

Emi Nakamura: 2019 John Bates Clark Medalist

Janice Eberly and Michael Woodford

Emi Nakamura, winner of the 2019 John Bates Clark Medal, is an empirical macroeconomist. She has made a signature contribution to the field by integrating microeconomic and macroeconomic theory with data to increase our understanding of some of the most consequential, challenging, and long-standing questions in macroeconomics. Emi’s distinctive approach displays a sophisticated understanding of alternative theoretical models of macroeconomic phenomena and then turns to both their unique micro implications and aggregate consequences to distinguish between models. In the past, most prior work on these big macroeconomic questions has been built on quarterly, aggregate time series for the post-World War II period. In contrast, Emi analyzes macro questions by considering implications that arise in more disaggregated, or higher frequency data, or extending over a longer historical period. Her empirical work requires painstaking analysis of data sources not previously exploited, and she has been notably creative in developing and using new sources of data. By bringing together insightful modeling and new data resources, she has managed to isolate variation in micro data that is more credible for drawing causal inferences. Moreover, she can then relate these results to earlier estimation approaches, interpreting existing evidence in light of new methods and models.

■ *Janice Eberly is James R. and Helen D. Russell Professor of Finance, Kellogg School of Management, Northwestern University, Evanston, Illinois. Michael Woodford is John Bates Clark Professor of Political Economy, Columbia University, New York City, New York. Their email addresses are eberly@kellogg.northwestern.edu and mw2230@columbia.edu.*

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Emi Nakamura

Emi's exposure to economics began early in life. Her grandfather, Guy Orcutt, was a distinguished econometrician (Watts 1991). Both of her parents, Alice and Masao Nakamura, were academic economists; her mother, Alice Orcutt Nakamura, is a past President of the Canadian Economic Association. In addition to an early exposure to economic ideas, Emi credits her parents with instilling in her "a deep sense of the importance of testing theories empirically" (Ng 2015). Emi attended academic conferences with her mother and began taking economics classes at the University of British Columbia as a high school student. She credits one of these early classes, a master's class on economic measurement and index number theory taught by Erwin Diewert, with making an early mark in her drive for clarity in measurement. In a similar vein, Emi watched the film "The Race for the Double Helix" about the discovery of the structure of DNA with her parents. They emphasized the role of the empiricist Rosalind Franklin and the notion that "there is nothing worse than a wrong fact."

During her undergraduate studies at Princeton, she took many of the graduate classes in economics. This included Bo Honore's graduate course in econometrics, where she pressed forward her interest in measurement and estimation, and also met her future husband and frequent coauthor, Jón Steinsson, who was also a Princeton undergraduate at the time. Emi's interest in macroeconomics was piqued at Princeton under the guidance of her undergraduate advisor, Mike Woodford. She particularly remembers writing to him with a question on the real business cycle model over the winter break and receiving a detailed response on Christmas Day. A revised version of her Princeton senior thesis was published as [5], shown in Table 1.

