Where Does Fiscal Stimulus Create Jobs?

Evidence from U.S. Counties

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Abstract

I study how the allocation of national stimulus across US counties affects aggregate job creation. Using county-level variation in American Recovery and Reinvestment Act (2009–2012) outlays, I find that local employment responses to government spending are largest in mid-sized counties (about 100,000 residents) and substantially smaller in both small and large counties (about 10,000 and 1 million residents). Evidence on local production structure, purchasing patterns, and hiring points to two opposing forces. While small counties leak most of the demand they receive to other places, large counties turn the demand they retain into fewer jobs, consistent with greater worker bargaining power and higher recruiting costs. Mid-sized counties balance the two. I interpret and rationalize these patterns using a multi-region New Keynesian model in which locations are linked through trade, and labor markets feature search and matching frictions. I reallocate funds from large to mid-sized counties until large counties receive the same funding per adult as small counties. This reallocation would have created about 91,400 additional job-years without increasing total spending. At the baseline cost per job-year, this gain is equivalent to about $4.4 billion in additional stimulus spending. The spatial allocation of stimulus is thus an important dimension of stabilization policy distinct from the size of the program.

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1 Introduction

The federal government often responds to a sharp and persistent rise in the national unemployment rate with aggressive fiscal measures. These typically combine large discretionary increases in government purchases, tax cuts, and extensions of unemployment insurance. Of these three, tax cuts and unemployment insurance extensions have an implicit spatial allocation rule: established tax schedules and eligibility formulas provide a mapping between the distribution of benefits across counties and the geographic distribution of eligible recipients (Crucini and Vu, 2021). Government purchases, on the other hand, have no comparable rule. Though every purchase must ultimately take place in some state, city, or county, it lacks a defined spatial fiscal policy function that governs where spending lands.

When a stimulus program explicitly aims to support employment, where the funds are spent may matter as much as how much is spent. A natural benchmark allocates funds by population alone, assigning the same amount per resident in every location. Yet local economies vary systematically with their size. A long literature has shown that larger markets feature more productive firms (Combes et al., 2012), a broader range of suppliers, and better matches between workers and firms (Duranton and Puga, 2004; Davis and Dingel, 2020; Dauth et al., 2022). These advantages may allow firms in larger markets to turn government spending into jobs more readily. As workers spend their additional earnings, they raise demand in other local sectors (Moretti, 2010), where the same advantages may help firms expand and hire in turn.

In this paper, I first test whether the productive advantages of larger markets indeed translate into more effective stimulus. Using county-level variation in American Recovery and Reinvestment Act (2009–2012) outlays, I find that the local employment response is hump-shaped in county size: it is largest in *mid-sized counties* with about 100,000 residents and substantially muted in small and large counties with about 10,000 and 1 million residents.

This pattern is consistent with two opposing forces that grow with county size. Larger counties, with more local suppliers and residents who make a larger share of their purchases locally, have greater scope to retain demand. But their more skilled workforce and greater competition among employers can make workers more costly to recruit and employ. The balance between demand retention and hiring costs can produce a response that peaks in mid-sized counties. Evidence on production structure, purchasing patterns, and hiring supports this interpretation.

I embed both forces in a multi-region New Keynesian model: locations are linked through trade, allowing for spillovers across regions, and labor markets feature search and matching frictions. I use the model to assess the program's national impact and evaluate counterfactual spatial reallocations of the same budget. In the model, the ARRA raised employment by 4.3 million job-years over

2009–2012 at a cost of $48,700 per job-year. Reducing spending per adult in large counties to the level in small counties and allocating the difference to mid-sized counties would have added about 91,400 job-years. This gain is equivalent to about $4.4 billion of additional spending at the baseline cost per job-year.

Setting and empirical strategy. The ARRA provides a setting in which the geographic allocation of federal spending can be measured at a granular level. In February 2009, as the Great Recession deepened, Congress passed the ARRA at an estimated cost of $787 billion. The act bundled together tax cuts, transfers to households and states, and federal spending on projects (Congressional Budget Office, 2015). I focus on the grants and contracts, which accounted for roughly $208 billion in my sample. Recipients of these funds filed quarterly reports, beginning with the quarter ending September 2009, that recorded the award, the amount received, and the place of performance, which allow government spending to be measured at the county level (Crucini and Vu, 2021; Dupor et al., 2023).

ARRA funds may have been directed to areas that were hit the hardest by the recession, correlating spending with unobserved local conditions that affect employment outcomes. To address this endogeneity, I instrument for ARRA funding using components of the Act that were "allocated using criteria orthogonal" to the state of the local business cycle (Dupor et al., 2023). I further control for other variables that could be plausibly correlated with my instrument and short-run county employment dynamics.

I estimate how the local employment response varies with county size in two ways. First, I approximate the relationship with a restricted cubic spline in population, allowing the response to vary smoothly with size. Second, to keep the quantitative model tractable, I group counties coarsely: I rank them by population and divide them into three groups, small, mid-sized, and large, containing about 10, 40, and 50 percent of the sample population, and estimate a separate response for counties within each group. Mean population is about 16,000 in small counties, 115,000 in mid-sized counties, and 1 million in large counties. These groups form the three region types in the quantitative model. The grouped estimates provide the local employment response for each type.

The spline estimates peak near 100,000 residents, where a 10 percent increase in spending per adult raises the cumulative employment-to-population ratio over 2009–2012 by 0.22 percentage-point-years. The grouped estimates follow the same ordering. A 10 percent increase in spending per adult raises the cumulative employment-to-population ratio by 0.18 percentage-point-years in mid-sized counties, compared with 0.06 in small counties and 0.04 in large counties, though the small- and large-county estimates are imprecise. The pooled response is 0.10. In terms of jobs, an additional $1 million creates about 20 local job-years over 2009–2012 in mid-sized counties,

compared with 9 in small counties, 4 in large counties, and 12 in the pooled sample.[1] Whether these local differences translate into aggregate gains from reallocating spending away from large counties to mid-sized counties is the question I ask with the model.

Local economic structure. How intensely a location responds to stimulus depends on how much of the spending it can absorb within its borders (Nakamura and Steinsson, 2014; Dupor et al., 2023). Large counties, which on average contain more than 800 six-digit industries compared with fewer than 200 in small counties (Figure 2), provide greater *scope* for spending to remain local. The difference is larger still in the sectors most likely to supply government purchases.

In card-spending data from Dunn and Gholizadeh (2023), the share of residents' spending at merchants in their own county rises from 60 percent in small counties to 72 percent in large ones (Figure 3). Thus more of the stimulus may stay local in large counties, which, other things equal, should produce a larger employment response.

More local demand, however, need not raise hiring proportionally. Hiring costs typically rise with occupational skill requirements, both in recruitment and in bringing new hires to full productivity (Blatter et al., 2012). Larger, mostly urban counties employ a more skill-intensive mix of workers and occupations (Davis and Dingel, 2020).[2] Hiring induced by stimulus draws on this county-wide mix, and filling the positions it creates may be more costly in large counties.

The local estimates leave two questions open: how much the ARRA raised national employment, and whether reallocating funds from large to mid-sized counties would have raised it further. Cross-sectional regressions compare counties with one another, differencing out effects common to all counties. These comparisons alone do not recover the full national response, which depends on the monetary policy response and on how spending in one county affects demand and employment elsewhere (Nakamura and Steinsson, 2014; Chodorow-Reich, 2019; Dupor et al., 2023). I use the model to account for these effects.

Model. In each region wholesale firms produce goods using labor. They post costly vacancies to find workers and bargain with them over wages, while households choose how many members look for work. Intermediate firms buy wholesale output and sell differentiated goods under Calvo pricing (Calvo, 1983). Final-good producers combine local and imported intermediate goods into a final good purchased by local households and the government. Home bias determines the weight they place on local inputs relative to imports. A federal government finances spending through

[1] I convert the estimated semi-elasticities into job-years using 2008 adult population and evaluate them at mean spending per adult, weighted by 2008 adult population, within each group or in the pooled sample.

[2] This difference holds even within industries, though it is concentrated in a few skill-intensive sectors (Elvery, 2010).

taxes on households across regions, and a common central bank sets the interest rate. The baseline includes aggregate shocks that keep the rate at its zero lower bound during the ARRA expansion. By tracking employed workers, the model expresses spending effects in job counts.

Each force maps onto a distinct set of parameters. Demand retention is parsimoniously captured by home bias, which summarizes how much of a county's spending falls on its own producers. Recruiting costs and workers' bargaining weight govern the cost of a hire and the wage.

I first assess whether the model, calibrated with standard parameters and targets from the New Keynesian and labor search literature, can closely match my empirical pooled estimate. The empirical regression compares counties that received more ARRA funding with those that received less. To replicate this comparison in the model, I use a two-region setup where region 1 is a single county and region 2 aggregates the remaining counties to represent the overall United States (Dupor et al., 2023). In each simulation, I repeatedly shock region 1 using observed ARRA spending paths while holding spending in region 2 fixed. I then run the corresponding regression on the simulated employment and spending series for region 1. A 10 percent increase in spending raises the cumulative employment-to-population ratio by 0.11 percentage-point-years in the model, close to my empirical estimate of 0.10.

Next, I repeat this exercise separately for each county type: small, mid-sized, and large. Greater supplier diversity and higher local purchasing shares suggest higher demand retention in larger counties, while their more skilled workforce and lower employer concentration point to higher hiring costs. I therefore restrict home bias, workers' bargaining weight, and recruiting costs to increase with county size. I search jointly over a grid of these parameters to best match the grouped estimates using each type's observed spending paths. The model response is largest in mid-sized counties (0.18) and smaller in small (0.06) and large (0.07) counties. Under these restrictions, the model slightly overstates the large-county response, which is 0.04 in the data.

National effects and reallocation. To move from these local responses to the national effect of the ARRA, I combine all counties in one general equilibrium model. To make the national model tractable, I group the roughly 3,000 counties into three regional blocks, one for each county type. The three-block economy reproduces the full model's equilibrium outcomes exactly (Proposition 1) provided the counties within a group share the same primitives and face identical shocks. Purchases between counties of the same type stay within the block, hence a block retains a larger share of spending than any county within it(4.20).

In the model, the observed allocation raised employment by 4.3 million job-years over 2009–2012, at a cost of about $48,700 per job-year.[3] One benchmark reduces spending per adult in large counties

[3] A job-year is one job held for one year.

to the level in small counties and moves the difference to mid-sized counties. This reallocation would have added about 91,400 job-years, an increase of 2.1 percent over the baseline. At the baseline cost per job-year, this gain is equivalent to about $4.4 billion of additional spending, achieved without increasing the budget. Mid-sized counties gain more jobs than large counties lose. How a fixed stimulus budget is divided across places therefore changes how many jobs it creates.

The employment gains from reallocation are robust to relaxing the requirement that the three parameters increase with county size. Without this ordering, nine parameters must match three grouped estimates, and many combinations do. Across a broad set of these calibrations, the benchmark reallocation adds between 82,000 and 117,000 job-years, equivalent to between $4.4 and $5.7 billion of additional spending at each calibration's baseline cost per job-year.

The monetary policy response also affects aggregate job creation. In the baseline experiment, the interest rate remains at its lower bound during the fiscal expansion, and additional government spending does not raise the policy rate. I compare this with an experiment that removes the aggregate shocks that keep the interest rate at its lower bound, while retaining the same ARRA spending and monetary policy rule. In this case, the central bank raises the interest rate in response to the expansion and offsets part of the additional government demand. The program then generates 2.1 million job-years over 2009–2012, about half the baseline effect, at a cost of approximately $97,000 per job-year. The same fiscal budget therefore creates fewer jobs when monetary policy responds by raising interest rates.

Related literature. The paper relates to three strands of work. First, I use local employment responses to infer the national effects of reallocating government spending, building on work that draws aggregate conclusions from regional evidence. Nakamura and Steinsson (2014) clarify the relationship between regional and aggregate fiscal multipliers, and Dupor et al. (2023) use regional consumption responses to discipline a heterogeneous-agent model. Related work draws aggregate implications from regional wage and employment variation (Beraja et al., 2019), stock-market wealth shocks (Chodorow-Reich et al., 2021), and bank lending shocks (Herreño, 2023). I instead use local employment responses, and how they vary with county size, to discipline a regional model of job creation. In the model, employment is determined in frictional labor markets, and county types differ in how much demand they retain and how costly it is to hire, building on work on fiscal policy with search frictions (Monacelli et al., 2010; Campolmi et al., 2011). This structure links the cross-county estimates to the national effects of reallocating spending.

