Discussion of Guren, McKay, Nakamura, Steinsson: What Do We Learn From Regional Empirical Estimates in Macroeconomics

Gabriel Chodorow-Reich*
Harvard University

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*Contact: chodorowreich@fas.harvard.edu.

In this paper, Guren, McKay, Nakamura, and Steinsson (hereafter GMNS) advocate using regional cross-sectional empirical estimates to measure microeconomic parameters such as the marginal propensity to consume out of housing wealth. The "divide-by-the multiplier" method recovers the microeconomic parameter by dividing the regional response to a shock by a "demand multiplier" estimated separately as the regional response to a government spending shock. This method has many potential applications in regional data. (Full disclosure: in Chodorow-Reich, Nenov, and Simsek (2019) I use it to measure the stock market wealth effect on consumption.) GMNS provide a comprehensive yet accessible theoretical exposition and a numerical evaluation in the context of a model of housing wealth.

I will divide my comments into four parts. The first part provides background on literatures using regional data in macroeconomics and on demand multipliers. Second, GMNS apply the method to a shock to preferences for housing. This choice introduces complications because housing is both part of wealth and an expenditure item and both construction and consumer spending may respond to changes in house prices. I illustrate the relationship using a simpler yet still fully microfounded model with pure wealth shocks. Third, I use this model to make my main critique of the paper, or, more accurately, of the paper's title. A casual reader might infer that divide-by-multiplier provides the *only* valid way to interpret regional empirical estimates. My simple model illustrates an additional property of regional effects of demand shocks, namely that they provide a lower bound for the appropriately-defined aggregate effect of the shock. I conclude by reviewing other recent approaches to interpreting regional regressions and their applicability to different sources of regional variation.

Comment I: Context. Researchers have come up with many creative approaches to measuring shocks at the regional level, for example variation in the location of government spending or in sensitivity to the aggregate housing cycle that is orthogonal to other local variables. Chodorow-Reich (2020) counts 50 articles published in top field or general interest journals between 2012 and 2018 using regional data to address macroeconomic questions. This explosion reflects the rich variation across subnational regions and the availability of long regional time series. The question in GMNS is what structural parameters or causal effects these regional shocks can help to identify.

To understand the appeal of the divide-by-the-multiplier method, it helps first to state the problem with the usual interpretation of cross-sectional regressions. The Rubin (1978) potential outcomes model provides the canonical framework for interpreting cross-sectional regressions in applied microeconomics. In this model, unit i receives treatment W and has a potential outcomes function $Y_i(W)$ that relates the outcome to the treatment. Identifying a causal effect requires "as good as random" assignment of the treatment (conditional on covariates) with respect to the potential outcomes function, expressed in the examples in the preceding paragraph as the orthogonality of regional treatment to other local variables. Furthermore, in applied microeconomic settings researchers typically assume the potential outcome of unit i is independent of the treatment applied to all units $j \neq i$, known as the Stable Unit Treatment Value Assumption, or SUTVA. Under these conditions, a cross-sectional regression consistently identifies the Average Treatment Effect (ATE) of changing from treatment W to W', defined as the population expectation $E\left[\left(Y_i(W') - Y_i(W)\right) / \left(W' - W\right)\right]$.

The problem is that SUTVA almost certainly fails in a regional context. For example, a positive spending shock in region i causes output in region j to increase because some of the spending of people in i naturally falls on goods produced in j and prices in i rise relative to prices in j, leading to expenditure switching. This failure does *not* necessarily invalidate the ATE interpretation; if the impact on each j of a shock to i is sufficiently small, a cross-sectional regional regression can still consistently identify the average effect of the shock to i on region i. However, macroeconomists typically want to know the impact of a shock on all regions, which requires *summing* over the spillovers to each other region j. Even if the SUTVA violation to each individual region is *de minimus*, the sum of many small spillovers can drive a quantitatively important wedge between the treatment effect on i that is identified from the cross-sectional regression and the effect on the total economy.[1]

GMNS propose to circumvent this difficulty by instead using demand multipliers to relate regional estimands to microeconomic objects. By demand multiplier, I mean the proposition that the same general equilibrium multiplier applies to different components of demand. This idea goes back at least to the Keynesian cross, which is a market clearing condition where consumption depends on income. Formally, one substitutes into the (for simplicity, closed economy) market clearing condition $Y = C + I + G$ the consumption function $C = C_y(Y - T) + C_x X$ relating consumption C to disposable income $Y - T$ via the marginal propensity to consume out of income C_y and to any other determinant of consumption such as housing wealth X via the marginal propensity to consume out of that determinant C_x. Then the government purchases multiplier is $dY/dG = 1/(1 - C_y)$, while for any other determinant of consumption such as housing wealth, the output multiplier dY/dX is the direct propensity to consume out of that component, C_x, multiplied by the demand multiplier

[1]See Chodorow-Reich (2020) for further discussion of the potential outcomes framework as applied to regional data.

