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Do technology shocks lower hours worked? – Evidence from Japanese industry level data ☆

Jun-Hyung Ko [a,*], Hyeog Ug Kwon [b]

[a] Aoyama Gakuin University, 4-4-25 Shibuya, Shibuya-ku, Tokyo 150-8366, Japan
[b] Nihon University, 1-3-2 Misaki-cho, Chiyoda-ku, Tokyo 102-8360, Japan

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ABSTRACT

We examine the response of productivity and hours worked to technology and nontechnology shocks using the Japan Industrial Productivity (JIP) Database. We find that, at the aggregate level, positive technology shocks increase hours worked both in the manufacturing and the nonmanufacturing sector, accounting for a large fraction in the variances of hours worked. At the two- and three-digit industry levels, in contrast, we find that the correlation between productivity and hours worked in response to sectoral technology shocks tends to be negative. Further, we find that neither aggregate nor sectoral technology shocks appear to be the dominant factor underlying fluctuations in hours worked at the disaggregate level. The productivity decline in response to nontechnology shocks is not related to a permanent change in the relative size of industries.

1. Introduction

What is the relationship between productivity and hours worked? Canonical real business cycle (RBC) models predict that labor input increases in response to a favorable technology shock,[1] while canonical New Keynesian (NK) models expect a negative sign of hours worked.[2] Following the seminal study by Galí (1999), which, using a structural vector-auto regression (VAR) model, suggested that technology shocks reduce hours worked in the G7 countries except Japan, a substantial number of subsequent studies have sought to empirically examine the relationship between productivity and employment.[3] Further,

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* Corresponding author.
E-mail addresses: kojunhyung@aoyamagakuin.jp (J.-H. Ko), kwon.hyeogug@nihon-u.ac.jp (H.U. Kwon).

[1] This is because firms demand more labor when the marginal product of labor exceeds its cost. See, for example, Cooley and Prescott (1995) among others.

[2] In such models, even though a favorable technology shock lowers the marginal cost of production, firms reduce their labor input if output prices are sticky in the short run and actual demand by households as a result remains more or less unchanged.

[3] Studies confirming Galí's (1999) results for the U.S. economy include Francis and Ramey (2009) and Galí (2005). Shea (1998) found a negative correlation between productivity and hours worked using alternative measures of technology such as patents and R&D, while Basu et al. (2006) similarly found a negative correlation, identifying aggregate technology by estimating a Hall-style regression equation. Alexius and Carlsson (2005) showed that structural VAR models produce technology measures that are highly correlated with the classic and refined Solow residuals.

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with the growing availability of industry- and firm-level data, there has also been a considerable increase in studies on the relationship between productivity and employment at disaggregate levels.[4]

Another growing strand of literature also studies much broader implications rather than just testing two conflicting theoretical predictions. For example, Dotsey (2002) theoretically showed that the specification of monetary policy is important in understanding the comovement of productivity and hours. Lindé (2009) showed that the standard RBC model can produce a substantial fall in hours worked when the process of permanent technology shocks is positively correlated in growth rates. Using CES production function, Cantore et al. (2014) showed that the response of hours depends on the factor-augmenting nature of technology shocks and the capital-labor substitution elasticity in both RBC and NK models. Investigating firm-level relationship between productivity and hours, Carlsson and Smedsaas (2007) divided aggregate shocks and firm-specific shocks.

Studies on Japan investigating the relationship between productivity and hours worked have used aggregate-level data. For example, employing a sign-restriction VAR, Braun and Shioji (2004) found that hours worked increased in response to favorable technology shocks. Estimating a time-varying-parameter VAR model, Ko and Murase (2013) found that hours worked increased in most of the observation periods in response to positive technology shocks. In contrast, using an aggregate technology measure constructed from industry-based data, Miyagawa et al. (2006) found the relationship between positive technology shocks and labor input to be negative. However, none of the existing studies for Japan investigates whether the aggregate-level results can also be observed at disaggregate levels. Furthermore, to the best of our knowledge, there are no studies to date investigating the relationship between productivity and hours worked outside the manufacturing sector – be it in Japan, the United States, or any of the other G7 countries.

