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The dynamics of hours worked and technology☆

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ABSTRACT

The response of hours worked to technology shocks in the postwar US economy has increased over time. We offer a structural interpretation of this important time-varying macroeconomic moment. The time varying patterns captured by a structural VAR are consistent with those obtained from a parsimonious RBC model with a less than unitary elasticity of substitution between capital and labour (σ). The observed changes in the response of hours are attributable to increases in the magnitude of the degree of capital-labour substitution. Finally, we conjecture that the observed time-variation in σ is related to changes in the skill composition of the work force and biases in technological change.

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1. Introduction

One of the most controversial issues in business cycle theory regards the impact of technology shocks on hours worked. From a theoretical standpoint, the sign and size of the responses of hours to a positive technology shock was used as evidence to distinguish between theories, i.e. the RBC and the New Keynesian paradigms, see Galí (1999). This particular impulse response, it was argued, could tell us whether we live in a world where output is largely driven by supply shocks or a Keynesian world in which output is largely demand-determined over the short-run due to price (and possibly wage) rigidities. If it is the former, then a positive technology shock induces people to work more. If it is the latter, then demand

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remains unchanged in the short-run and firms would lay off workers. As a consequence, a large empirical literature developed to identify technology shocks and analyze the response of hours in order to shed light on the empirical validity of competing theories of business cycle fluctuations. However, it relied on two crucial assumptions: (i) that the impact of technology shocks does not change over time[2] and (ii) that the impact of technology shocks on hours crucially depends on the demand side of the economy via the speed of price adjustments.

In this paper, we contribute to the literature by relaxing both assumptions. We first present further evidence that the response of hours to technology shocks has changed from negative to positive for the US economy between the post-WW2 period and the advent of the Great Recession. We then present an alternative structural explanation for the change in this impulse response that relies solely on the supply side of the economy: we argue that this observed change is due to changes in the degree of input complementarity in production. We propose and estimate parsimonious RBC model with a Constant Elasticity of Substitution production function and show that the elasticity of capital-labour substitution increased substantially throughout the sample period. We then test empirically the validity of our explanation to replicate the time variation in the response of hours to technology shocks.

Previous studies (e.g. Galí and Gambetti, 2009) show that the response of hours has substantially changed over time, i.e. it was typically negative at the beginning of the post-war sample and it turned positive or zero towards the end.[3] However, while they propose some explanations for these changes, the empirical framework they adopt, by construction, does not allow for structural interpretations of this phenomenon. One of our contributions is to provide a plausible explanation.

We start off presenting further evidence and robustness on the time varying relationship between hours and technology shocks by estimating a SVAR on overlapping windows of fixed length. Regardless of the amplitude of the windows, the filter used on hours, and the measure of hours worked, we find that the response of hours worked has increased over the sample. The response is negative at the beginning of the sample and turns positive or zero towards the end in line with the findings of Galí and Gambetti (2009). Moreover, we complement the VAR analysis with a reduced form framework where we study the correlation between hours and an empirical measure of TFP growth over the same overlapping windows. The estimated regression coefficients have a qualitative pattern comparable to the conditional correlation obtained from the SVAR. We also argue that this is one of the few *robust* changing moments in US macroeconomic time series on productivity, hours, and output that has a direct interpretation in terms of model shocks.

We then interpret such patterns using a parsimonious structural model. The model is a standard RBC where the production technology combines labour and capital with a constant – but not necessarily unitary – elasticity of substitution. Within this framework, in line with Cantore et al. (2014), the response of hours to a technology shock depends crucially on the value of the elasticity of capital-labour substitution. When capital and labour are strongly gross complements, as recent empirical evidence suggests,[4] an increase in labour efficiency leads to a reduction in wages and hours until firms have enough capital to combine with labour.[5] Thus, the demand for labour falls in the short-run in response to a technology shock, but not for reasons related to price and wage rigidities. When we bridge the model to the same overlapping sub-samples of the SVAR, we find that the response of hours worked obtained with the RBC model mimics fairly well those from the SVAR.[6] The driving factor behind the increase in the conditional correlation of hours is an increase in the estimate of the elasticity of substitution over time from a value close to 0.2 in early samples to 0.8 towards the end of the period considered.

We then carry out a series of empirical and theoretical robustness exercises. We start on the empirical side by noting the large increase in our structural estimates, we therefore estimate the elasticity of substitution in rolling sub-samples using the (static) normalised system method of (León-Ledesma et al., 2010). We also observe a substantial increase of similar (albeit smaller) magnitude that supports our previous estimates. On the theoretical side, we compare our structural interpretation to alternative competing explanations. Since there are several potential structural explanations available in the literature for the negative response of hours in the full sample then *changes* in the parameters of these models could offer competing explanations for the observed *change* in the response of hours. When we compare our model performance to those alternatives, we find that these competing explanations are unable to match the empirical findings. We conclude that our structural model offers a plausible and robust explanation for the observed changes in the response of hours. This is important given the increased focus in the literature on explaining the changing macroeconomic moments observed in the US data (see, e.g. Fernald and Wang (2016)).

In our model, the observed variation of the elasticity of capital-labour substitution means that it is not a structural parameter in a strict sense. We thus offer an interpretation these changes. We conjecture that changes in the skill composition of the labour force (and biased technical change) could account for the protracted increase in σ. Since the skill composition of the labour force has deep implications for the elasticity of capital-labour substitution, it can affect the way technology shocks are transmitted into the labour market and hence on aggregate hours worked. Of course, we do not rule out the

[2] This assumption is difficult to entertain given the number of structural changes undergone by the US economy from the postwar era until recent years.

[3] See also Stiroh (2009) for an analysis of changing unconditional correlations between productivity growth and hours growth.

[4] See León-Ledesma et al. (2015) and Klump et al. (2012) for a survey.

[5] See also Francis and Ramey (2005) and Wang and Wen (2011).

[6] In the online Appendix, we perform a reverse engineering exercise *à la* Erceg et al. (2005) and Chari et al. (2008), comparing the responses of hours in a SVAR model obtained using data generated by the estimated theoretical model to those obtained using actual data. The results indicate that both sets of responses are reasonably similar.