Second, I show that the local employment effect of fiscal spending varies systematically with county size. Studies of the ARRA have used regional variation to estimate its employment effects (Feyrer and Sacerdote, 2011; Chodorow-Reich et al., 2012; Wilson, 2012; Dupor and Mehkari,

2016; Dupor and McCrory, 2018). These studies focus mainly on average local effects and do not translate them into national effects, which also depend on trade between regions and on the monetary policy response. I estimate how the response varies with county population and find a hump-shaped relationship that a pooled estimate does not capture. This heterogeneity is what makes the geographic allocation of spending matter for its employment effects. It also complements work on aggregate fiscal effects (Blanchard and Perotti, 2002) and their dependence on economic conditions (Auerbach and Gorodnichenko, 2012; Ramey and Zubairy, 2018), which Ramey (2019) reviews.

Third, I connect research on place-based policy to the spatial allocation of temporary fiscal stimulus. This research evaluates regional development programs (Kline and Moretti, 2014a), Empowerment Zones (Busso et al., 2013), and the design of welfare-improving spatial policies (Fajgelbaum and Gaubert, 2020); Kline and Moretti (2014b), Neumark and Simpson (2015), and Bartik (2020) review this work. Austin et al. (2018) emphasize differences across places in the employment response to demand, and Kline and Moretti (2013) analyze local hiring subsidies in a model with search frictions. I ask whether reallocating a fixed stimulus budget across county types can raise national employment during a recession. Local employment gains alone cannot answer this question, because gains in one place may come at the expense of another. I therefore evaluate reallocations in an economy linked by trade, counting employment changes in every county type, including those whose funding does not change.

The rest of the paper is organized as follows. Section 2 describes the data and outlines the institutional background of the ARRA. Section 3 estimates how the employment response varies with county size and describes how the economic structure of counties changes with size. Section 4 presents the model and connects these county characteristics to the parameters that govern the local response. Section 5 matches the local responses, and Section 6 computes national effects and evaluates reallocations. Section 7 concludes.

2 Data and institutional setting

I combine several publicly available datasets to measure labor-market outcomes, demographics, and economic structure at the county level. Employment, unemployment, and labor-force counts come from the Bureau of Labor Statistics' Local Area Unemployment Statistics (LAUS). These measures, combined with annual estimates of population aged 16 and older, yield county employment-to-population and labor-force participation rates. The Quarterly Census of Employment and Wages (QCEW) provides payroll, average pay, and establishment counts, as well as the industry employment shares used in the analysis. Population totals and age composition come from Census-based county estimates, while educational attainment comes from the 2000 Census tabulations compiled by the

USDA Economic Research Service. Gross income is obtained from the Internal Revenue Service's Statistics of Income. To characterize local production and commuting patterns, I use establishment counts by detailed industry from 2007 County Business Patterns and residence–workplace flows from the 2008 LEHD Origin–Destination Employment Statistics (LODES). Finally, government spending is measured from the recipient reports of the American Recovery and Reinvestment Act (ARRA). The federal government set up the now defunct Recovery.gov which provided detailed ARRA award information including final recipient zip codes. Following Dupor et al. (2023) and Crucini and Vu (2021), spending on a particular location is assigned based on ultimate recipient locations. This section describes the institutional background of the ARRA and each of the measures used in the analysis.

2.1 The Recovery Act

The American Recovery and Reinvestment Act was signed on February 17, 2009, fourteen months into the deepest postwar recession. The roughly $800 billion package combined tax relief, extensions of unemployment insurance and other transfers, aid to state budgets, and federal grants and contracts for infrastructure, energy, education, research, and other activities. Grants and contracts were spent primarily funding transportation, infrastructure, energy, and education projects. I focus on these grants and contracts for my analysis.

Recipients of grants and contracts filed quarterly reports, beginning with the quarter ending September 2009, that recorded the award, the amount received, and the place of performance. Much of the grant money passed through state agencies before reaching the organization that spent it. Dupor et al. (2023) and Crucini and Vu (2021)[4] assign each portion of an award to its ultimate recipient (Figure A1). I use the Dupor et al. (2023) county measure of grants and contracts, which totals to roughly $208 billion in my sample. The measure excludes the tax and entitlement provisions and covers a large part of the Act's discretionary spending. Outlays began in the second half of 2009 and were largely complete by the end of 2012.

I reconstruct the awards from the archived recipient reports to describe what the money paid for. Table 1 reports the composition of grants and contracts by funding agency for the United States as a whole and across the three county groups: "Large," "Mid-sized," and "Small." Education accounts for 34.5 percent of the total and transportation for 16.9 percent, and together they make up about half of spending in every size group. Transportation and agriculture take slightly larger shares in small counties (24.9 and 7.0 percent, against 15.5 and 0.6 percent in large counties). Health and general services take larger shares in large counties. Section A.2 provides details on the reconstruction.

[4] Crucini and Vu (2021) work with grants; Dupor et al. (2023) combine grants and contracts.

Table 1. Composition of reconstructed ARRA grants and contracts through 2012

Funding department or agency	Total ($bn)	All (%)	Small (%)	Mid-sized (%)	Large (%)
Education	72.79	34.5	31.9	33.2	36.1
Transportation	35.56	16.9	24.9	16.6	15.5
Energy	25.64	12.2	6.8	15.3	10.8
Health and Human Services	19.49	9.3	4.0	7.1	11.9
Housing and Urban Development	10.39	4.9	3.9	4.0	5.8
Environmental Protection Agency	6.83	3.2	5.5	3.8	2.4
Defense	6.22	3.0	1.3	4.0	2.5
General Services Administration	4.46	2.1	0.3	0.9	3.4
Labor	4.34	2.1	1.4	2.1	2.2
Army Corps of Engineers (civil)	4.28	2.0	5.4	2.4	1.1
Commerce	3.80	1.8	1.6	2.4	1.4
Agriculture	3.50	1.7	7.0	1.8	0.6
Justice	3.00	1.4	1.2	1.5	1.4
Other and unclassified	10.40	4.9	4.6	4.8	5.1
Total	210.69	100.0	100.0	100.0	100.0

Notes: Reconstruction from the archived recovery.gov recipient reports through 2012, for the 3,047 counties in the estimation sample. Amounts combine grant expenditures and contract award values. Percentages are shares of reconstructed funding in the full sample or within each county group, with no population weighting. The small, mid-sized, and large groups contain 1,864, 1,040, and 143 counties and about 10, 40, and 50 percent of the 2008 sample population. Funding codes are aggregated to the department level, and selected independent agencies and the civil works programs of the U.S. Army Corps of Engineers are shown separately; Section A.2 gives details.

The allocation of spending across counties depended on program rules, on the projects that state and local governments proposed, and possibly on local economic conditions. Section 3 addresses this endogeneity with the narrative instrument of Dupor et al. (2023), built from programs whose allocation rules did not target local economic conditions.

2.2 Employment and spending

Let E_{it} denote employed residents and N_{it} the adult population (residents aged 16 and older) of a county i. I capture the employment response of the county i as the cumulative change in the employment-to-population ratio (EPOP) over 2009–2012 relative to 2008 coinciding with the spending period of the ARRA:

$$Y_i = \sum_{t=2009}^{2012} (e_{it} - e_{i,2008}), \qquad e_{it} = 100\frac{E_{it}}{N_{it}}. \tag{2.1}$$

Y_i is measured in percentage-point-years, so a one-percentage-point increase in EPOP sustained for four years raises Y_i by four. Summing over 2009–2012 covers the years in which the money was spent. For cumulative county spending G_i, the treatment is log spending per adult,

$$g_i = \log(G_i/N_{i,2008}). \tag{2.2}$$

Spending per adult is skewed. The county at the 90th percentile received about seven times as much as the county at the 10th, $1,497 against $208 per adult. With spending in logs, a coefficient measures the response to a proportional increase in spending. For both spending intensity and the regression weights, I use 2008 adult population.

2.3 Controls

I control for a rich set of county characteristics. Baseline labor-market and income controls include the employment-to-population ratio in 2008, its change from 2000 to 2008, the unemployment rate in 2008, and county adjusted gross income in 2008 divided by the county labor force, using income data from the Internal Revenue Service's Statistics of Income. To account for age composition, I include the shares of the county population aged 25–54 and 65 or older in 2008. Educational attainment is captured by the shares of adults aged 25 and older with less than a high school diploma, a high school diploma or equivalent only, and some college or an associate degree, using 2000 Census tabulations provided by the USDA Economic Research Service. I also include baseline goods- and service-sector employment shares using the Quarterly Census of Employment and Wages (QCEW). To capture prior demographic trends, I control for population growth among residents aged 16 and older from 2000 to 2008. Finally, motivated by Yagan (2019), I proxy local recession severity using the percentage-point change in the unemployment rate from February 2007 to February 2009.[5] In the grouped specifications, I allow every control coefficient to vary across county-size groups; in the spline specifications, I allow these coefficients to vary smoothly with log county population through interactions with the population spline basis.

3 Employment response across county size

With measures of employment and spending in hand, I estimate how the response of employment to spending varies with county size. I first estimate the response as a smooth function of population using a restricted cubic spline and separately for three population groups, and in both cases I instrument spending with the narrative instrument of Dupor et al. (2023).

[5]The window ends in the month the Act was signed, before outlays began.

3.1 Empirical design

I first allow the spending response to vary smoothly with county size using a restricted cubic spline in log population. I estimate

$$Y_i = \alpha_{s(i)} + \mathbf{b}(p_i)'\delta + \beta(p_i)g_i + X_i'\Gamma\mathbf{h}(p_i) + u_i, \qquad \beta(p_i) = \theta'\mathbf{h}(p_i), \tag{3.1}$$

where $p_i = \log P_{i,2008}$, $\mathbf{b}(p_i)$ is the spline basis, and $\mathbf{h}(p_i) = (1, \mathbf{b}(p_i)')'$.[6] The function $\beta(p_i)$ captures how the spending response varies with county size. Interacting the controls with the same spline basis also allows their coefficients to vary smoothly with size. Second, to keep the quantitative model tractable, I group counties coarsely. For the grouped benchmark, I rank counties from largest to smallest and form groups containing approximately 50, 40, and 10 percent of population. Each group therefore holds a substantial share of the population and of the program dollars. The groups contain very different numbers of counties. The large group consists of the 143 counties above about 433,000 residents, the mid-sized group of the 1,040 counties between about 38,500 and 433,000, and the small group of the 1,864 counties below 38,500. Table 2 reports mean population and the distribution of spending.

Table 2. County size and ARRA spending intensity

Group	Counties	Population share (%)	Mean population	Adult-weighted mean ($)	P10 ($)	Median ($)	P90 ($)
All	3,047	100.0	97,982	888	208	502	1,497
Small	1,864	10.0	16,031	716	180	429	1,543
Mid-sized	1,040	40.1	115,083	904	281	556	1,411
Large	143	49.9	1,041,851	909	394	728	1,635

Notes: Population is total county population in 2008, and mean population is unweighted across counties. Spending is the Dupor et al. (2023) grants-and-contracts measure for 2009–2012 per 2008 resident aged 16 or older. P10, Median, and P90 are unweighted percentiles of county spending per adult within each group.

I estimate a separate response for each county size group:

$$Y_i = \sum_{k\in\{S,M,L\}} 1\{i \in k\}\left[\alpha_{s(i),k} + \beta_k g_i + X_i'\gamma_k\right] + u_i, \tag{3.2}$$

where Y_i is the cumulative EPOP change in (2.1), g_i is log spending per adult in (2.2), X_i contains the thirteen controls, and $\alpha_{s(i),k}$ are state-by-group effects. Every coefficient, including those on the controls and the state effects, is specific to the group, so I estimate each β_k from variation among counties in the same group and state. The three groups are also the county types to which I calibrate the model, and in the reallocation exercise I move spending across them. The grouped model also

[6] The restricted cubic spline has four knots at the 5th, 35th, 65th, and 95th percentiles of log population and is centered at 100,000 residents. It is constrained to be linear beyond the outer knots.

provides a check on the spline, since it estimates the response separately within three ranges of population.

The coefficients in both models are semi-elasticities. A 10 percent increase in spending changes cumulative EPOP by $\beta \log(1.10) \approx \beta/10$ percentage-point-years. Both models measure the response of a county relative to other counties in the same state; Sections 5 and 6 return to this point.

