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## *Discussion*

Daron Acemoglu began by responding to several points raised by the discussants, Xavier Gabaix and Lawrence Christiano. He agreed with Gabaix that this paper fits into the larger literature about the microeconomic origins of macroeconomic fluctuations. Acemoglu described the Cobb-Douglas production and utility functions in the paper as a natural starting point, because under those assumptions the input-output tables reveal preference and production function parameters. Under other production functions and preferences, relative prices can change dramatically, resulting in input-output tables that are unstable. Acemoglu argued that input-output analysis in some sense forces one to assume preferences and production close to Cobb-Douglas and mentioned that in a recent paper with Asuman Ozdaglar and Alireza Tahbaz-Salehi, he showed that the equations derived under the Cobb-Douglas assumption can be viewed as a first-order approximation under more general production functions (Acemoglu et al. 2015).

Acemoglu next acknowledged Xavier Gabaix's suggestions regarding the discussion of multipliers in the paper. In the paper, the most natural object to analyze is the Leontief cumulative effect. However, this effect is not exactly the same as a multiplier. To capture the notion of a multiplier, the authors study shocks to a particular firm and then trace out the impulse response that this shock causes to other firms throughout the network. Relatedly, the Hulten (1978) formula summarizes the manner in which firm-level shocks sum up to form an aggregate shock, but it does not help determine which other firms are most affected by a shock to one particular firm. Acemoglu also acknowledged that issues about double counting complicate the interpretation of their regression results. He also mentioned another project (Acemoglu et al. 2014) that

looks at plant-level shocks relating to import competition and how those shocks propagate through both input-output channels and other channels.

Finally, Acemoglu commented on the discussion by Lawrence Christiano. He emphasized that the precise meaning of the terms “upstream” and “downstream” come from the notion of the input-output table as representing a directed graph. Imagine that the arrows in this graph point from suppliers to their customers. Supply shocks travel “downstream,” meaning that they follow the direction of the arrows in this graph, whereas demand shocks travel “upstream,” meaning that they move in the opposite direction as do the arrows in this graph. In his discussion Lawrence Christiano pointed out that, over time, the production of all the firms in the economy would comove together. Acemoglu noted that the US input-output matrix forms a strongly connected network, meaning that a shock hitting one sector will ultimately affect all other firms in the economy. As a result, the production of all firms would comove over time, but the extent to which any particular subset of firms is affected by a specific shock, which is what the authors sought to test in their empirical work, would be determined by the network structure.

Next, Robert Hall expressed concern about the authors’ interpretation of their regression results. In their results on exposure to Chinese import competition, which the authors argue is a demand shock for firms, the regression results show a large, negative point estimate and large standard errors for the downstream effects. This coefficient is not significantly different from zero, in a statistical sense. Hall characterized the authors’ position as claiming that, because the coefficient was not statistically significantly different from zero, it was consistent with their theory. He argued that the right interpretation is that the regressions are uninformative and that this issue arose in several of the regressions run by the authors. Acemoglu responded by arguing that the authors did not find statistically significant effects (for downstream coefficients in response to demand shocks) in any of their specifications. Hall pointed out that this was also consistent with large standard errors, but Acemoglu argued that this issue was not critical for the paper.

Pierre-Olivier Gourinchas noted that shocks such as China opening up to trade should have effects on relative prices. Daron Acemoglu responded by agreeing that relative price impacts could be important. He mentioned a paper on the Japanese earthquake (Carvalho et al. 2014) as an example of downstream effects arising from a demand shock and also mentioned work by Yu Shi, a graduate student at MIT. In general,

with CES (as opposed to Cobb-Douglas) production, there are downstream effects from a demand shock, arising because income and substitution effects, which go in opposite directions, do not exactly cancel. However, the prediction that demand shocks cause upstream effects is robust and does not depend on the assumption of Cobb-Douglas preferences.

Christopher Sims recalled a paper by Olivier Blanchard (Blanchard 1988) that used input-output dynamics to discuss the propagation of effects from nominal price changes. Sims suggested that the author consider the dynamics of prices in their framework, and Daron Acemoglu agreed, mentioning that Chad Jones had a series of papers that considered network models with wedges.

Ben Bernanke spoke next, suggesting that inventory dynamics, arising for issues like time to order, delivery times, and the like might help connect the model to an older literature on business cycles and identify whether particular shocks were upstream or downstream of a particular firm. Daron Acemoglu agreed and recalled the work of Long and Plosser (1983). In their model, output depends on inputs purchased in the previous period. Acemoglu pointed out that these types of delays would vary substantially across industries. However, in these models, the second-round effects occur in the second period after the shocks, the third-round effects in the third period, and so on. Acemoglu suggested that there is potentially interesting research to be done using these models but stated that the authors chose to focus on static models initially because they lead to empirically testable regressions.

John Fernald mentioned that Susanto Basu wrote a paper about intermediate inputs and sticky prices (Basu 1995). In the present paper, Acemoglu, Akcigit, and Kerr find no upstream effects of a technology shock because that shock immediately changes prices. In his work with coauthors (Basu et al. 2013), Fernald finds that one-third of the technology shocks passes through into relative prices within one year. Daron Acemoglu agreed that this was an interesting point and that in more realistic models both quantities and prices would adjust slowly. Yuriy Gorodnichenko pointed out that the authors' model makes a strong prediction about how prices should respond to demand shocks and that the authors' data set would allow them to test this. Daron Acemoglu expressed his skepticism about the quality of the price data and pointed out that under the Cobb-Douglas assumptions, the results would be the same regardless of whether one used real value added, nominal value added, real shipments, or nominal shipments.

Finally, Harald Uhlig asked about the stability (over time) of the input-output matrices, and in particular about how this was affected by the ongoing process of firm creation and destruction. Daron Acemoglu replied that they are very stable, with the correlation of entries across five-year periods of above 0.9. He referenced a paper of his (Acemoglu et al 2013) that documented this. However, there is some change over time, and Acemoglu speculated that it would be interesting to combine these changes with high-quality data on prices.