Table 1

Selected Publications of Emi Nakamura

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1. “Cost Pass-Through in the U.S. Coffee Industry” (with Ephraim Leibtag, Alice Nakamura, and Dawit Zerom). 2007. Economic Research Report Number 38.
 2. “Layoffs and Lemons over the Business Cycle.” 2008. *Economics Letters* 99 (1): 55–58.
 3. “Pass-Through in Retail and Wholesale.” 2008. *American Economic Review: Papers & Proceedings* 98 (2): 430–37.
 4. “Five Facts about Prices: A Reevaluation of Menu Cost Models” (with Jón Steinsson). 2008. *Quarterly Journal of Economics* 123 (4): 1415–64.
 5. “Deconstructing the Success of Real Business Cycles.” 2009. *Economic Inquiry* 47 (4): 739–53.
 6. “Accounting for Incomplete Pass-Through” (with Dawit Zerom). 2010. *Review of Economic Studies* 77 (3): 1192–1230.
 7. “Monetary Non-Neutrality in a Multi-Sector Menu Cost Model” (with Jón Steinsson). 2010. *Quarterly Journal of Economics* 125 (3): 961–1013.
 8. “Price Dynamics, Retail Chains and Inflation Measurement” (with Alice O. Nakamura and Leonard I. Nakamura). 2011. *Journal of Econometrics* 161 (1): 47–55.
 9. “Price Setting in Forward-Looking Customer Markets” (with Jón Steinsson). 2011. *Journal of Monetary Economics* 58 (3): 220–33.
 10. “Lost in Transit: Product Replacement Bias and Pricing to Market” (with Jón Steinsson). 2012. *American Economic Review* 102 (7): 3277–3316.
 11. “Crises and Recoveries in an Empirical Model of Consumption Disasters” (with Jón Steinsson, Robert Barro, and José Ursúa). 2013. *American Economic Journal: Macroeconomics* 5 (3): 35–74.
 12. “Price Rigidity: Microeconomic Evidence and Macroeconomic Implications” (with Jón Steinsson). 2013. *Annual Review of Economics* 5: 133–63.
 13. “Fiscal Stimulus in a Monetary Union: Evidence from US Regions” (with Jón Steinsson). 2014. *American Economic Review* 104 (3): 753–92.
 14. “Are Chinese Growth and Inflation Too Smooth? Evidence from Engel Curves” (with Jón Steinsson and Miao Liu). 2016. *American Economic Journal: Macroeconomics* 8 (3): 113–44.
 15. “The Power of Forward Guidance Revisited” (with Alisdair McKay and Jón Steinsson). 2016. *American Economic Review* 106 (10): 3133–58.
 16. “Growth-Rate and Uncertainty Shocks in Consumption: Cross-Country Evidence” (with Dmitriy Sergeyev and Jón Steinsson). 2017. *American Economic Journal: Macroeconomics* 9 (1): 1–39.
 17. “Informational Rigidities and the Stickiness of Temporary Sales” (with Eric Anderson, Benjamin A. Malin, Duncan Simester, and Jón Steinsson). 2017. *Journal of Monetary Economics* 90: 64–83.
 18. “Identification in Macroeconomics” (with Jón Steinsson). 2018. *Journal of Economic Perspectives* 32 (3): 59–86.
 19. “High-Frequency Identification of Monetary Non-Neutrality: The Information Effect” (with Jón Steinsson). 2018. *Quarterly Journal of Economics* 133 (3): 1283–1330.
 20. “The Elusive Costs of Inflation: Price Dispersion during the U.S. Great Inflation” (with Jón Steinsson, Patrick Sun, and Daniel Villar). 2018. *Quarterly Journal of Economics* 133 (4): 1933–80.
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Emi went on to graduate school to study economics at Harvard, where she took full advantage of the rich curriculum and varied methodological offerings. Taking Caroline Hoxby's empirical labor course back-to-back with Ariel Pakes's structural industrial organization course turned out to be a fruitful pairing, as Emi recalls feeling challenged to integrate Hoxby's description of the "revolution in identification" with the sophisticated structural models from Pakes's class. Emi's research collaboration with Jón began during graduate school, and she received her PhD from Harvard in 2007.

Emi began her career at Columbia University, where she held joint appointments in the Department of Economics and the Graduate School of Business. At Columbia, she received tenure in 2013 and was promoted to full professor in 2017. Since 2018, she has been the Chancellor's Professor of Economics at the University of California, Berkeley.

Emi is often asked what it is like to work so closely with her husband, both in research and in child-rearing. They both describe the communication necessary to succeed in all these roles as complementary. And of course, their willingness to apply principles of economic efficiency helps, as well. Recognizing that they do not have to do everything themselves liberates time for activities at which they excel (like research) and which they especially value (like child-rearing). Their family choices were described as "out-sourcing" by the *New York Times* (Rampell 2013), but many working parents will recognize such trade-offs and survival skills.

Of course, the American Economic Association is not the first to recognize Emi's promise and accomplishments, which include a CAREER Award from the NSF (2011), a Sloan Research Fellowship (2014), the Elaine Bennett Research Prize from the AEA (2014), and being named a member of "Generation Next: Top 25 Economists Under 45" by the IMF (2014). As her work has become more influential, she has in turn influenced other scholars by taking on leadership roles in the economics profession: for example, she serves as a co-editor of the *American Economic Review* and as co-director of the NBER Program on Monetary Economics. She also serves on the Panel of Economic Advisers for the Congressional Budget Office, the AEA Committee on National Statistics, and the Technical Advisory Committee of the Bureau of Labor Statistics. These appointments testify to the role she has quickly gained in the profession as an expert on issues relating to data construction and use.

The breadth of Emi's research agenda is apparent in the five main topics we discuss here: 1) Models of Price Adjustment, 2) Models of Pass-Through of Costs to Prices, 3) Empirical Studies of Asset Pricing, 4) Empirical Studies of Fiscal Stimulus, and 5) The Effects of Monetary Policy. We refer to her papers by number, as enumerated in Table 1.

Models of Price Adjustment

Emi is arguably best known for her work on the nature and consequences of price rigidity. Her research on this general topic encompasses both theoretical and

empirical work on a variety of models of price adjustment, and it considers implications of price rigidity for both domestic and open-economy issues.

Her most widely known paper is “Five Facts about Prices: A Reevaluation of Menu Cost Models” [4], with Jón Steinsson. This paper is a key reference in one of the more important recent developments in monetary economics, which is studying price adjustment by looking at changes in individual prices, rather than just using aggregate price indices. Measures of the average time that prices of individual goods remain unchanged have long been an important source of evidence for price rigidity. However, until very recently, most evidence of this kind came from detailed studies of a very small number of markets. Availability of new datasets that allow changes in the prices of a very large number of goods to be tracked simultaneously has radically transformed this literature, and Emi and Jón’s careful work in [4] has been one of the most influential contributions.