Instrument ARRA funds may have been directed to areas that were hit the hardest by the recession, correlating spending with unobserved local conditions that affect employment outcomes. Following Dupor et al. (2023), I use as the instrument funding from programs whose stated allocation criteria did not target local economic recovery. For example, special-education grants were allocated by the population of children with disabilities, and highway funds by state population density and passenger miles. Dupor et al. (2023) and Dupor and Mehkari (2016) provide more details on the construction of the instrument. To examine how spending and instrument funding vary with local economic conditions, I estimate the following regressions

$$\begin{aligned} G_i/N_{i,2008} &= a^G_{s(i)} + \pi^G C_i + \varepsilon^G_i, \\ z_i &= a^z_{s(i)} + \pi^z C_i + \varepsilon^z_i, \end{aligned} \tag{3.3}$$

separately within each county-size group. Here, $G_i/N_{i,2008}$ and z_i denote total ARRA spending and instrument funding per 2008 adult, respectively, and C_i is one local characteristic. Each regression includes state fixed effects and is weighted by 2008 adult population. Table 3 reports $\hat{\pi}^G$ and $\hat{\pi}^z$.

As documented by Dupor et al. (2023), the instrument is not related to local income or to pre-recession unemployment, but both spending and the instrument are lower where the recession was deeper (Table 3). Both spending and the instrument fall with the rise in unemployment from 2007 to 2009. Economic targeting would imply the opposite, with more spending where the recession was deeper. The regressions control for this margin through the change in the unemployment rate from February 2007 to February 2009.

In the spline model, I interact the instruments with the spline basis; in the grouped model, I interact them with the group indicators. Identification requires that these funding components affect employment only through measured spending, conditional on the controls and state effects. I estimate the model by two-stage least squares weighted by 2008 adult population and cluster standard errors by state.

A pre-trend check and a placebo check support the identifying assumption (Section B.1). First, spending does not predict the change in EPOP from 2007 to 2008, before the program began: the

pooled coefficient is close to zero (Table B1). Second, I shuffle spending and the instruments jointly across counties 1,999 times. The shuffled estimates are centered on zero, for both the mid-sized-county coefficient and the spline at 100,000 residents (Figure B1).

Table 3. ARRA spending and local economic characteristics by county group

	Small		Mid-sized		Large	
Characteristic	Total	Instrument	Total	Instrument	Total	Instrument
Income per tax return, 2007 ($10,000)	−21.2	−0.8	−15.5	−7.1	55.4	12.3
	(31.4)	(5.6)	(15.9)	(4.7)	(36.7)	(10.2)
Income change, 2007–2009 ($10,000)	71.7	24.4	136.9*	8.0	−192.1	−40.0
	(77.2)	(20.3)	(72.4)	(17.1)	(161.7)	(46.6)
Unemployment rate, 2007 (p.p.)	61.2*	−1.2	−72.2	1.7	−46.0	−0.5
	(30.6)	(6.8)	(44.0)	(8.1)	(58.4)	(14.3)
Unemployment change, 2007–2009 (p.p.)	−41.3**	−15.3**	−198.6***	−15.6**	−121.2**	−26.6*
	(15.9)	(7.5)	(66.7)	(7.6)	(54.0)	(14.3)
Counties, income rows	1,821	1,821	1,036	1,036	143	143
Counties, unemployment rows	1,864	1,864	1,040	1,040	143	143

Notes: Each cell reports the slope from a separate regression of spending per 2008 adult (Total) or narrative instrument funding per 2008 adult (Instrument) on the row characteristic and state fixed effects, estimated within the indicated group and weighted by 2008 adult population. Income is adjusted gross income per tax return, in units of $10,000; counties with no tax returns are excluded from the income rows (43 small and 4 mid-sized counties). The unemployment rows use annual rates for 2007 and 2009. Standard errors clustered by state are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

3.2 Estimates

3.2.1 Spline estimates

Figure 1 plots the continuous estimates $\beta(p)$, and Table 4 evaluates them at three populations. The response is 0.05 at 10,000 residents, rises to 2.31 at 100,000, and falls to 0.36 at one million. It peaks near 100,000 residents, inside the mid-sized group, and declines gradually toward the largest counties.

3.2.2 Grouped estimates

Table 5 reports the grouped estimates. The coefficient is 1.86 in mid-sized counties, 0.65 in small counties, and 0.39 in large counties. A 10 percent increase in spending therefore raises cumulative EPOP by 0.18 percentage-point-years in a mid-sized county and by 0.04 to 0.06 percentage-point-years in large and small counties. The pooled estimate, which imposes a common response across all counties, is 1.09.

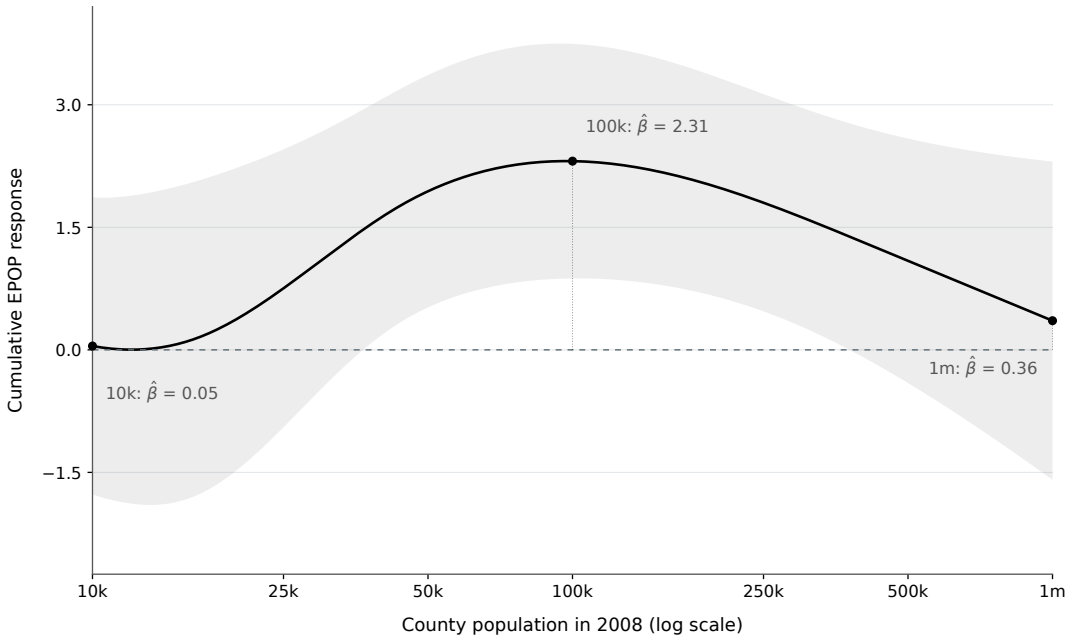

Figure 1. County employment responses across population size

Notes: Restricted cubic spline IV estimates of (3.1) for the 3,047 counties. The black curve is the estimated response, and the grey band is the pointwise 95 percent confidence interval from state-clustered standard errors (48 states). The labeled points mark 10,000, 100,000, and one million residents. The horizontal axis spans 10,000 to one million residents; larger counties remain in the estimation. The vertical axis is percentage-point-years per log point of spending.

Table 4. County EPOP spline: estimates and equality tests

Panel A. Spline response	
Response at 10,000 residents	0.05
	(0.93)
Response at 100,000 residents	2.31***
	(0.73)
Response at one million residents	0.36
	(0.99)
Panel B. Equality tests	
Null hypothesis	p-value
$\beta(100\text{k}) = \beta(10\text{k})$	0.05
$\beta(100\text{k}) = \beta(1\text{M})$	0.08
$\beta(10\text{k}) = \beta(100\text{k}) = \beta(1\text{M})$	0.08

Notes: Panel A evaluates the spline of Figure 1 at the stated populations. Panel B reports Wald tests based on the full state-clustered covariance matrix. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Only the mid-sized coefficient is individually distinguishable from zero, and it is significant at the 1 percent level. The grouped estimates therefore show the same pattern as the spline: the response is concentrated in the middle of the size distribution.

Table 5. County employment responses: pooled and grouped IV estimates

	Pooled	By county size
Log spending	1.09*	
	(0.61)	
Small × log spending		0.65
		(0.80)
Mid-sized × log spending		1.86***
		(0.55)
Large × log spending		0.39
		(1.49)
Counties	3,047	3,047
Kleibergen–Paap F	97.74	26.41

Notes: The outcome is the cumulative 2009–2012 change in the employment-to-population ratio relative to 2008, in percentage-point-years. Spending is the log of spending per 2008 adult, and weights are 2008 adult population. Both models include the thirteen controls. The pooled model includes state effects. The grouped model interacts the controls, state effects, spending, and instruments with the county size groups. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

The peak in the middle of the size distribution is robust to excluding counties with no narrative funding. The response of a fixed-population employment outcome also peaks in the middle of the population range (Section B).

3.3 Jobs per dollar

I convert the grouped EPOP responses into job-years per million dollars of spending using 2008 adult population. The implied effect is roughly 20 job-years per million dollars in mid-sized counties, compared with 9 in small counties and 4 in large counties (Table B9).

Let β_k denote the EPOP coefficient for group k, N_k the group's adult population in 2008, and G_k its total observed spending in millions of dollars. A 1 percent increase in spending raises cumulative EPOP by $0.01\beta_k$ percentage-point-years, which corresponds to $0.01\beta_k N_k/100$ job-years, at a cost of $0.01G_k$ million dollars. The implied number of job-years per million dollars is

$$\frac{0.01\,\beta_k N_k/100}{0.01\,G_k} = \frac{\beta_k N_k}{100\,G_k}.$$

3.4 County characteristics and county size

Larger counties have a broader industrial base, particularly in the sectors that supply government purchases, and their residents make a larger share of their purchases locally; both patterns point to higher scope of local retention. The same counties employ a more skill-intensive workforce, have larger establishments, and have less concentrated employment within industries, features associated with higher recruiting costs and higher wages. I use this suggestive evidence to restrict how the corresponding model parameters vary with county size in Section 5.

Demand retention

The scope for retaining demand rises with county size. A first measure is the breadth of local production: the number of six-digit industries with at least one establishment in the county, which captures the range of goods and services that local firms could supply. Government projects draw on many such industries. A highway contract pays for asphalt, equipment, engineering services, and crews. A school renovation pays for building materials and construction trades. A county that lacks these suppliers buys the inputs elsewhere, and the spending leaves the county.

The average number of industries present rises from 187 in small counties to 485 in mid-sized and 815 in large counties (Figure 2). Across construction, manufacturing, wholesale trade, and transportation, the count rises from 58 to 184 to 406, and in manufacturing alone from 20 to 88 to 266. A small county has local suppliers for only a small part of what a project requires.

Larger counties have a broader range of industries and therefore more opportunities to source locally than small counties, although firms may still buy some inputs elsewhere.

Figure 2. Local industry breadth by county size

Notes: Means weighted by 2008 adult population, using 2007 CBP and 2002 NAICS. Panel (a) counts six-digit industries with at least one establishment. Panel (b) restricts the count to goods and logistics industries, which comprise construction, manufacturing, wholesale trade, and transportation and warehousing (NAICS 23, 31–33, 42, and 48–49), and panel (c) restricts it to manufacturing.

Residents' purchasing patterns also point to greater demand retention in larger counties. In the card-spending data of Dunn and Gholizadeh (2023), the share of residents' purchases made at merchants in their own county rises from 60.0 percent in small counties to 66.2 percent in mid-sized and 72.1 percent in large ones (Figure 3).

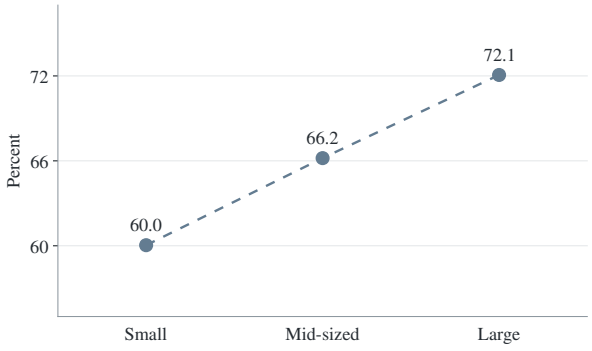

Figure 3. Residents' spending at home-county merchants by county size

Notes: Share of residents' card spending at merchants in the home county, from the 2015 card-spending flows of Dunn and Gholizadeh (2023). Spending at all merchant locations enters each county's denominator. Means weighted by 2008 adult population.