dY/dG: $dY/dX = C_x dY/dG$.[2]

Government and professional forecasters have long made use of demand multipliers. For example, the Congressional Budget Office (CBO) describes their procedure for estimating the output effects of different policies as follows (Reichling and Whalen, 2012):

> Direct effects consist of changes in purchases of goods and services by federal agencies and by the people and organizations who are recipients of federal payments or payers of federal taxes. The size of the direct effects of a change in policies depends on the behavior of those recipients and payers. The indirect effects can be summarized by a demand multiplier. CBO's analysis applies the same demand multiplier to any $1 of direct effect from a change in fiscal policies. The product of a direct effect and a demand multiplier is sometimes referred to as an output multiplier. A change in federal purchases has a direct effect of 1, so the output multiplier for federal purchases equals the demand multiplier; most other changes in fiscal policies have direct effects that are less than 1 (because recipients of benefits and payers of taxes tend to adjust their spending less than one-for-one with changes in their income).

Thus, for example, CBO would estimate the output effects of tax rebates to individuals by multiplying their estimate of the direct marginal propensity to consume out of tax rebates, the direct effect, by their estimate of the government purchases multiplier.

Academic economists have historically made less use of demand multipliers, perhaps reflecting a discomfort with the absence of proper microfoundations or dynamic considerations in the traditional Keynesian cross. Auclert, Rognlie, and Straub (2018) broke through this barrier by deriving an intertemporal version of the Keynesian cross, with the scalar C_y replaced by a matrix with the response of consumption in period s to income in period t. GMNS (and their companion paper (Guren et al., 2020)) extend the demand multiplier structure to the regional level and, crucially, recognize that it can be used *in reverse* to go from regional effects to the direct, microeconomic effect. By changing the object of interest from the national effect of a shock to the microeconomic effect, this approach sidesteps the cross-region SUTVA violation.

Two additional aspects merit amplification. First, the method has power only if regional fiscal multipliers are strongly identified. While no single study may be perfect, Chodorow-Reich (2019) reviews the recent proliferation of empirical estimates of the output effects of

[2] This exposition assumes that investment I does not depend on income, but the formulas extend straightforwardly to that case.

the federal government spending more in one region than another and finds support for a multiplier in the neighborhood of 1.8, close to the value of 1.5 used in GMNS. Furthermore, the theoretically-correct regional fiscal multiplier should *not* be adjusted for the fact that federal spending in a local region does not raise the relative tax burden in that region, making the empirical multipliers the proper analog for the regional demand multiplier. Second, as stressed in GMNS as well as in contemporaneous work by Wolf (2019), the dynamic considerations require a fiscal multiplier based on the same persistence of government spending as the direct spending effects of the shock. The numerical results in GMNS based on a dynamic, microfounded model provide some assurance that the static adjustment gets the magnitude roughly correct. Of course, whether acknowledging a reasonable range of uncertainty over the magnitude of the demand multiplier or the bias of the static multiplier still allows for meaningful conclusions about microeconomic effects will depend on the application.

Comment II: Demand multiplier in a simpler model. The application to housing wealth in GMNS complicates their analysis because housing is both part of wealth and an expenditure item and both construction and consumer spending respond to changes in house prices. I now describe a simpler yet still microfounded model of wealth effects on consumption and derive an exact version of the regional divide-by-demand-multiplier result. I then use this model to illustrate another use of regional data in macroeconomics, which I will call the lower bound result.

The environment is a simplified version of the model in Chodorow-Reich, Nenov, and Simsek (2019). I describe the key equations and direct the reader to that paper for additional details. A continuum of areas indexed by a produce a tradable and nontradable good each period with technologies $Y_{a,t}^T = L_{a,t}^T, Y_{a,t}^N = L_{a,t}^N$. A national retailer aggregates the tradable output into a final good Y_t^T using the technology $\ln Y_t^T = \int_a \ln Y_{a,t}^T da$. A representative agent in each area has preferences across the tradable and nontradable goods of $C_{a,t} = (C_{a,t}^N)^{1-\phi}(C_{a,t}^T)^{\phi}$ and maximizes intertemporal utility $\sum_{t=0}^{\infty} 1/(1+\tilde{\rho}) \ln C_{a,t}$. At time 0, each area a experiences an unexpected change in wealth of $\Delta_a = \bar{\Delta} + \tilde{\Delta}_a$, where $\int_a \tilde{\Delta}_a da = 0$. This wealth increase stems from the sudden blooming of a Lucas tree, which starting in period 1 will produce fruit that is a perfect substitute for the composite tradable good Y_t^T. Thus, the only shock at time 0 is to wealth.