Emi and Jón study the data from the Bureau of Labor Statistics on individual prices used to construct the Consumer and Producer Price Indexes. They document a variety of facts about changes in individual prices that can be compared to the implications of a popular theoretical model of price adjustment, the “menu cost” model. For example, while past studies using other sources had concluded that the median time between price changes in the US economy was a large fraction of a year, the first work using the BLS micro data by Bils and Klenow (2004) had argued that prices actually changed much more frequently, with a median duration of prices only a little over four months.

However, Bils and Klenow (2004) used an extract from the Bureau of Labor Statistics micro dataset, for the period between 1995 and 1997. In [4], Emi and Jón obtained access to the BLS micro data containing all of the price observations collected for the period from 1988 to 2005. Emi and Jón show that conclusions about the frequency of price changes depend on the method used to distinguish sales from changes in “regular prices.” They find both that changes in “regular prices” occur much less often than price changes that include sales (they find a median duration of 8–11 months for “regular prices,” depending on the precise method used to classify price changes), and that producer prices (for which there is less of a need to filter out “sales”) also change quite infrequently. This paper suggests that the microeconomic evidence for substantial “stickiness” of individual prices is considerably stronger than Bils and Klenow had implied.

In addition, the paper [4] documents several features of the data on individual price changes that can be used to test popular models of price adjustment. Emi and Jón stress two features of the data in particular that are contrary to the predictions of popular “menu cost” models of price adjustment: clear seasonality in the frequency of price adjustments and the failure of the likelihood of price changes to increase with the amount of time that has passed since the last change in price. In contrast, “menu cost” models emphasize that changing prices has a cost, and so if the existing nominal price becomes less appropriate over time—perhaps because of inflation or changes in cost conditions—the price adjustments will happen only after a lag and will often involve substantial discrete jumps.

The ability of a “menu cost” model to account for the quantitative characteristics of the micro data on price changes is considered further in Emi’s paper “Monetary Non-Neutrality in a Multi-Sector Menu Cost Model” [7]. Prior numerical analyses of the implications of menu cost models, such as the very influential paper by Golosov and Lucas (2007), had used a one-sector model which assumed that all goods in the economy were subject to menu costs of the same size, in addition to being produced with the same technology, and so on. In this approach, the parameters common to all goods were assigned numerical values to match statistics for the set of all price changes, such as the overall frequency of change in prices and the average absolute size of price changes. But one of the facts documented by Emi and Jón in [4] is that there is tremendous heterogeneity across sectors of the US economy in the frequency of (nonsale) price changes.

In [7], Emi and Jón calibrate a multi-sector menu cost model to match the distribution across sectors of both the frequency of price changes and the average size of price changes. They find that the real effects of a monetary disturbance are three times as large in their multi-sector model as in a one-sector model, like that of Golosov and Lucas (2007). Indeed, whereas Golosov and Lucas argue that price rigidity is not an empirically plausible explanation for the observed effects of monetary disturbances in their one-sector model, Emi and Jón show that their calibrated multi-sector model (with nominal shocks of the magnitude observed for the US economy) predicts output fluctuations that would account for nearly one-quarter of the US business cycle. This magnitude would be roughly in line with the fraction of GDP variability that is attributed to monetary disturbances in atheoretical vector-autoregression studies. The emphasis of [7] on the importance of taking sectoral heterogeneity into account when parameterizing the degree of price stickiness has been highly influential.

Emi and Jón have also addressed the open-economy implications of alternative models of price-setting. Their paper “Lost in Transit: Product Replacement Bias and Pricing to Market” [10] looks at microeconomic data on individual price changes to reassess an important issue in open-economy macroeconomics, which is the extent to which exchange-rate changes are “passed through” to changes in the prices of US imports and exports. Previous literature had suggested that the relative prices of US imports change by only 0.2 to 0.4 percent in the case of a 1 percent change in the exchange rate, while the relative price of US exports changes by nearly 1 percent. This incomplete adjustment of import prices (even after substantial periods of time) is often taken as evidence of “pricing to market” by the foreign suppliers of US imports, whereas US exporters evidently “price to market” to a much lower extent.

However, Emi and Jón argue in [10] that conventional measures are seriously biased, owing to measurement errors created by price rigidity and relatively frequent product replacement. They show that as a result of these factors, about 45 percent of the individual price series used to construct the US import and export price series have no price changes at all, while roughly 70 percent have only two price changes or fewer over the time that price is measured. Emi and Jón argue that a large number of price changes occur at the time of product replacements,

but are ignored in the construction of the indices—because changes in the index frequently reflect only price changes that occur in the case of a good whose characteristics have not also changed. They estimate the magnitude of the bias that this produces in measures of “pass-through” to be as large as a factor of two. When they correct for the bias, they find that relative import prices respond by 0.6–0.7 of the size of the change in the exchange rate, while the relative price of US exports responds by only 0.8 of the change in the exchange rate. Thus, their results suggest that there is much less difference in the behavior of US exporters and importers to the US economy than is commonly believed. Again, the use of micro pricing data can shed light on the nature of price adjustment that was not obtainable by previous studies using aggregate price indices.