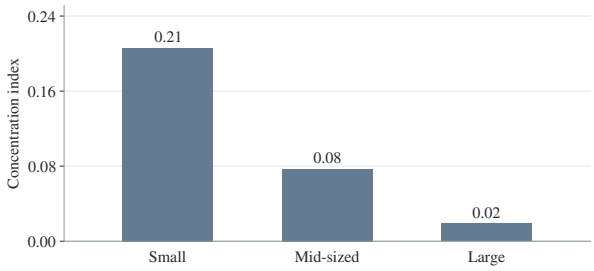

Figure 4. Establishment concentration by county size

Notes: Unweighted medians across counties of the employment-weighted average of within-industry establishment HHIs. Employment is imputed from 2007 CBP size classes; two-digit industries are weighted by their shares of imputed county employment. Section C describes the construction.

Together, industry breadth and home-county spending suggest greater demand retention in larger counties. Industry breadth indicates the scope to source goods and services locally, while card-spending flows measure the share of residents' purchases made at local merchants. Section C reports commuting closedness, a further measure of how closed county economies are, which also rises with county size.

Hiring conditions

Greater demand retention need not translate into proportionately more jobs. The employment response also depends on firms' wage and recruiting costs.

I measure establishment concentration using an employment-weighted average of within-industry Herfindahl–Hirschman indices (HHIs). Each industry HHI sums the squared employment shares of its establishments, and industries employing more county workers receive greater weight in the average. The index approaches zero when employment within industries is spread across many establishments and equals one when each industry has a single establishment. Its median falls from 0.21 in small counties to 0.08 in mid-sized and 0.02 in large counties (Figure 4). Lower concentration is associated with higher posted wages (Azar et al., 2022) and, in the model of Berger

et al. (2022), a larger labor share. These patterns are consistent with more local employment options and stronger worker bargaining positions in larger counties.

Larger establishments may also devote more resources to recruiting. The median across counties of employees per establishment rises from 9.8 in small counties to 13.9 in mid-sized and 16.5 in large counties (Figure 5, panel a). In the separate 1980 EOPP employer survey summarized by Faberman (2011), recruiting, screening, and interviewing time per hire rises from 6.2 hours at employers with fewer than ten employees to 12.7 hours at those with more than 250 (panel b).

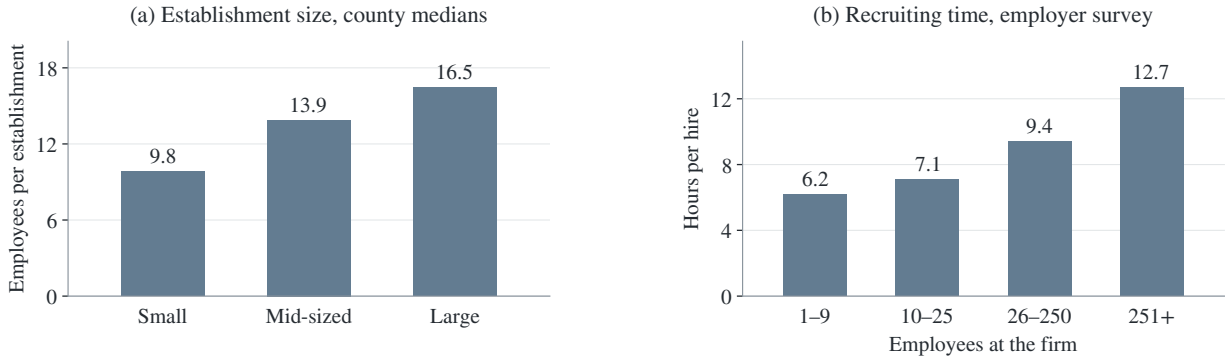

Figure 5. Establishment size and recruiting time

Notes: Panel (a): unweighted medians across counties of average establishment size, calculated as county employment divided by the number of establishments, 2007 CBP (3,047 counties). Panel (b): recruiting, screening, and interviewing hours per hire by employer size, reproduced from Faberman (2011), Table 2, using the 1980 EOPP employer survey.

Skill composition provides another reason hiring may be more costly in larger counties. The share of residents aged 25 and older with a bachelor's degree or more rises from 12.8 percent in small counties to 17.2 in mid-sized and 27.7 in large counties. The share of private employment in information, finance, and professional and business services rises from 10.8 to 15.5 to 27.8 percent (Figure 6). Hiring costs tend to increase with the skill requirements of a position (Blatter et al., 2012), so these patterns are consistent with higher hiring costs in larger counties.

The evidence on concentration, establishment size, and skills is consistent with higher wage and recruiting costs in larger counties. These costs may offset some of the employment gains from greater demand retention.

Summary

Broader local supply in larger counties supports demand retention, so more of the spending and of the income it generates stays local. Workers' wider alternatives and the higher requirements of recruiting may affect how firms in those counties translate that demand into employment. I build a model that represents both margins in Section 4 and compute jobs per dollar for the program as a whole in Section 6.

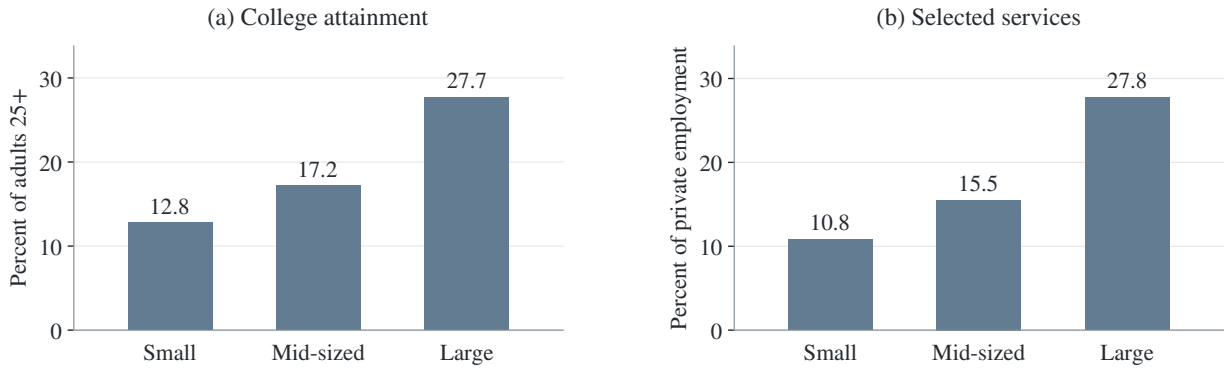

Figure 6. Skill and sector composition by county size

Notes: Unweighted county medians. Panel (a): share of residents aged 25 and older with a bachelor's degree or more, 2000 Census (3,047 counties). Panel (b): information, finance, and professional and business services as a share of private employment, 2006 QCEW (1,857 small, 1,040 mid-sized, and 143 large counties).

4 A regional monetary economy

This section presents the model. The regional structure builds on Nakamura and Steinsson (2014), who distinguish the local and aggregate effects of government purchases in a monetary union. Search frictions make the employment response depend on the return to hiring, as in Monacelli et al. (2010); Campolmi and Gnocchi (2016); Campolmi et al. (2011). With both elements, a region that retains more of its spending can still create fewer jobs, if the retained demand does little to raise the return to recruiting.

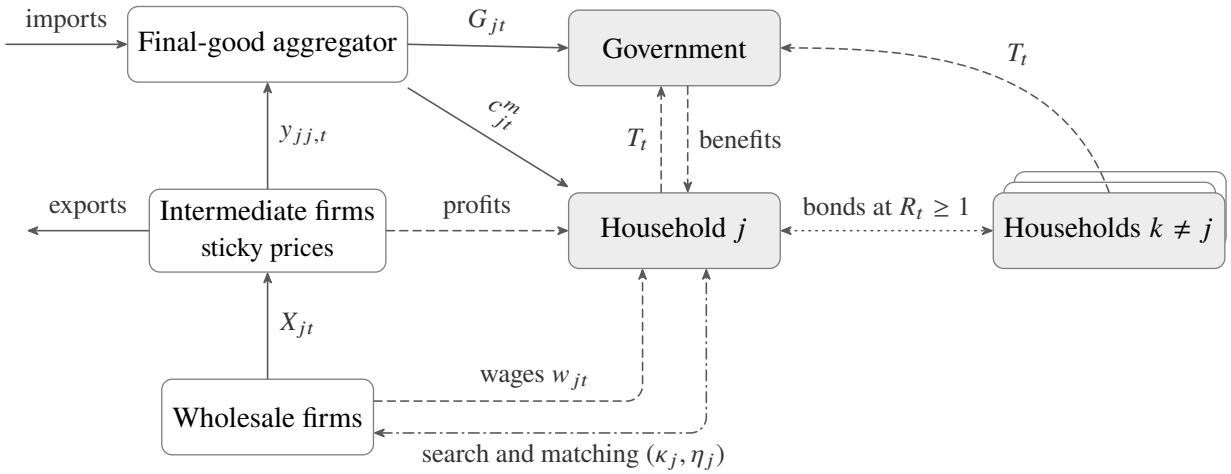

Figure 7. Agents and flows in the economy

Notes: Region j is shown in full; the stacked box stands for the households of all other regions. Solid lines: goods. Dashed: payments. Dash-dotted: labor market. Dotted: bonds. The household also receives the wholesale firms' profits, which the figure omits.

Description of the economy. The union consists of N regions. Each region has a representative household of unit mass with population weight s_j, where $\sum_j s_j = 1$. Labor is immobile across regions,[7] while goods and a nominal bond are traded within the union. In the household and firm problems below I drop the region subscript j from choice variables to reduce clutter; every allocation and parameter still carries a region-specific subscript. Each region has four agents (Figure 7). The representative household makes consumption and savings decisions and decides how many of its members participate in the labor market. Wholesale firms produce a homogeneous good with labor from the household and choose how many vacancies to post. Intermediate firms transform wholesale output into differentiated varieties, set prices subject to Calvo frictions, and sell to final-good firms in every region. Final-good firms aggregate varieties from all regions through a CES technology and sell the final good to households and the government. A federal fiscal authority buys final goods in each region and runs a union-wide balanced budget, and a common central bank sets the nominal interest rate subject to the zero lower bound.

4.1 The household's problem

The representative household is the central decision-making unit. Its core problem is to balance the consumption of goods bought in the market, c_t^m, against the consumption of goods produced at home, c_t^h. To do so, the household decides how to allocate its members across three states, employed (e_t), unemployed (u_t), and out of the labor force (n_t). I closely follow the structure of Campolmi and Gnocchi (2016) in the treatment of the household decision problem.

Objective. Members pool their income and share consumption whatever their employment status. The household maximizes

$$\mathbb{E}_0 \sum_{t \geq 0} \beta^t \, U(c_t^m, c_t^h), \qquad U(c_t^m, c_t^h) = Z_t \log c_t^m + \phi \, \frac{(c_t^h)^{1-\nu}}{1-\nu}, \tag{4.1}$$

where ϕ governs the value of home goods relative to market goods and ν the curvature of their utility. The preference shifter Z_t scales the marginal utility of market consumption. A fall in Z_t makes market goods less attractive relative to home goods, and it is the demand shock that generates the recession in the quantitative analysis.

[7] The assumption here is that fiscal shocks do not cause people to move.

Labor market dynamics. At the start of period t a fraction ρ of existing jobs separates, and the household then chooses the size of its labor force, ℓ_t. The pool of searchers consists of all members of the labor force who do not hold a surviving job, and employment evolves according to

$$\mathcal{S}_t = \ell_t - (1-\rho)e_{t-1}, \qquad e_t = \underbrace{(1-\rho)e_{t-1}}_{\text{Survivors}} + \underbrace{f_t\,\mathcal{S}_t}_{\text{New Hires}}, \tag{4.2}$$

where f_t is the job-finding rate, which the household takes as given. New matches produce immediately. The number of unemployed members is $u_t = \ell_t - e_t$, and the number of nonparticipants is $n_t = 1 - \ell_t$. Matching follows Mortensen and Pissarides (1994). With vacancies v_t, the number of matches is $m_t = \omega v_t^{1-\gamma}\mathcal{S}_t^{\gamma}$, where ω is matching efficiency and γ is the elasticity of matches with respect to searchers. Labor-market tightness $\theta_t = v_t/\mathcal{S}_t$ determines the finding and filling rates,

$$f_t = \omega\,\theta_t^{1-\gamma}, \qquad q_t = \omega\,\theta_t^{-\gamma}. \tag{4.3}$$

A tighter market raises the chance that a searcher finds a job and lowers the chance that a vacancy is filled.