The effect on period 0 log nominal expenditure illustrates the demand multiplier:

$$d\left(p_{a,0} + c_{a,0}\right) = \frac{dP_{a,0}C_{a,0}}{P_{-1}C_{-1}} = \frac{\mathcal{M}_a \rho \Delta_a}{P_{-1}C_{-1}}, \tag{1}$$

where $z_{a,0} = dZ_{a,0}/Z_{a,-1}$ denotes the log deviation of a variable z from the pre-shock value, $P_{a,t}$ the ideal consumption price index, and $\rho = \tilde{\rho}/(1+\tilde{\rho})$. Wealth goes up by Δ_a, which, with log preferences, causes a direct, household-level increase in expenditure of $\rho\Delta_a$. This increase gets multiplied by the demand multiplier $\mathcal{M}_a$, given by $\mathcal{M}_a = 1/[1-(1-\phi)\rho]$. This demand multiplier coincides exactly with the open-economy (nominal) government spending multiplier.

Comment III: Lower bound result. Aggregating over all local areas yields the aggregate response to the wealth shock when interest rates do not change:

$$d\left(w_0 + \ell_0\right) = d\left(p_0 + c_0\right) = \frac{\mathcal{M}\rho\bar{\Delta}}{P_{-1}C_{-1}}, \tag{2}$$

where $\mathcal{M} = 1/(1-\rho)$. The aggregate economy is closed, so the change in nominal output equals the change in expenditure. This expression also takes the form of a direct consumption response multiplied by a demand multiplier, where now the multiplier is the closed economy multiplier $\mathcal{M}$.

Comparing equation (2) to the response of local output to the shock yields the lower bound result. The response of local output, equal to the response of local labor income $W_{a,t}L_{a,t}$ (because there is a single factor of production), is:

$$d\left(w_{a,0} + \ell_{a,0}\right) = (1-\phi)\, d\left(p_{a,0} + c_{a,0}\right) = \frac{\mathcal{M}_a(1-\phi)\rho\Delta_a}{P_{-1}C_{-1}}. \tag{3}$$

The aggregate output response $d\left(w_0 + \ell_0\right)$ in equation (2) exceeds the local output response $d\left(w_{a,0} + \ell_{a,0}\right)$ in equation (3) for two reasons. First, local output responds only to the part of the increase in local demand that falls on nontradable goods. As a result, the local output response is a fraction $(1-\phi)$ of the local expenditure response. In the aggregate closed economy, everything is nontradable, so the aggregate response also includes the increase in production of tradable goods. Second, $\mathcal{M}_a < \mathcal{M}$ — the local demand multiplier is smaller than the closed economy demand multiplier, precisely because of trade leakages at the local level to other areas.

This lower bound result for output turns out to hold across many economic environments, under certain conditions. First, the result applies to demand shocks. Second, it requires making a proper comparison to the closed economy case; the comparison should hold fixed endogenous responses to the shock such as monetary policy that do not vary across regions. While this condition sounds restrictive, in practice we often want to know the aggregate impact of a shock holding as much else constant as possible. Third, the result depends on factors of production not moving across local areas, insofar as these factors, such as population, are fixed nationally. Finally, it applies to output, not necessarily to absorption. Under these conditions, regional analysis directly informs about the aggregate effect of a demand shock by providing a lower bound.

Just as divide-by-multiplier will perform better in some settings than others, these conditions show that the lower bound result is not universal. Indeed, it does not necessarily hold in the structural model in GMNS. It is informative to understand why. The primitive shock in their environment is not a pure wealth shock that raises demand, but rather a shock to the demand for housing relative to the consumption good, which increases the relative price of housing. In the version of their model without produced construction, and under Cobb-Douglas aggregation of the housing and consumption contributions to utility and log preferences across time, the increase in demand for housing has no effect on either utility from consumption or the economy-wide resources to produce the consumption good. Therefore, the aggregate response of output is zero in this case.[3]

Conclusion. Divide-by-multiplier is a useful method with many potential applications. GMNS exposit the method in both a simple, static and a fully specified, microfounded, dynamic setting and show that the simple version can work pretty well as an approximation.

I do not however view this method as offering the only Kosher use of regional data in macroeconomics. I gave an example where regional estimates provide a lower bound for an aggregate response of interest. I will briefly mention two other recent approaches. Beraja, Hurst, and Ospina (2019) show how the response of regional wage inflation to regional employment can identify microeconomic wage rigidity parameters if labor markets do not spill across regions. Huber (2018), Berg and Streitz (2019), and Egger et al. (2019) use research designs with multiple levels of randomization to estimate directly a part of the spillovers to other units, an approach that offers the possibility of more tightly characterizing the aggregate response at the cost of greater demands on the cross-regional variation. Each of these methods has virtues and limitations. It is a promising development that macroeconomists now have many tools to incorporate regional data. Context should dictate the tool used in a particular application.

[3] I follow GMNS here in defining aggregate output as the sum of the consumption good and government purchases. National income accountants would also include in output and consumption the rental value of owner-occupied housing. Valuing the change in the rental value in the presence of preference shocks poses further complications.

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