One of Emi’s major research efforts in recent years has been a labor-intensive multi-year project of extending the BLS micro-level dataset on consumer prices back in time by more than a decade to 1977. This project required more than the usual amount of empirical resourcefulness, as Emi found the data on microfilm cartridges in old file cabinets at the Bureau of Labor Statistics. These cartridges were not readable with modern equipment, nor could they be taken out of the Bureau of Labor Statistics. Even when a machine could be retrofitted, the scans had to be done by the Bureau of Labor Statistics (on their budget and staff-time) to meet confidentiality and ethics requirements. Finally, the scans resulted in a million PDF files, which could not leave the Bureau of Labor Statistics for transcription. Emi and Jón worked with a developer to create an optical character recognition program of sufficient accuracy to convert the images to machine-readable data. One of many advantages is that the resulting extended database includes a period in the late 1970s and early 1980s when inflation was much higher and more volatile than it has been since 1988 and also a period of deep recession. There will be much more scope to study how patterns of price adjustment change in response to changing macroeconomic conditions—an issue of central importance for macroeconomic uses of models of price-setting.

A first (though likely not the last) important paper using this new dataset is “The Elusive Costs of Inflation: Price Dispersion during the U.S. Great Inflation” [20], written by Emi and Jón with Patrick Sun and Daniel Villar. The paper considers how the process of adjustment of firms’ prices to changing market conditions differs in a higher inflation environment—a question that is important for assessing the welfare costs of higher inflation. They find that “regular” (nonsale) prices were adjusted more frequently in the earlier higher inflation part of their dataset and by about the amount that would be predicted by a model of optimal price adjustment taking into account a fixed “menu cost” of adjusting the firm’s price. They conclude that in assessing the welfare costs expected to follow from a permanently higher rate of inflation, it is important to take into account the increased frequency of price adjustments that should be expected to occur.

The paper also seeks to measure the degree to which there is greater dispersion in the prices of similar products in a higher inflation environment. Some common models of price adjustment imply that price dispersion should rise in a high-inflation

setting, owing to staggering of the times at which different firms' prices happen to be reconsidered. However, measuring price dispersion is difficult because it can be hard to tell if different prices across firms might just reflect heterogeneity of the goods. For this reason, Emi and her coauthors take an indirect approach: they look at how the average size of price changes differs between high- and low-inflation periods and find that the average size of price increases, when they occur, is about the same (a 7 percent increase on average) in their pre-1988 sample as in their post-1988 sample. Thus, they argue that a higher inflation rate does not increase price dispersion.

This paper [20] is an important contribution along several dimensions: to policy debates about the costs of inflation, to our understanding of historical facts about price adjustment in the United States, and to the empirical basis for assessing the realism of alternative theoretical models of price-setting. It further cements Emi and Jón's reputations as preeminent experts on price dynamics and the empirical evidence for models of price-setting, as already indicated by their 2013 review article on the topic: "Price Rigidity: Microeconomic Evidence and Macroeconomic Implications" [12].

Emi and Jón have also made theoretical contributions to models of price-setting. As mentioned earlier, an important pattern that they observe about the micro price data is that many goods tend to have a "regular" price that changes infrequently, while various "sale" prices are also charged at times between occasions on which the "regular" price changes. In "Price Setting in Forward-Looking Customer Markets" [9], Emi and Jón offer a theoretical explanation for such a dynamic pattern of prices in the context of a dynamic model of price setting in the context of a "deep habits" model (Ravn, Schmitt-Grohé, and Uribe 2006). In this approach, the demand for goods that a firm faces depends not only on the current price the firm charges but also on past sales (because households have habit-forming preferences) and on expected future prices of the good (because households know they have habit-forming preferences and worry about becoming accustomed to consuming a good with high future prices). In this setting, firms have an incentive to use time-inconsistent pricing policies: that is, they want to promise low prices in the future to attract customers today, but once consumers have developed a habit of consuming this good, firms have an incentive to break their promises and start charging high prices.

Characterizing time-consistent pricing strategies in this environment is challenging, and Emi and Jón compare several possibilities in [9]. In several of these approaches, a situation arises of time-consistent price dynamics in which regular prices will appear to be nonresponsive to variations in the exogenous state and in which sales prices will involve varying discounts and hence can be interpreted as responding to the exogenous state of the economy. In one such approach, a firm's prices can be contingent on its past prices, using an equilibrium concept similar to the one that Chari and Kehoe (1990) refer to as "sustainable plans." In this case, Emi and Jón show that there exist time-consistent equilibria in which the price is unresponsive to the values of exogenous shocks in (for example) all even periods, while it is responsive to shocks in all odd periods.