Home production. The household's labor-market choices determine how much time is left for home production. Nonparticipants devote all of their time to it, the unemployed give up a fraction Γ of their time to search, and employed members give up all of it. Let h_t denote the time devoted to home production:

$$\begin{aligned} h_t &= 1 \cdot n_t + (1-\Gamma)\,u_t \\ &= (1-\ell_t) + (1-\Gamma)(\ell_t - e_t) \\ &= 1 - (1-\Gamma)e_t - \Gamma\ell_t. \end{aligned}$$

Home output is linear in home time,

$$c_t^h = A^h h_t = A^h\big[1 - (1-\Gamma)e_t - \Gamma\ell_t\big]. \tag{4.4}$$

Home production supplies the opportunity cost of both searching and working.

The budget constraint. The budget constraint ties the household's consumption and savings to the income it earns in the labor market and the profits it receives from firms. Total nominal spending equals total nominal income,

$$P_t c_t^m + R_t^{-1} D_t + P_t \frac{\phi_b}{2} \left(\frac{D_t}{P_t} - \frac{D_{ss}}{P_{ss}} \right)^2 = D_{t-1} + W_t e_t + P_t b(\ell_t - e_t) - P_t \tau_t + \Pi_t, \tag{4.5}$$

where P_t is the regional price level, D_t is nominal bond holdings, W_t is the nominal wage, b is the unemployment benefit in units of the final good, τ_t is the real federal tax, and Π_t is nominal profit income. Following Schmitt-Grohé and Uribe (2003), a quadratic cost of holding real bonds $d_t \equiv D_t / P_t$ away from d_{ss} keeps regional bond positions stationary. I write $w_t \equiv W_t / P_t$ for the real wage and $\pi_t \equiv P_t / P_{t-1}$ for regional inflation.

Marginal values. Three objects from the household's problem recur below. The marginal utility of a nominal dollar, the discount factor, and the marginal rate of substitution between home and market goods are

$$\lambda_t = \frac{U_{c_t^m}}{P_t} = \frac{Z_t}{P_t c_t^m}, \qquad Q_{t,t+1} = \beta \frac{\lambda_{t+1}}{\lambda_t}, \qquad \mathrm{MRS}_t = \frac{U_{c_t^h}}{U_{c_t^m}} = \phi Z_t^{-1} c_t^m (c_t^h)^{-\nu}. \tag{4.6}$$

The marginal product of home time is $\mathrm{MP}^h = A^h$, and $\mathrm{MRS}_t \, \mathrm{MP}^h$ is the value of a unit of home time in market-consumption units. It rises when the household consumes more and when Z_t falls. Real payoffs next period are discounted with $Q_{t,t+1} \pi_{t+1}$. The consumption–saving decision gives the familiar Euler equation,

$$R_t^{-1} + \phi_b (d_t - d_{ss}) = \mathbb{E}_t \left[Q_{t,t+1} \right].$$

All regions face the same nominal interest rate. Section E derives the household's first-order conditions.

4.2 The participation decision

The participation decision is central to the model. It depends on two objects, the value to the household of a member's job and the cost of a member's search.

The centralized decision maker is considering whether to send a member out on the labor market. Entering costs the fraction Γ of the member's home time, worth $\mathrm{MRS}_t \mathrm{MP}^h$ per unit. In return

she receives the benefit b and, with probability f_t, finds a job worth V_t^W, the shadow value of an additional employed worker measured in units of market goods:

$$\underbrace{\Gamma \, \mathrm{MRS}_t \, \mathrm{MP}^h}_{\text{opportunity cost of entry}} \quad = \quad \underbrace{b + f_t \, V_t^W}_{\text{expected gain from entry}} \quad . \tag{4.7}$$

4.3 The wholesale firm's problem and wage bargaining

A representative wholesale firm produces a homogeneous good with a linear technology in labor, $X_t = A\,(s_j e_t)$, and sells it competitively at the nominal price P_t^x, or $p_t^x \equiv P_t^x / P_t$ relative to the regional price level. It posts vacancies at a cost of κ units of the final good each, and a vacancy is filled at the rate q_t. The firm chooses vacancies to maximize the discounted value of its profits subject to $e_t = (1-\rho)e_{t-1} + q_t v_t$ (Section E).

Its value at the start of period t is

$$F(e_{t-1}) = \max_{v_t, e_t} \Big\{ s_j (P_t^x A - W_t) e_t - s_j P_t \kappa v_t + \mathbb{E}_t \big[Q_{t,t+1} F(e_t) \big] \Big\} \quad \text{s.t.} \quad e_t = (1-\rho) e_{t-1} + q_t v_t, \tag{4.8}$$

where v_t is vacancies per resident, κ is the real cost per vacancy, and q_t is taken as given.

Its first-order conditions give the value of a filled job, V_t^F, and the free-entry condition:

$$V_t^F = \underbrace{p_t^x A - w_t}_{\text{current surplus}} + (1-\rho)\, \mathbb{E}_t \big[Q_{t,t+1} \pi_{t+1} V_{t+1}^F \big], \qquad V_t^F = \frac{\kappa}{q_t}. \tag{4.9}$$

The value V_t^F is the firm's *marginal match surplus*, the value in consumption units of an extra filled job. The job-creation condition equates the expected cost of a hire, κ / q_t, with the expected present value of the surpluses the job generates. When the value of a filled job rises, firms post vacancies until the fall in the filling probability raises the expected cost per hire enough to restore the equality.

Nash bargaining. Wages are set by Nash bargaining over the joint surplus of the match, with worker weight η. The wage maximizes $(V_t^W)^\eta (V_t^F)^{1-\eta}$, which gives the sharing rule $(1-\eta) V_t^W = \eta \, V_t^F$. The worker receives the fraction η of the joint surplus $V_t^W + V_t^F$. The two surpluses can be written as $V_t^W = w_t - W_t^{\min}$ and $V_t^F = W_t^{\max} - w_t$, where

$$\begin{aligned} W_t^{\min} &= b + (1-\Gamma)\, \mathrm{MRS}_t \, \mathrm{MP}^h - (1-\rho)\, \mathbb{E}_t \big[Q_{t,t+1} \pi_{t+1} (1 - f_{t+1}) V_{t+1}^W \big], \\ W_t^{\max} &= p_t^x A + (1-\rho)\, \mathbb{E}_t \big[Q_{t,t+1} \pi_{t+1} V_{t+1}^F \big] \end{aligned}$$

are the reservation wage of the worker and the highest wage the firm will pay. The sharing rule then gives $w_t = \eta\, W_t^{\max} + (1-\eta)\, W_t^{\min}$, and the bargaining weight sets where the wage falls between the two bounds.

An increase in demand for a region's goods raises the wholesale price p_t^x and hence the value of a filled job. A higher bargaining weight η passes more of any increase in revenue into wages, and the job value rises by less. For a given filling probability, a higher vacancy cost κ discourages job posting.

4.4 Final-good firms, intermediate firms, and trade

Final-good firms. Goods are differentiated by origin, as in Armington (1969). A competitive final-good firm in destination j combines a continuum of varieties $y_{jk,t}(a)$, $a \in [0,1]$, from every origin k with the CES technology

$$Y_{jt} = \Big[\sum_{k=1}^{N} \xi_{jk}^{\frac{1}{\varepsilon}} \int_0^1 y_{jk,t}(a)^{\frac{\varepsilon-1}{\varepsilon}}\, da\Big]^{\frac{\varepsilon}{\varepsilon-1}},$$

where $\varepsilon > 1$ is the elasticity of substitution between varieties and $\xi_{jk} \geq 0$, with $\sum_k \xi_{jk} = 1$, is the trade weight that destination j places on origin k. The same elasticity ε governs substitution within and across origins and sets the markup, $\varepsilon/(\varepsilon-1)$. Profit maximization gives the demand for each variety and the destination's price index,

$$y_{jk,t}(a) = \xi_{jk}\left(\frac{p_{kt}(a)}{P_{jt}}\right)^{-\varepsilon} Y_{jt}, \qquad P_{jt}^{1-\varepsilon} = \sum_k \xi_{jk} \int_0^1 p_{kt}(a)^{1-\varepsilon}\, da. \tag{4.10}$$

The weights equal expenditure shares at equal prices. The own-region weight (home bias) $\xi_j \equiv \xi_{jj}$ governs how much of an increase in local absorption reaches local producers. Home bias captures the demand-retention margin described in Section 3.4. Government purchases use the same basket as private consumption. Spending assigned to one region therefore generates demand for goods produced elsewhere in the union. Summing over destinations, weighted by population, origin k faces the demand

$$y_{kt}(a) = \left(\frac{p_{kt}(a)}{P_{kt}}\right)^{-\varepsilon} \mathcal{D}_{kt}, \qquad \mathcal{D}_{kt} = \sum_j s_j \xi_{jk}\, \mathcal{Q}_{jk,t}^{\varepsilon}\, Y_{jt}, \qquad \mathcal{Q}_{jk,t} \equiv \frac{P_{jt}}{P_{kt}}, \tag{4.11}$$

where $\mathcal{Q}_{jk,t}$ is the bilateral real exchange rate between destination j and origin k. A fiscal expansion in destination j raises demand in origin k according to the trade weight and relative prices.

Intermediate firms. A monopolistically competitive firm in origin k turns one unit of the wholesale good into one unit of its variety, $y_{kt}(a) = X_{kt}(a)$.[8] Following Calvo (1983), a firm can reset its price with probability $1-\delta$ each quarter. A resetting firm chooses its price p^*_{kt} to maximize the expected discounted profits earned, subject to the demand (4.11) (Section E). This leads to the optimal pricing equations:

$$p^{\#}_{kt} \equiv \frac{p^*_{kt}}{P_{kt}} = \frac{\varepsilon}{\varepsilon - 1}\frac{K_{kt}}{F_{kt}}, \qquad \begin{aligned} K_{kt} &= \mathbb{E}_t \sum_{h\geq 0} \delta^h Q^k_{t,t+h}\, \mathcal{D}_{k,t+h}\, \mathrm{RMC}_{k,t+h}\left(\frac{P_{k,t+h}}{P_{kt}}\right)^{1+\varepsilon}, \\ F_{kt} &= \mathbb{E}_t \sum_{h\geq 0} \delta^h Q^k_{t,t+h}\, \mathcal{D}_{k,t+h}\left(\frac{P_{k,t+h}}{P_{kt}}\right)^{\varepsilon}, \end{aligned} \tag{4.12}$$

where $Q^k_{t,t+h} = \beta^h \lambda_{k,t+h}/\lambda_{kt}$. The weights are the demand the firm expects while its price survives, discounted by the probability δ^h that the price is still in place. A firm that resets today therefore sets its price with an eye to the marginal costs of the coming quarters.

With sticky price setting, firms meet additional demand at their posted prices. To do so they buy more wholesale output, which bids up p^x_{kt} and raises the value of a filled job in (4.9). Nominal rigidity links demand to job creation. As firms reset their prices, the region's varieties become more expensive than those made elsewhere, final-good firms substitute toward other varieties, and demand for the region's goods returns toward its previous path.

4.5 Fiscal policy, monetary policy, and equilibrium

The federal authority finances regional purchases G_{jt} and unemployment benefits and runs a balanced budget every period. Each region pays a tax bill proportional to its population, and the nominal tax per resident is common across the union,

$$T_t = \sum_k s_k P_{kt} G_{kt} + \sum_k s_k P_{kt} b_k u_{kt}, \qquad \tau_{jt} = \frac{T_t}{P_{jt}}, \tag{4.13}$$

where τ_{jt} is the real tax paid by a resident of region j. Monetary policy responds to population-weighted inflation and output, subject to the zero lower bound:

$$\begin{aligned} \log R^*_t &= \rho_R \log R_{t-1} + (1-\rho_R)\left[-\log\beta + \varphi_\pi \log\left(\sum_j s_j \frac{\pi_{jt}}{\pi_{j,ss}}\right) + \varphi_y \log\left(\sum_j s_j \frac{\bar{Y}_{jt}}{\bar{Y}_{j,ss}}\right)\right], \\ \log R_t &= \max\left\{0,\, \log R^*_t\right\}. \end{aligned} \tag{4.14}$$

[8] Being able to differentiate its good gives it pricing power.

where $\bar{Y}_{jt} \equiv \int_0^1 (p_{jt}(a)/P_{jt})\, y_{jt}(a)\, da$ is the real output of region j, and steady-state inflation is $\pi_{j,ss} = 1$. Away from the lower bound, the common interest-rate response dampens the demand generated by fiscal purchases. When the bound binds, higher expected inflation lowers real interest rates without a contemporaneous increase in the nominal rate, supporting private demand. Regional employment responses depend on this common policy environment as well as on local trade and hiring conditions.

