tasks and workers' supply of skills. The model structures production as a function of routine and abstract task where occupations are distinct bundles of these labor inputs. Skills, on the other hand, are either innate or accumulated through a workers attainment of human capital. The labor market is thus characterized by an imperfect matching of skills to tasks and the sorting of workers across occupations based on comparative advantage. The model uses a fully developed supply and demand framework to derive comparative statics related to task replacing technology, an important characteristic of the RBTC hypothesis. The model has been subsequently expanded to accommodate empirical applications in a stream of literature that has recently been characterized as taking a task-based approach.

This nuanced view of technical change suggests that the primary driving force behind observed changes in the labor market is the falling price of computing power coupled with the increased capability of technology to replicate human tasks. More specifically, these factors have displaced workers in occupations with a high degree of routine task content while simultaneously increasing the demand for workers engaged in abstract tasks. Empirical evidence of this predicted pattern of displacement and wage polarization has been documented by Katz and Murphy (1992), Autor et al. (1998), Autor et al. (2003), Autor et al. (2005), Acemoglu and Autor (2011).

More recently, Firpo et al. (2013) develop a cross-sectional Roy model that they use to examine the distribution of wages within occupations. The application of a Roy model accommodates the task-based framework and allows for the cross-occupation transferability of skills described by Gathmann and Schönberg (2010). Autor and Handel (2013) apply a similar Roy model to a cross-sectional survey of self-reported task engagement within occupations. Combining occupation-level task content with self-reported levels of task engagement, the authors find evidence in favor of self-selection on comparative advantage in tasks. Altonji et al. (2014) use a similar framework to investigate the forces behind changes in the wage distribution across college graduates from different fields of study. Each of these analyses document important aspects of wage and employment polarization using cross-sectional data on occupational task content.¹

Cortes et al. (2014; 2016) links cross-sectional measures of task content to panel data on individual workers and examines both employment and wage dynamics of those initially employed in routine occupations. Cortes (2016) finds evidence that workers with high ability are more likely to switch into abstract occupations and that workers with low ability have a higher probability of switching to occupations dominated by abstract tasks. In examining task variation across occupations, Cortes et al. (2014) details empirical evidence that an increase in the transition rate from non-employment to employment coupled with a decrease in the transition from employment to non-employment has played a crucial role in the disappearance of routine jobs.

Similarly, Böhm (2015) documents evidence suggesting that the premium for routine tasks has declined through the 1990s and 2000s while that for abstract tasks has grown. Deriving a linear estimation equation from a Roy model of wages, Böhm finds that polarization increased most rapidly for young males from 1999 to 2007 as well as males of all ages. Comparing the estimated to the actual changes in the wage distribution over the last three decades, he finds strong evidence that changes to task premiums and minimum wage laws explain a large portion of the variation in wages. Relative to estimates using traditional measures of skill (i.e. education groups), Böhm concludes that tasks are critical for studying the evolution of the earnings distribution over time.

As detailed above, the existing empirical literature on RBTC has been limited by the use of cross-sectional data of occupational tasks. Autor and Handel (2013) use self-reported cross-section of task engagement to test an integral component of the RBTC hypothesis, specifically that comparative advantage drives self-selection across occupations. Thus, panel data on occupational task content allows for further testing of the model outlined by Autor and Handel as well as how wages change over time in response to changes in task content. Further, combining panel data on occupational tasks with a panel of workers allows for the estimation of wage effects related to RBTC and the ability to control for unobserved individual and occupation heterogeneity. In this analysis, I develop such a dataset and use these data to isolate the effect of changes to task content related to RBTC on the variation of wages over time.

There exist two notable exceptions to the use of cross-sectional data in the prior literature where authors use German panel data that includes reported levels of task engagement within occupations over time, Spitz-Oener (2006) and Gathmann and Schönberg (2010). Although distinct in both purpose and scope from the focus of this paper, these analyses provide additional evidence in support of an empirical strategy that relies on within occupation variation in task content. In particular, Spitz-Oener (2006) examines changes in reported task engagement both within and across occupations over a twenty-year period and relates these changes to technology. The author finds evidence that the most significant changes in task content have occurred in occupations that have experienced a rapid adoption of computer technology since 1979. Using the same data, Gathmann and Schönberg (2010) explore the differences between task-specific (semi-portable) occupational skills and more general forms of human capital. The authors find evidence that individuals are more likely to transition to an occupation with similar task engagement to their source occupation and that patterns of wage growth persist through these transitions.

This analysis constructs a similar dataset as the previously mentioned German panel but focuses on U.S. and explicitly examines the RBTC hypothesis via a direct examination of wage and employment dynamics. Specifically, I use the combined panel to examine changes in the premium paid for abstract relative to routine task content as well as wage effects in response to changes in task content over time. Further, I explore how unobserved worker heterogeneity effects wage estimates and find evidence of the consequent sorting of workers in response to RBTC. Since identification comes from within occupation variation in task content over time, I am able to control for time invariant unobserved occupation and worker heterogeneity through fixed-effects estimation. My findings provide compelling new evidence supporting the RBTC hypothesis and the related mechanisms driving observed wage and employment polarization.

This paper proceeds as follows: The next section contains an extension of the existing theory underlying the RBTC hypothesis and derives several empirically testable implications. The third section details the construction of a synthetic panel of occupational task content and provides descriptive statistics from that data as well as the panel of individual workers. The fourth section provides an empirical analysis of changes to the relative task premium. The fifth section contains a robustness check using a two-step estimation procedure. The final section summarizes the findings and provides some concluding remarks.

2. Theory

To frame the empirical analysis, I follow the existing literature by detailing a task-based model of the labor market and derive important implications related to the effect of RBTC on wages.

¹ Related work includes Blender (2007), Jensen and Kletzer (2010), and Yamaguchi (2011).

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