Another interesting finding in this paper [9] arises when the firm has private information about marginal costs and the strength of demand. For this environment, Emi and Jón apply theoretical results from the work of Athey, Bagwell, and Sanchirico (2004) to show that the sustainable price that maximizes the value of the firm has the feature that there is a maximum price cap that the firm does not exceed, even if the exogenous state variables exceed a certain threshold. Again, price data from this economy would potentially be consistent with the pattern of a regular price that is visited frequently and with the observation of temporary sales with flexible prices. In an empirical analysis using the Dominick's Finer Foods database of supermarket prices, they find that the frequency of sale price adjustment is about eight times higher than the frequency of regular price adjustment, which they interpret as supporting the prediction of their theoretical model. This is an ambitious and highly creative paper on a challenging and important topic.

Models of Pass-Through of Costs to Prices

In work that bridges industrial organization, international trade, and macroeconomics, Emi has studied the pass-through of changes in costs to the prices that firms charge for their products.

One of Emi's first papers [1] studied the pass-through of foreign marginal cost shocks to the US ground coffee market. This was further developed in "Accounting for Incomplete Pass-Through" [6], with Dawit Zerom, which undertakes a structural econometric estimation of the sources of imperfect pass-through. The ground coffee industry provides a good laboratory for the study of pass-through of exogenous cost shocks for several reasons: green coffee beans represent at least 50 percent of costs of ground coffee manufacturers, green coffee beans are a fairly homogeneous input, and the world price of green coffee beans is subject to large weather shocks in the coffee-growing regions that can compellingly be treated as exogenous to US business cycle factors.

The paper presents a careful and skillful combination of data compilation and state-of-the-art econometrics, industrial organization theory, and computational methods. Emi and Dawit decompose imperfect pass-through into three potential sources: domestic cost components, desired markup adjustment, and nominal price adjustment costs. The paper finds that at the wholesale level, local costs reduce pass-through by 59 percent, mark-up adjustments reduce pass-through by 33 percent, and price adjustment costs have a negligible effect on pass-through after six quarters. Price adjustment costs, while of little importance in accounting for incompleteness of long-run pass-through, are found to be important in explaining the delayed pass-through in the short run. This paper, together with the Goldberg and Hellerstein (2013) study of the beer industry, represent the first attempts to incorporate price adjustment costs as a third determinant of incomplete cost pass-through in the context of structural estimation, and the results are consistent across the two studies.

The paper [6] also sheds some light on the different degree of cost pass-through at the wholesale and the retail levels. In particular, incomplete cost pass-through is shown to occur at the wholesale level; that is, changes in green coffee bean costs are incompletely passed through to wholesale ground coffee prices. By contrast, Emi and Dawit show that changes in wholesale ground coffee prices tend to be passed through to retail ground coffee prices fully and without much delay.

Emi also studies the differences between retail and wholesale pass-through in “Pass-Through in Retail and Wholesale” [3]. This time she works with a large panel dataset on weekly observations of prices for the year 2004 for a cross section of about 100 grocery items at the barcode level collected at 7,000 grocery stores operated by the largest supermarket chains in the United States. The dataset has close to 50 million price and quantity observations. She seems to have been the first to study this dataset in a macro context. An important aspect of Emi’s dataset is that it has price observations for the same good at the same time at different grocery chains, whereas most of the related literature used data from a single grocery chain (the Dominick’s Finer Foods data mentioned earlier).

Emi’s focus in [3] is not on the extent to which cost shocks are passed through from the wholesale level to the retail level, but rather, what are the sources of retail price variations and are they related to shocks at the wholesale level? It turns out that only 16 percent of price changes are common across stores selling an identical item, which implies that only a small fraction of retail price variation is due to common cost shocks. Emi further finds that 65 percent of the price variation is common to stores within a particular retail chain, which suggests that the source of price fluctuations might be specific to shocks that the retail chain faces.

Emi’s most recent contribution to the analysis of pass-through from costs to prices is “Informational Rigidities and the Stickiness of Temporary Sales” [17], with Eric Anderson, Benjamin Malin, Duncan Simester, and Jón Steinsson. This paper asks whether aggregate cost shocks are transmitted to retail prices via regular prices or sales. Although 95 percent of movements in prices are changes in sales prices, the paper provides evidence that aggregate cost shocks are mostly transmitted via changes in base prices. The empirical analysis is based on 195 weeks of scanner price data from 102 stores at a larger retailer that sells products in the grocery, health and beauty, and general merchandise categories. The central finding is that in a substantial fraction of cases, when the base wholesale price increases (that is, a cost shock for the retailer), the regular retail price responds quickly and completely while sales experience no reductions either in frequency or in size. On the contrary, discounts temporarily increase when regular retail prices increase, which the authors interpret as attempts to mask the associated regular price increase. The paper performs a number of robustness checks, including documenting that base retail prices respond more consistently than sales to changes in commodity price and to changes in unemployment, and by documenting that sales have a small contribution to overall inflation relative to base-price changes. This paper should change many views on the role of sales in the transmission of aggregate shocks.

Empirical Studies of Fiscal Stimulus

Establishing the size of the government spending multiplier is a fundamental question in macroeconomics, but despite a very large body of work, the answer remains controversial. Existing estimates on the fiscal multiplier are quite dispersed. Some studies suggest that the fiscal multiplier is close to zero, while others find that it is as large as two.