The common interest rate, federal financing, and trade make a local employment response differ from a national one.

Two exogenous processes drive the economy.[9] Government purchases in region j are steady-state purchases plus program spending, and the preference shifter moves around its steady-state value:

$$G_{jt} = G_{j,ss} + \Delta G_{jt}, \qquad \log Z_{jt} = \log Z_{j,ss} + \zeta_{jt}. \tag{4.15}$$

Program spending ΔG_{jt} is zero outside 2009Q3–2012Q4, and I take its path from the data in Section 5.2. A negative innovation ζ_{jt} lowers the value of market consumption and is the source of the recession. In the quantitative analysis the innovations are chosen such that conditional on the path of G_{jt}, ζ_t exactly reproduces the path of employment of the United States. These shocks are then applied to all regions uniformly.

Goods, wholesale, and bond markets clear:

$$Y_{jt} = c^m_{jt} + G_{jt} + \kappa_j v_{jt} + \frac{\phi_b}{2}(d_{jt} - d_{j,ss})^2, \qquad A_j\, s_j e_{jt} = \Delta_{jt} \mathcal{D}_{jt}, \qquad \sum_j s_j P_{jt} d_{jt} = 0, \tag{4.16}$$

where $\Delta_{jt} \equiv \int_0^1 [p_{jt}(a)/P_{jt}]^{-\varepsilon} da$ measures price dispersion among region j's varieties.

Definition 1 (Equilibrium)**.** Take as given the initial conditions $e_{j,-1}$, $d_{j,-1}$, $\bar{Y}_{j,-1}$, $\mathcal{D}_{j,-1}$, $\Delta_{j,-1}$, and $P_{j,-1}$ for every region, the initial interest rate R_{-1}, and the exogenous paths G_{jt} and Z_{jt} for every region and date. An equilibrium is a sequence, for every region j and date $t \geq 0$, of household allocations $(c^m_{jt}, c^h_{jt}, \ell_{jt}, d_{jt})$; labor-market outcomes $(e_{jt}, \mathcal{S}_{jt}, v_{jt}, \theta_{jt}, f_{jt}, q_{jt})$; values $(\lambda_{jt}, Q_{j,t,t+1}, \mathrm{MRS}_{jt}, V^W_{jt}, V^F_{jt})$; quantities $(Y_{jt}, \bar{Y}_{jt}, \mathcal{D}_{jt}, \Pi_{jt})$; prices $(P_{jt}, \pi_{jt}, p^x_{jt}, w_{jt}, p^{\#}_{jt}, \Delta_{jt})$; and union-wide objects (R_t, T_t), such that:

(i) *Households.* Given prices, wages, profits, and taxes, the allocation maximizes (4.1) subject to (4.2), (4.4), and (4.5).

(ii) *Matching.* Employment and the search pool evolve by (4.2), and $(\theta_{jt}, f_{jt}, q_{jt})$ satisfy (4.3).

[9] I solve the model with the piecewise-linear OccBin method of Guerrieri and Iacoviello (2015). The shocks to both processes are unanticipated: in each quarter, households and firms learn that quarter's program spending and preference innovation as a surprise and expect no further innovations.

(iii) *Wholesale firms and wages.* The value of a filled job and free entry satisfy (4.9), and the wage satisfies the Nash sharing rule $(1-\eta_j)V^W_{jt} = \eta_j V^F_{jt}$.

(iv) *Intermediate firms.* Resetting firms choose $p^{\#}_{jt} = p^*_{jt}/P_{jt}$ according to the Calvo recursions in Section E.

(v) *Final-good producers.* Demands satisfy (4.10) and (4.11), and each region's CPI evolves as in Section E.

(vi) *Policy.* The federal tax satisfies (4.13) and the nominal interest rate satisfies (4.14).

(vii) *Market clearing.* The goods, wholesale, and bond markets clear according to (4.16).

4.6 How does government spending expand employment?

Government purchases add directly to demand for final goods:

$$Y_{jt} = c^m_{jt} + G_{jt} + \kappa_j v_{jt} + \frac{\phi_b}{2}(d_{jt} - d_{j,\text{ss}})^2.$$

The trade weights dictate how this demand reaches producers: at equal prices, the share ξ_j reaches producers in region j, while the remainder purchases goods produced elsewhere.

With prices slow to adjust, firms meet additional orders by expanding production. Intermediate firms purchase more wholesale output, which requires more workers because wholesale output per resident is $A_j e_{jt}$. Higher demand for wholesale output puts upward pressure on its price and hence on revenue per worker, $p^x_{jt} A_j$. This is the demand channel through which spending can increase the return to employing a worker.

Hiring depends on the surplus from a match. Nash bargaining allocates the fraction $1-\eta_j$ of the current gain to the firm.

When a filled job becomes more valuable, firms are willing to incur a higher expected hiring cost. Vacancies rise relative to searchers, making jobs easier to find but vacancies harder to fill. The decline in the filling probability raises κ_j/q_{jt} until it again equals the value of a filled job.

Households now compare the home production lost during search with the expected gain from entering the labor force:

$$\Gamma \,\text{MRS}_{jt}\,\text{MP}^h_j = b_j + f_{jt}V^W_{jt} = b_j + \frac{\eta_j}{1-\eta_j} f_{jt} V^F_{jt}.$$

Better job-finding prospects and a larger worker surplus make entry more attractive. This account shows where county characteristics enter. Home bias ξ_j acts at the first step and determines how much of the impulse reaches local producers. The bargaining weight η_j acts at the second, where it decides how much of the retained revenue the firm keeps, and the vacancy cost κ_j, which I pin down

by targeting the recruiting cost υ_j in (4.17), acts at the third, where it decides how many vacancies a given gain in the job value pays for. Both labor-market parameters make a dollar of retained revenue buy fewer hires. In the quantitative analysis the matching elasticity equals the bargaining weight, $\gamma_j = \eta_j$ (Section 5.3), and a higher η_j also lowers the elasticity of the job-finding rate with respect to tightness, $1 - \gamma_j$. A region with a high ξ_j can therefore retain most of the impulse and still convert little of it into jobs, and the two margins can offset each other as counties grow.

4.7 County size and the model's parameters

I connect the county characteristics of Section 3.4 to each parameter. The broader production and purchasing patterns suggest a closer local economic integration in larger counties, which I represent through a higher home bias. Lower establishment concentration suggests a stronger worker position in wage setting, which I represent through a higher bargaining weight. Larger establishments, a more skilled mix of jobs, and a denser network of placement agencies (Section C) motivate higher recruiting costs. I express the vacancy cost through the recruiting cost, the expected cost of a hire relative to the wage. A vacancy fills with probability $q_{j,ss}$, and a hire therefore costs $\kappa_j / q_{j,ss}$ in expectation:

$$\upsilon_j \equiv \frac{\kappa_j}{q_{j,ss}\, w_{j,ss}}. \tag{4.17}$$

I collect the three orderings together,

$$\xi_{\mathrm{L}} > \xi_{\mathrm{M}} > \xi_{\mathrm{S}}, \qquad \eta_{\mathrm{L}} > \eta_{\mathrm{M}} > \eta_{\mathrm{S}}, \qquad \upsilon_{\mathrm{L}} > \upsilon_{\mathrm{M}} > \upsilon_{\mathrm{S}}. \tag{4.18}$$

I impose the above orderings across county types. Section 5 chooses the parameter levels to match the grouped employment responses.

4.8 Aggregating counties into blocks

I solve the model with one region for each group of similar counties, because counties that are alike move together and a single region can represent each group. The result below holds for any number of groups, and I use it twice in Sections 5 and 6, once with two groups and once with three.

The result needs a description of trade among counties. With one region per county, s_i is county i's share of national population. Partition the counties into K groups, $k \in \mathcal{K} = \{1, \ldots, K\}$, with $\mathcal{I}_k$ the counties in group k and $S_k = \sum_{i \in \mathcal{I}_k} s_i$ the group's share. A county in group k spends the share ξ_k on its own goods and distributes the rest across all other counties in proportion to their populations:

$$\xi_{ii} = \xi_k, \qquad \xi_{ii'} = (1 - \xi_k)\frac{s_{i'}}{1 - s_i} \quad (i' \neq i), \qquad i \in \mathcal{I}_k. \tag{4.19}$$

The own share ξ_k captures demand retention, and population governs where the remaining purchases go.

Proposition 1 (Block representation)**.** *Suppose that within each group k, counties have the same population share $\bar{s}_k$ and the same preferences, technologies, labor-market parameters, and pricing frictions, receive the same shocks per resident, and start from the same intensive states, including price distributions. Under* (4.19) *and the federal policies of Section 4.5, the equilibrium of the N-county economy that is symmetric within groups is equivalent to the equilibrium of a K-region economy with population shares S_k and trade weights*

$$\Xi_{kk} = \xi_k + (1-\xi_k)\frac{S_k - \bar{s}_k}{1-\bar{s}_k}, \qquad \Xi_{kr} = (1-\xi_k)\frac{S_r}{1-\bar{s}_k} \quad (r \neq k). \tag{4.20}$$

The equivalence preserves group allocations and national aggregates.

The detailed proof is in Section F. A group of identical counties behaves like one region, and merging them changes only the trade matrix. A block's own weight Ξ_{kk} is larger than the home bias ξ_k of any of its counties, because what a county buys from other counties in its group leaves the county but stays inside the block. When individual counties are small, the weights simplify to

$$\Xi_{kk} \simeq \underbrace{\xi_k}_{\text{own county}} + \underbrace{(1-\xi_k)S_k}_{\text{other counties of the same group}}, \qquad \Xi_{kr} \simeq (1-\xi_k)S_r \quad (r \neq k). \tag{4.21}$$

Equal population shares within a group are needed only for the exact result. The approximate weights in (4.21) do not depend on the size of individual counties, and I use them in Section 6.1.

Two cases of the proposition organize the rest of the paper. To compute the response of a single county, I set $K = 2$, so that one group contains only the focal county, and the other contains the remaining $N - 1$ counties (Section 5.1). To compute national effects, I set $K = 3$, with one group for each county size type (Section 6.1).

5 Matching the local responses

This section matches the model to the local coefficients of Section 3. I simulate many counties that live in the same aggregate environment and differ only in the spending they receive, and I run the corresponding county regression on the simulated data. With standard parameters, the model reproduces the pooled estimate without targeting it (Section 5.3). With home bias, the bargaining weight, and the recruiting cost rising with county size, it also reproduces the peak in mid-sized counties (Section 5.5).

5.1 One county and the rest of the United States

To understand the relative response of a county, I start with two regions, the focal county and a single region that stands in for all other counties (Figure 8). This economy is the case $K = 2$ of Proposition 1. The focal county forms a group of its own, with population share s, and the other $N - 1$ counties form the second group, with share $1 - s$. If the other counties are alike, receive the same shocks, and start from the same state, they move together in equilibrium and act as one region. I keep the focal county apart because its spending varies across the simulations below.

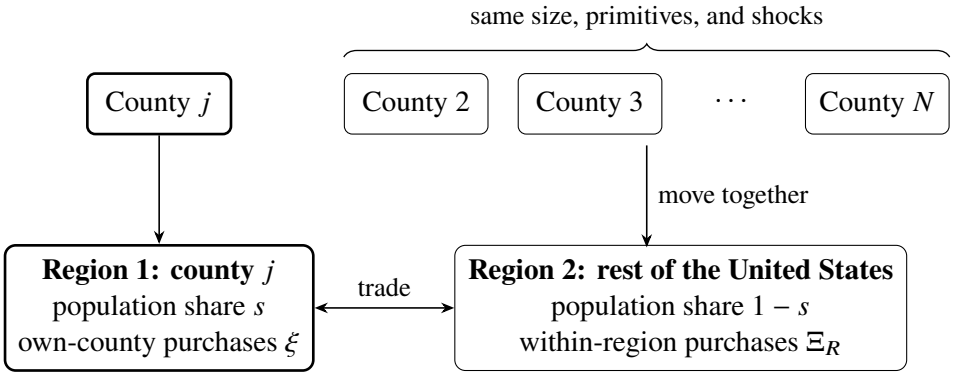

Figure 8. Reducing the union to a county and the rest of the United States

Notes: The focal county's spending path may differ from the others'. Counties 2 to N share size, primitives, shocks, and initial states, and move together in equilibrium. Purchases among them become purchases within region 2.