Given this, the key aim of this paper is to examine the relationship between productivity and hours worked at both the aggregate and disaggregate levels. Furthermore, we investigate whether there are any differences between manufacturing and nonmanufacturing industries, an issue which the existing literature so far has ignored. Our analysis using the Japan Industrial Productivity (JIP) Database suggests that, at the aggregate level, hours worked increase in response to positive technology shocks. While this finding is not new, what is new is that our investigation indicates that this applies to both the manufacturing and the nonmanufacturing sector. Furthermore, we find that technology shocks explain approximately the half of the variances in hours worked in the aggregate economy and the manufacturing sector. On the other hand, conditional on nontechnology shocks, we find a negative correlation between productivity and hours worked, which has not been observed in other G7 countries.[5]

At the 2-digit and 3-digit industry levels, we find four additional results as follows. First, the size and sign of the impact on labor input of a positive technology shock differs across industries. For example, when a favorable technology shock hits the economy, some manufacturing industries still show a significantly positive short-run response of hours worked as in the aggregate case.[6] On the other hand, for the nonmanufacturing sector we find that hours worked decline in most industries, despite the finding mentioned above that hours worked increase at the aggregate level.[7]

Second, we find that the contributions of the estimated structural shocks at the disaggregate level are remarkably different from those at the aggregate level. Unlike the considerable contribution of technology shocks observed at the aggregate level, they appear to explain less than 20% of average hours variances at the 2-digit level. Thus, while technology shocks appear to be an important source of changes in hours worked at the aggregate level, this is not the case at the disaggregate level. We find that, instead, in 27 of 28 industries more than 50% of the variances in hours worked is attributable to nontechnology shocks. In other words, common technology shocks identified in the aggregate level play a minor role once we focus on individual industries.

Third, estimating aggregate and sectoral shocks in one model, we find that the conditional correlation between sectoral productivity and hours is still positive for aggregate technology shocks both in the manufacturing and nonmanufacturing sector. However, for sectoral technology shocks, it appears to be negative in both sectors. We also find that aggregate shocks play a minor role in explaining fluctuations in sectoral hours.

Finally, we decompose nontechnology shocks into composition shocks and noncomposition shocks. Specifically, composition shocks are defined as shocks that permanently increase the size of a certain industry relative to other industries, which may reflect a permanent change in consumer preferences. On the other hand, noncomposition shocks are defined as shocks that affect neither the relative size of an industry nor its long-run productivity. We find that in the case of both types of shocks, hours worked increase permanently, but the productivity and share responses differ somewhat. The findings of the decomposition analysis can be summarized as follows: (1) in response to technology and composition shocks, the share

[4] For instance, using 4-digit manufacturing sector data for the United States, Chang and Hong (2006) found that technology improvements raise employment in more industries than they lower employment. On the other hand, using U.S. industry and firm-level data, Kiley (1998), Alexius and Carlsson (2007) and Franco and Philippon (2007) found a negative correlation between productivity and employment in response to a technology shock. Meanwhile, Kim and Chun (2011) found that firms in industries with low inventory-sales ratios employ more workers in response to a favorable technology shock, while those with high inventory-sales ratios employ fewer workers. In contrast, using Italian firm-level data for the manufacturing sector, Marchetti and Nucci (2007) observed that the contractionary effect was stronger for firms with stickier prices, and weaker or not significant for firms with more flexible prices. A contractionary labor input response to technology shocks is also found by Carlsson and Smedsaas (2007) using Swedish firm-level data.

[5] See Galí (1999) for details.

[6] Specifically, a significant positive correlation between productivity and labor input is observed in the "fabricated metal products," "machinery," and "precision instruments" industries.

[7] The negative correlation is particularly large in "agriculture, forestry, and fishing," "mining," "real estate," "communications," and "personal services."