One difficulty in estimating the fiscal multiplier is to find truly exogenous changes in government spending. For example, military purchases are one plausible candidate for exogenous variations in government spending, but as Barro and Redlick (2011) note, there is likely to be insufficient variation in national-level US military spending in the last 50 years for a persuasive empirical test. Another problem with previous studies of the fiscal multiplier is that the output effects of government spending should depend on the nature of the monetary policy reaction. For example, if a study does not take into account how positive output effects can be reduced by the typical monetary response, the estimated size of the fiscal multiplier could be biased downward.

In “Fiscal Stimulus in a Monetary Union: Evidence from U.S. Regions” [13], Emi and Jón bring a fresh identification approach and new data to this long-standing debate. They sidestep the problem of insufficient national-level variation in military spending by showing that there has been sizable variation in regional military spending and those regional variations can thus be used to estimate the government spending multiplier. In addition, because the monetary policy reaction is common to all states, it is not a factor in explaining the differential effects on output across states. A further complication in estimating government spending multipliers is that their size depends on how government spending changes are financed. An advantage of Emi and Jón’s empirical strategy in [13] is that regional military spending is financed by federal taxation and thus regions that receive a large chunk of military spending will not have associated tax payment structures that are different from regions that do not receive military spending.

For all of these reasons, considering variations in regional military spending and relating it to regional output variations should provide a more reliable estimate of the government spending multiplier than previous studies. In [13], Emi and Jón find that an increase in government spending equal to 1 percent of GDP increases output by 1.5 percent; that is, the government-spending multiplier measured in this way is 1.5.

However, this influential paper offers more than an instrument for measuring the “multiplier” effect of government purchases. As the authors point out, the multiplier for the effect of relatively higher purchases in one state on relative economic activity in that state need not be the same as the multiplier effect on national GDP of a nationwide increase in government purchases. The reason is that spillovers are likely to occur between states of the effects of increased purchases in any given state.

Emi and Jón [13] address the likely magnitude of the difference between the two multipliers by developing and analyzing a quantitative multi-region New

Keynesian general-equilibrium model. They use the paper to ask what the national multiplier would be in the case of a model parameterization that can account for their estimated relative state-level effects. The paper provides an excellent example of work that combines nonstructural empirical work with careful model-based analysis of what can be learned from the estimates.

The Effects of Monetary Policy

A key question in recent monetary policy debates is the extent to which central bank commitments about future policy, perhaps years into the future, can influence financial conditions and stimulate aggregate demand. The Federal Reserve and other central banks have been experimenting with “forward guidance” of this kind since the Great Recession.

Indeed, there is a “forward guidance puzzle” in which economic theory suggests that such guidance should be far more powerful than it actually seems to be. Specifically, some New Keynesian dynamic stochastic general equilibrium models find that a credible forward guidance commitment to maintain a fixed low nominal interest rate several years into the future will create a degree of output stimulus and/or inflation immediately that is difficult to regard as a realistic prediction. Of course, one possible resolution of the puzzle is that actual experience with forward guidance has not in fact involved credibly long-dated and such unconditional commitments, which is why actual forward guidance has had much more modest effects.

In their paper “The Power of Forward Guidance Revisited” [15], Emi and Jón, with Alisdair McKay, argue that this unrealistic implication of the simple New Keynesian models implying implausibly strong effects of forward guidance results from their assumption that each agent has a single intertemporal budget constraint. In turn, this assumption is the result of an underlying assumption (for modeling convenience) of complete financial markets and no borrowing constraints. They instead analyze the effects of a long-horizon commitment to a fixed nominal interest rate in a model that instead allows for the existence of uninsurable income risk and borrowing constraints. They find that while the effects of expectations about monetary policy at shorter horizons are similar to those predicted by the simpler model, the predicted effects of a long-lasting commitment to a fixed nominal interest rate are much weaker. Essentially, in the case of a household with a significant probability of facing a binding borrowing constraint over the next several quarters, expectations about monetary policy farther in the future do not affect its current ability to spend. In this way, the expectation of borrowing constraints substantially reduces the predicted effects on forward guidance—though it hardly implies that this policy tool is therefore irrelevant.

The paper [15] is important both as a contribution to a policy debate and as a methodological contribution on the use of New Keynesian models to assess alternative monetary policies. Its essential conclusion, that the effects of forward guidance are muted in more complex (and realistic) New Keynesian models, has

been supported by a number of subsequent analyses by other authors that consider generalizations of the basic model. The paper has also stimulated an active recent literature on “heterogeneous-agent New Keynesian models,” which explores the implications for other aspects of macroeconomic dynamics of introducing income heterogeneity and borrowing constraints.