The two-region trade matrix. Merging the other counties changes the trade weights. Purchases that the other counties make from one another were imports for each of them, and in the two-region economy they become purchases within region 2. When all counties share the same size and home bias ξ, (4.20) gives the rest of the country a within-region share of

$$\Xi_R = 1 - \frac{s}{1-s}(1-\xi). \tag{5.1}$$

Collecting the weights, with rows for buyers and columns for sellers, gives the two-region trade matrix

$$\boldsymbol{\Xi}^{(2)}(s,\xi) = \begin{pmatrix} \xi & 1-\xi \\ \dfrac{s(1-\xi)}{1-s} & \Xi_R \end{pmatrix}. \tag{5.2}$$

Because s is small, Ξ_R is close to one. The rest of the country buys almost everything from itself, while the focal county buys the share $1 - \xi$ of what it needs from outside. The off-diagonal weights balance trade between the two regions. At equal prices and equal absorption per resident, the rest of the country buys from the focal county exactly what the focal county buys from it.

When I later give the focal county the characteristics of a county type, the counties are no longer symmetric. I keep the weights in (5.2) with the focal county's own ξ. This is a modeling choice rather than an implication of Proposition 1, which would build region 2's weights from the home bias of the other counties. Bilateral purchases then still balance at equal prices, and the rest of the country keeps the standard calibration. The rest of the country is part of the equilibrium throughout. It buys the county's goods, receives part of its spending, and shares in federal financing and monetary policy. Section G shows that the local response depends little on how I calibrate it.

5.2 The model counterpart of the regression coefficient

Each simulated county receives the spending path of an actual county in the data. Let $\widetilde{G}_{it}$ denote county i's ARRA spending per resident in quarter t, measured in units of its 2006 quarterly wage. Multiplying by the county's steady-state real wage $w_{i,ss}$ gives the model's program purchases,

$$\Delta G_{it} \equiv G_{it} - G_{i,ss} = \widetilde{G}_{it}\, w_{i,ss}. \tag{5.3}$$

All simulated counties face the same recession. I lower the preference shifter with a common sequence of innovations, $\log Z_{jt} = \log Z_{j,ss} + \zeta_t$, with ζ_t chosen such that conditional on the ARRA spending the model-implied path of aggregate US EPOP matches that of the actual US. This sequence of negative shocks simultaneously takes the economy to the zero lower bound. I solve the transitions with the piecewise-linear OccBin method of Guerrieri and Iacoviello (2015), which handles the occasionally binding lower bound.

For a calibration ϑ, let $\mathcal{T}$ be the set of model quarters from 2009 through 2012. The model counterpart of the outcome is cumulative EPOP relative to its 2008 level, in percentage-point-years, and the model counterpart of the treatment is log cumulative ARRA spending:

$$\mathcal{E}_i(\vartheta) = \frac{100}{4} \sum_{t \in \mathcal{T}} \left(e_{it}^{Z+G} - e_{i,2008} \right), \tag{5.4a}$$

$$g_i(\vartheta) = \log \sum_{t \in \mathcal{T}} \Delta G_{it}, \tag{5.4b}$$

where all model objects on the right-hand side are evaluated at ϑ. The factor 100 converts the employment rate to percentage points, and dividing by 4 converts quarters to years. Here e_{it}^{Z+G} is county i's employment rate when it experiences both the recession and its spending, and $e_{i,2008}$ is its 2008 employment rate. Across the simulated counties, I then run the regression

$$\mathcal{E}_i(\vartheta) = \alpha(\vartheta) + \beta^m(\vartheta) g_i(\vartheta) + \epsilon_i. \tag{5.5}$$

The aggregate is absorbed by the intercept $\alpha(\vartheta)$, just as the intercept absorbs common conditions in the empirical regression. The slope β^m is therefore identified from differences in spending alone,[10] and it is the model counterpart of β in Section 3.

5.3 Common inputs and the standard calibration

The period is a quarter. Table 6 lists the inputs. The top panel contains the parameters common to every region and every county type, which I take from the literature. The bottom panel describes a standard county, which shares its productivity and labor-market targets with the rest of the country. Its home bias of 0.59 comes from Dupor et al. (2023), its bargaining weight of 0.50 from Petrongolo and Pissarides (2001), and its recruiting cost of 4.5 percent of the quarterly wage from Campolmi and Gnocchi (2016). The matching elasticity equals the bargaining weight, $\gamma_j = \eta_j$, as in Hosios (1990). Given these targets, the steady state determines the remaining parameters, $(\omega_j, \kappa_j, b_j, \phi_j)$, jointly with wages and relative prices (Section E.9).

The untargeted response. I choose all of these inputs independently of the employment response. The standard county nevertheless produces a model coefficient of $\widehat{\beta^m} = 1.13$, close to the pooled estimate of 1.09 (standard error 0.61). A county with average characteristics and conventional parameters responds to spending by about as much as the average county in the data. The model's transmission from spending to employment is therefore of the right size before I choose any county-specific parameter.

5.4 What governs the local response

Home bias is the main determinant of the local response, and the two labor-market parameters lower it. Figure 9 shows how the three local parameters move the model coefficient. Holding the other inputs at the standard county's values, I compute β^m on a $5 \times 5 \times 5$ grid of home bias, bargaining weight, and recruiting cost, and I plot three slices of the resulting surface, at $\xi = 0.65$, $\eta = 0.50$, and $\upsilon = 4.5$ percent. Each contour connects parameter combinations that give the same local response, and the dashed contour marks $\beta^m = 1$.

Home bias and the bargaining weight. Panel (c) holds the recruiting cost at 4.5 percent of the wage. The colors change mainly from bottom to top. At $\eta = 0.50$, raising ξ from 0.35 to 0.85 raises β^m from 0.60 to 2.27, which makes home bias the strongest single determinant of the local response. For given home bias, a higher bargaining weight lowers the response, and the contours

[10] Note that g_i is exogenous by construction.

Table 6. Common parameters and the standard county

	Parameter	Value	Source or target
Common to all regions			
β	Discount factor	0.99	4 percent annual real rate
ε	Elasticity of substitution across varieties	6	20 percent markup; Christiano et al. (2011)
δ	Probability of not resetting the price	0.85	McKay et al. (2016)
ρ	Quarterly separation rate	0.12	Shimer (2005)
Γ	Share of home time used in search	0.44	Campolmi and Gnocchi (2016)
ν	Curvature of home utility	0	Linear home utility
q_{ss}	Vacancy-filling probability	0.90	Andolfatto (1996)
$\rho_R, \varphi_\pi, \varphi_y$	Policy-rule coefficients	0.8, 1.5, 0.5	Standard Taylor-rule values
ϕ_b	Portfolio-adjustment cost	0.02	Stationarity of bond positions
G_{ss}/Y_{ss}	Government purchases	0.20	Share of output
Standard county and external region			
s	Population share (%)	3.1	Dupor et al. (2023)
A	Productivity	1.00	Normalization
e_{ss}	Employment rate (%)	61.6	LAUS county aggregate
ℓ_{ss}	Participation rate (%)	65.2	LAUS county aggregate
ξ	Home bias (%)	59.0	Dupor et al. (2023)
$\eta = \gamma$	Bargaining weight and matching elasticity	0.50	Petrongolo and Pissarides (2001); $\gamma = \eta$ as in Hosios (1990)
υ	Recruiting cost (% of quarterly wage)	4.5	Campolmi and Gnocchi (2016)

Notes: Productivity is common to market and home production. The external region uses the standard inputs throughout Section 5; its trade weights follow (5.2). Dupor et al. (2023) set the population share equal to the average size of a county relative to the Census region (weighted by county-level income in 2010). At such a low value this weight matters little for the local response.

rise to the right. At $\xi = 0.60$, raising η from 0.30 to 0.80 lowers β^m from 1.34 to 1.05. A higher bargaining weight passes more of any revenue gain into wages.

Home bias and the recruiting cost. Panel (b) holds the bargaining weight at 0.50. Home bias again matters most, and the contours are close to vertical, but they tilt to the right as the recruiting cost rises. At $\xi = 0.60$, raising the recruiting cost from 1 to 10 percent of the wage lowers β^m from 1.41 to 1.09.

The two labor-market parameters. Panel (a) holds home bias fixed and varies the bargaining weight and the recruiting cost together. Its contours slope downward, and the response is highest in the lower-left corner, where both parameters are low. A county with a low bargaining weight and

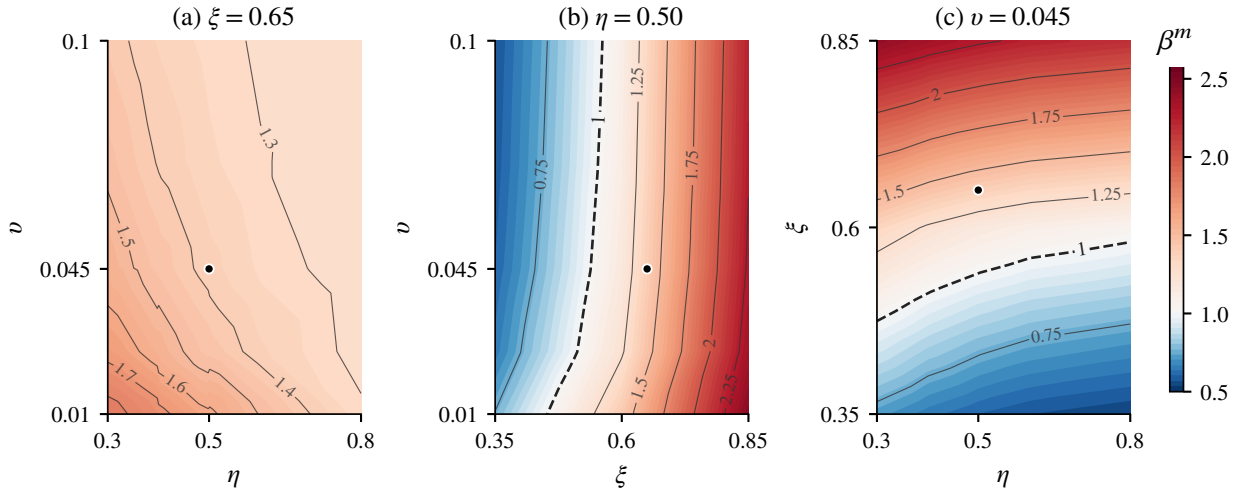

Figure 9. Local transmission and county characteristics

Notes: Slices of the $5 \times 5 \times 5$ parameter grid at $\xi = 0.65$, $\eta = 0.50$, and $\upsilon = 4.5$ percent. Colors and contours show the model coefficient β^m, interpolated linearly between grid points; the dashed contour is $\beta^m = 1$. Dots mark $\eta = 0.50$, $\upsilon = 4.5$ percent, and $\xi = 0.65$.

a high recruiting cost responds like one with a high bargaining weight and a low recruiting cost, because both parameters work through the same channel, the cost of turning retained revenue into hires.

Home bias sets how much of a county's spending reaches local producers, and the two labor-market parameters set how many hires that demand buys. A county with high home bias and a costly labor market can respond exactly like one with low home bias and a cheap labor market, because every point on a contour gives the same β^m. One coefficient per county type therefore cannot pin down three parameters. The county characteristics of Section 3.4 motivate an ordering of all three parameters across county sizes, and I impose that ordering, (4.18), in the type calibration.

5.5 Calibrating county types

I ask whether county types ordered as the evidence suggests can produce local responses of the estimated size. I calibrate one focal county for each size group, each trading with the standard rest of the country. Each county type has its own population share, productivity, and employment and participation targets, taken from the data for its group (Table 7). Its three local parameters follow the ordering in (4.18). Home bias rises with size, $\xi_{\mathrm{L}} > \xi_{\mathrm{M}} > \xi_{\mathrm{S}}$, and so do both labor-market parameters, $\upsilon_{\mathrm{L}} > \upsilon_{\mathrm{M}} > \upsilon_{\mathrm{S}}$ and $\eta_{\mathrm{L}} > \eta_{\mathrm{M}} > \eta_{\mathrm{S}}$, with each value at least 1.05 times the next smaller one.[11] Within these restrictions, I choose the levels of $(\xi_k, \upsilon_k, \eta_k)$ to bring the three model

[11] This restriction excludes nearly identical parameter values that satisfy monotonicity but introduce negligible heterogeneity along that dimension. The five-percent threshold serves as a calibration selection convention.