Another core question in macroeconomics is the effort to measure the effects of monetary policy shocks on the economy. One reason why answers to the question have remained controversial is because of the difficulty in distinguishing between exogenous changes in monetary policy and responses by the central bank to changes in economic conditions that have other sources. A recent strand of the literature looks at changes in financial market prices in a narrow time window around central bank policy announcements, based on the theory that these financial market movements can reveal how (or whether) the monetary policy announcement market movements indicate a change in the beliefs of market participants. In this approach, the size and direction of financial market movements can be taken as a measure of the monetary policy “shock” that has been revealed by the announcement. Regression of other variables on the time series of “shocks” identified in this way can then be taken to provide a measure of the causal effects of such shocks, as in Cook and Hahn (1989), Kuttner (2001), and Cochrane and Piazzesi (2002).

In “High Frequency Identification of Monetary Non-Neutrality: The Information Effect” [19], Emi and Jón note that this “high-frequency identification” strategy is subject to an important qualification, even if one grants that market movements during the short time window can only reflect information gleaned from the policy announcement. The issue is that new information from a central bank announcement might be of two types: a revelation that central bank policy will be different than would ordinarily be expected, given economic conditions; or alternatively, a revelation that the central bank’s view of current economic conditions is different than the public expected. News of the former kind would correspond to a policy “shock.” But to the extent that the central bank’s unexpected view of the situation would be taken to reveal the central bank’s superior information about economic conditions, such news should change people’s own understanding of those conditions as well, and hence change the way they trade in financial markets for reasons unrelated to the implications for monetary policy.

Emi and Jón ask whether it is possible to separate “information effects” of monetary policy announcements of this latter sort from the effects of news about monetary policy. They study nominal interest rate changes observed in a 30-minute window around 106 scheduled Federal Reserve announcements between January 2000 and March 2014. In [19], they propose an estimate of the effects of monetary policy shocks taking into account the presence of information effects and to build and estimate a theoretical model that can explain the observed effects of Fed announcements.

The paper [19] first documents that Fed announcements shift short-term nominal and real rates almost one-for-one; that is, if the announcement results in a ten-basis-point increase in nominal short rates, then it also causes a ten-basis-point

increase in real short rates. This effect on real rates is observed not only for short-term rates, but also for longer term ones. Further, and also consistent with the related empirical literature, the paper documents that Fed announcements have little effect on expected inflation and that announcements that lead to an increase in nominal rates tend to be associated with increased expectations of future output growth. The latter empirical regularity is not easily reconciled with interpreting the news in Fed announcements as pure monetary policy shocks, since in canonical monetary models such shocks should lead to a downward revision of future output growth.

This interpretation problem motivates their development of a model in which Federal Reserve announcements can have both an information effect and a pure monetary policy shock, accompanied by estimation of the size of each component. Using the proposed model, they find that about two-thirds of the announcement shock represents news about future economic fundamentals and hence only one-third represents a pure monetary policy shock. They also find that, despite the great importance of the information effect, the observed responses to Fed announcements are consistent with a high degree of monetary non-neutrality in the US economy. These important results about fundamental questions in monetary economics are relevant not only for policy design but for understanding of the kinds of models that can best account for the nature of business fluctuations more generally.

Empirical Studies of Asset Pricing

One of the largest literatures for any question in economics is the search for an explanation for the equity premium puzzle, which refers to the large differential over time between the average return on US equities and the average return to short-term Treasury securities. In the early 1980s, Grossman and Shiller (1981) and Mehra and Prescott (1985) noted that the risk of holding stocks for a representative household should not be quantitatively significant because the covariance between consumption growth and equity returns in the post-World War II US economy was very low—in great part because the volatility of aggregate consumption growth is itself quite low. As a result, a standard asset pricing model would then imply that the compensation in return for holding equity rather than bonds should also be small.

Many theories have been proposed to explain the equity premium puzzle, and two recent candidate explanations have attracted particular attention. The first, most fully developed by Barro (2006), argues that the post-World War II sample underestimates the volatility of consumption because it does not include an example of the rare, large disasters that lead to large falls in consumption. The other, put forward by Bansal and Yaron (2004), argues that there are persistent shocks to both the long-run mean growth rate of consumption and the variance of its innovations, which short samples miss. Both stories are plausible, and large follow-up literatures have shown that, if their premises are true, they can explain the equity premium together with other related asset-pricing puzzles.

Barro and Ursúa (2010) have put together a remarkable dataset with annual consumption for 24 countries and more than 100 years. Emi and various coauthors have used these data to test the premises behind the two leading explanations of the equity premium.

In “Crises and Recoveries in an Empirical Model of Consumption Disasters” [11], Emi and Jón, together with Barro and Ursúa, assess the extent to which rare disasters can account for the equity premium. They make two main changes from previous work. First, previous work had assumed that disasters unfold quickly and lead to a permanent fall in consumption. However, here the authors find that in the disasters in their sample, the trough occurred only six years after the disaster hit, and that more than half of the initial reduction in consumption was eventually reversed. Second, the authors assume Epstein-Zin preferences with an intertemporal elasticity of substitution of two, which suggests that people have a strong preference for early resolution of uncertainty, and so are very averse to extended disasters and their uncertain recoveries. Given these assumptions, along with a modest degree of risk aversion, the rare disasters of the type that have been historically observed would suffice to explain the equity premium.

In another paper on this topic, “Growth-Rate and Uncertainty Shocks in Consumption: Cross-Country Evidence” [16], Emi and Jón, with Dmitriy Sergeyev, use a subset of the same long panel of data on consumption to reassess the long-run risks model of Bansal and Yaron (2004). They allow for shocks to both the country-specific growth rate of consumption and also a world growth factor and their respective variances. They find that filtered estimates of the world growth rate track many of the medium-term fluctuations in macroeconomic variables that have been identified so far: the post-World War II productivity speed up, the slowdown in productivity after 1970, the Great Moderation from the 1980s to the 2000s, and the more recent increase in volatility. Again using Epstein-Zin preferences, Emi and her coauthors show that with a coefficient of intertemporal elasticity of 1.5 and a risk aversion coefficient of 6.5, the model can fit the average equity premium. These results provide validation for the long-run risks model, which had previously been untested in its key premise.

These papers illustrate Emi’s ability to go after big questions in the literature, to perceive testable implications in the theory, to bring different data to bear than had been previously used, and ultimately to provide more convincing answers. It is unlikely that these papers will be the last word on this important and controversial topic; for example, the methods used to filter world and country-specific growth rates can be sensitive to underlying assumptions. Still, the methodology in these papers represents an important advance over previous work.

Conclusion

The examples of Emi’s work described above are not exhaustive, but should suffice to illustrate some of her characteristic concerns. All of her work has been

driven not simply by a belief that careful measurement matters, but by close attention to subtle issues regarding the inferences that can legitimately be drawn from the available measurements.

Emi and Jón's views about the appropriate methodology for empirical work are most clearly enunciated in their paper on "Identification in Macroeconomics" [18] in the Summer 2018 issue of this journal. Here, they discuss why it has been so difficult to settle questions about the effects of monetary and fiscal policies and also to stress the limitations of two seemingly straightforward approaches. "Direct causal inference" seeks to find examples of exogenous changes in policy in the historical record and measure what happened. But as Emi and Jón point out, truly exogenous policy changes are relatively scarce, and those that can be observed seldom involve the kind of change that is relevant for policy development, raising questions of external validity from the available "natural experiments."

Accordingly, an influential alternative approach argues that one can only hope to answer questions about counterfactual policies using a fully specified structural model of the macro-economy. Many researchers in the real business cycle tradition further propose that the quantitative realism of such models should be validated by comparing the predicted values of various unconditional moments (the overall variability of aggregate investment spending relative to the overall variability of real GDP, and so on) to the empirical values of these moments. The advantage of a focus on matching the values of unconditional moments is that these quantitative targets can be defined in a way that is independent of any particular theoretical structure. But as Emi and Jón note, this approach has the disadvantage that predictions for the statistics in question depend on the simultaneous specification of a large number of aspects of a macro model. One can only judge the model as a complete whole to be successful or unsuccessful in matching reality.

Emi and Jón argue instead for the desirability of focusing on the measurement of what they call "identified moments," by which they mean estimates of the effects of particular types of identified disturbances. This approach differs from "direct causal inference" insofar as it admits that the responses that can be measured will not generally provide a direct answer to the questions about counterfactual policies that one actually wishes to answer; instead, one measures responses to disturbances that can be identified using assumptions that are as credible as possible and then uses the answers to these questions to discipline the parameterization of the structural models that will be used to answer the questions of real interest. At the same time, this approach differs from unconditional matching of statistical moments in that the quantitative targets that the structural model is required to match are selected so that they allow diagnosis of the quantitative realism of certain parts of the model, rather than depending equally on all aspects of the model specification. The paper provides a powerful case for the fruitfulness of this alternative approach, and shows how it has guided Emi and Jón's own work on the effects of monetary and fiscal policy, discussed above.

Emi's methodological approach to research is a signature contribution, as the many examples discussed in this paper should help to convey. She has demonstrated

that macro models have rich implications for the underlying dynamics of the economy. She has focused on testing these fine aspects of the empirical record as the most reliable way of determining which models best describe the world and hence can best be relied upon as guides to policy. She has shown extraordinary ingenuity in connecting micro data to macro models and has taken painstaking care in developing new data when needed. But despite Emi's frequent emphasis on the importance of careful scrutiny of fine-grained data, her work never loses sight of the big questions about the nature of economic fluctuations and the effects of policy that macroeconomic models are intended to answer. This combination of care in precisely defining what one really can measure while marshaling all possible evidence to answer questions of first-order importance is what has made her work so highly influential.

Some of the qualities that have made Emi's work influential arose early and naturally from her curiosity about metrics and her commitment to measurement. But these qualities could have been just as easily applied to small questions. Emi's research has been *transformative* because it has demonstrated that these qualities are also applicable to big, "messy" questions in macroeconomics, where the available data often seemed to be limited, and before her work, it was not obvious how to address these questions with more granular data. Emi's work shows how to reach the big questions, building from models and data that look at them "up close" so that we can see them clearly.

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