Table 7. County-type calibration and local employment responses

	Size group			
	Small	Mid-sized	Large	Standard
Type-specific inputs				
Focal-region population share, s (%)	0.045	0.170	1.300	3.100
Productivity, A	0.700	0.860	1.125	1.000
Employment-to-population ratio (%)	57.00	61.54	62.50	61.59
Participation rate (%)	61.59	65.02	66.12	65.16
Calibrated parameters				
Home bias, ξ (%)	20.52	60.93	63.97	59.00
Bargaining weight, $\eta = \gamma$	0.100	0.105	0.840	0.500
Recruiting cost, υ (% of quarterly wage)	0.40	0.42	4.00	4.50
Local employment response				
Model coefficient, $\widehat{\beta^m}$	0.65	1.85	0.71	1.13
Empirical estimate	0.65	1.86	0.39	1.09
	(0.80)	(0.55)	(1.49)	(0.61)

Notes: Standard is my pooled benchmark. The focal-region share s approximates the median county's share of its Census region's 2006 adult population within each size group; the external region receives the remaining weight, $1 - s$. Productivity A is chosen to match the ratio of group to national average annual pay, averaged over 1990–2006. Standard has $A = 1$, and home-production productivity is $A_h = A$ in all columns. Recruiting cost υ is defined in (4.17). Model coefficients are OLS slopes on log cumulative model spending. Empirical coefficients are IV slopes on log spending per 2008 adult, with state-clustered standard errors in parentheses. Both outcomes are cumulative 2009–2012 EPOP changes relative to 2008, in percentage-point-years. Samples and estimators differ between the two.

coefficients as close as possible to the grouped estimates of Table 5, $(0.65, 1.86, 0.39)$ for small, mid-sized, and large counties.

The ordered county types reproduce the estimated pattern. The calibrated coefficients are 0.65 for small, 1.85 for mid-sized, and 0.71 for large counties, against estimates of 0.65, 1.86, and 0.39. The model places the peak in mid-sized counties, as the data do, and each coefficient lies well within the 95 percent confidence interval of the corresponding estimate. These values are the combination that best fits the grouped estimates within the ordering. The county characteristics of Section 3.4 discipline the ordering of the parameters, not their levels, and Section 6.4 shows that the reallocation gains do not depend on the ordering.

Where the peak comes from. The mid-sized type has a home bias of 0.61 and a cheap labor market, with a bargaining weight of just 0.105 and a recruiting cost of 0.42 percent of the wage. Both labor-market parameters lie below the ranges plotted in panel (a), beyond its lower-left corner, where the response is highest. The large type retains slightly more demand, 64 percent, but with a

bargaining weight of 0.84 and a recruiting cost of 4 percent of the wage it sits at the right edge of panel (a), where the response is lowest for a given recruiting cost. The small type has an even cheaper labor market than the mid-sized type, but with a home bias of 21 percent it lies below the range of home bias plotted in panels (b) and (c), where most of the impulse leaves the county before it reaches local producers.

In the type calibration, I attribute differences in responses to each county's own parameters, and the rest of the country has little effect on them. In Section G, I change one external parameter at a time. A 20 percent change in external productivity changes the model coefficient by at most 7.8 percent, and the labor-market variations change it by at most 1.0 percent.

6 National employment effects of reallocation

A local response misses the jobs that the county's spending creates elsewhere through trade, as well as the response of monetary policy. I compute the employment consequences of a reallocation in an economy that contains all counties together.

6.1 Three blocks

For the national economy I set $K = 3$ in Proposition 1, with one group for each county size type (Figure 10). Each group's population share is its share in the data, $(S_S, S_M, S_L) = (0.10, 0.40, 0.50)$, and its counties take the home bias, bargaining weight, and recruiting cost calibrated in Section 5.5. Since individual counties are small, I use the weights in (4.21).

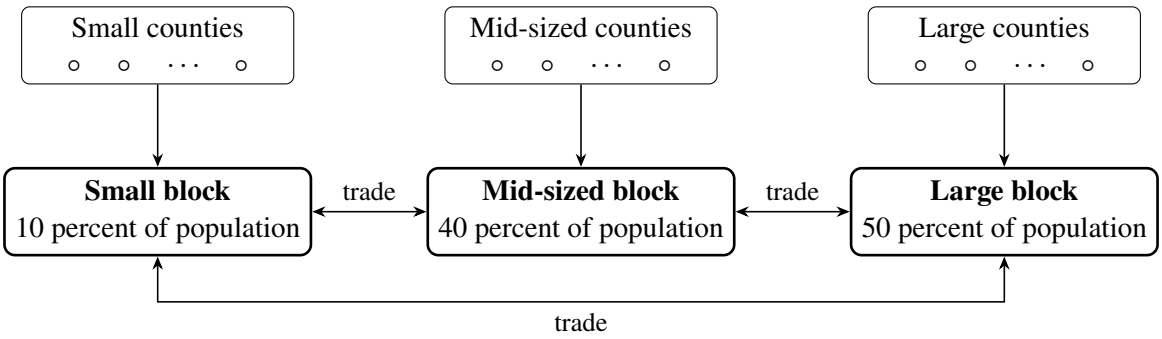

Figure 10. Counties of each type form a block

Notes: Counties within a type share primitives and receive identical shocks per resident. Each block keeps its county-level parameters; purchases among counties of the same type become purchases within the block. All three blocks share the federal tax and the interest rate.

With the calibrated home bias $(\xi_S, \xi_M, \xi_L) \approx (0.21, 0.61, 0.64)$, the block trade matrix, rounded for display, is

$$\boldsymbol{\Xi} = \begin{pmatrix} 0.28 & 0.32 & 0.40 \\ 0.04 & 0.77 & 0.20 \\ 0.04 & 0.14 & 0.82 \end{pmatrix}, \tag{6.1}$$

with rows for buying blocks and columns for selling blocks, ordered small, mid-sized, large.

A block keeps more of its demand than any single county of its type. The large block's own weight is 0.82, well above the county home bias of 0.64, because about half of what a large county buys from other counties comes from other large counties. Treating county home bias as block home bias would therefore overstate how much demand crosses from one type to another. The adjustment is small for the small block because the block itself is small, and that block sends 72 percent of its purchases to the other two.

I solve each two-region calibration of Section 5 against a standard rest of the country. In the three-block economy the types trade with one another, so I carry over each type's local parameters and its employment, participation, and recruiting-cost targets and solve for (κ_k, b_k, ϕ_k) and wages jointly. These values can differ from their two-region counterparts.

6.2 The baseline: the observed program in the recession

I evaluate every allocation in the environment in which the program actually operated, a deep recession at the zero lower bound. The baseline is the observed program in that recession, and I measure every reallocation in Section 6.3 against it.

The recession. I represent the recession with a sequence of preference shocks ζ_t to the shifter Z_t. A fall in Z_t lowers the value of current market consumption and holds down demand while the interest rate is at its bound. I recover the sequence, which covers 2007Q4–2015Q4, in the standard two-region economy so that national EPOP matches the data given observed fiscal spending. In this recession the nominal rate stays at its lower bound for 29 quarters. While the bound binds, monetary policy does not offset the demand that the program creates.

Fit to national employment. I then feed the same sequence to every block of the three-block economy, together with each block's observed spending, without recovering the shocks again. National employment is the population-weighted sum of block employment rates,

$$e_t^{U,(3)} = \sum_{k \in \mathcal{K}} S_k e_{kt}^{(3)}. \tag{6.2}$$

The observed allocation. I feed in the roughly $208 billion over 2009Q3–2012Q4. Table 8 divides this total among the three county types. Dollar shares are close to population shares. Small counties received 8.1 percent of the dollars and hold 10 percent of the population, mid-sized counties 40.9 percent against 40 percent, and large counties 51 percent against 50 percent. The reallocations below depart from this benchmark allocation.

Table 8. The observed allocation of program spending

County type	Program dollars ($ billion)	Dollar share (%)	Population share (%)
Small	16.96	8.1	10
Mid-sized	85.11	40.9	40
Large	106.05	51.0	50
Total	208.12	100.0	100

Notes: Program spending assigned to each county type in the 3,047-county estimation sample, allocated over 2009Q3–2012Q4 using the observed within-type quarterly spending profiles. These spending paths are inputs to the three-region economy. The population shares reported here are the corresponding model group weights S_k.

The program's employment effect. The program's employment effect is the difference between employment with and without the incremental spending in the same recession,

$$\Delta e_{kt} = e_{kt}^{Z+G} - e_{kt}^{Z}, \tag{6.3}$$

where e_{kt}^{Z+G} is employment in block k under the recession and the program, and e_{kt}^{Z} is employment under the recession alone. The difference separates the jobs the program supported from the movement in employment caused by the recession itself. It also counts jobs wherever they occur, including those that spending in one block creates in the others through trade. Under the observed allocation, the program generates 4.3 million job-years over 2009–2012, or about 1 million jobs in an average year, at a cost of $48,667 per job-year.

Comparison with other estimates. The cost per job-year lies within the range of about $25,000 to $125,000 in geographic studies of the Act. That cost is lower than the $90,000 to $120,000 per job-year implied by the initial spending forecasts of the Council of Economic Advisers (2009). Total job-years are harder to compare with official assessments, because those cover the whole Act, including tax relief and transfers to households that the model does not contain. For 2009–2012 the Council of Economic Advisers forecast 6.8 million job-years, and the assessment of the Congressional Budget Office (2015) implies between 1.6 and 7.9 million. The model's 4.3 million job-years from spending alone falls inside that range.

6.3 The employment consequences of reallocation

The observed program assigned a known sequence of dollars to each county type over 2009Q3–2012Q4. In the reallocation experiment, I change which type receives the dollars and hold everything else fixed, including parameters, trade weights, baseline purchases, the recovered recession, and the total and timing of program dollars. Mid-sized counties have the largest local response in both the estimates and the model, and large counties have a much lower response compared to the mid-sized counties both in the model and in the data. I move dollars from large to mid-sized counties. Let $\mathcal{G}_{kt}$ denote program dollars assigned to group k in quarter t. I transfer a fraction $\chi \in [0, 0.5]$ of the large-county allocation to mid-sized counties and leave the small-county allocation unchanged,

$$\begin{aligned} \mathcal{G}_{\mathrm{L}t}(\chi) &= (1-\chi)\mathcal{G}_{\mathrm{L}t}(0), \\ \mathcal{G}_{\mathrm{M}t}(\chi) &= \mathcal{G}_{\mathrm{M}t}(0) + \chi\,\mathcal{G}_{\mathrm{L}t}(0), \\ \mathcal{G}_{\mathrm{S}t}(\chi) &= \mathcal{G}_{\mathrm{S}t}(0). \end{aligned} \tag{6.4}$$

Adding the three lines shows that the national budget is the same in every quarter for any χ. At $\chi = 0$ the allocation is the observed one in Table 8, and at $\chi = 0.5$ half of large-county spending is transferred to mid-sized counties. I convert each allocation into model purchases with (5.3) and evaluate it in the joint equilibrium.

Job-years. The effect of allocation χ is $\Delta e_{kt}(\chi) = e_{kt}^{Z+G(\chi)} - e_{kt}^{Z}$, as in (6.3). Summing over blocks and quarters gives program job-years and the gain from reallocation,

$$\mathcal{J}(\chi) = \frac{1}{4}\sum_{k\in\mathcal{K}} \mathcal{N}_k \sum_{t=2009\mathrm{Q}1}^{2012\mathrm{Q}4} \Delta e_{kt}(\chi), \qquad \Delta\mathcal{J}(\chi) = \mathcal{J}(\chi) - \mathcal{J}(0), \tag{6.5}$$

where $\mathcal{N}_k$ is the adult population of group k, rates are fractions, and the factor $\frac{1}{4}$ converts quarters into years. The average cost per job-year is total program dollars divided by $\mathcal{J}$.

Table 9 reports transfers of up to half of large-county spending. The gains grow almost linearly with the share transferred. Moving 35 percent of large-county spending adds about 150,000 job-years, a 3.5 percent increase, and lowers the average cost per job-year from \$48,667 to \$47,015.

In another experiment (Table 10), I reduce cumulative spending per adult in large counties to the small-county level, transferring \$22.58 billion from large to mid-sized counties while holding small-county spending and the total budget fixed. This amounts to 21.29 percent of baseline large-county spending. Spending is allocated over 2009Q3–2012Q4. Total employment gains rise by 2.14 percent, adding approximately 91,400 job-years over 2009–2012. Valued at the baseline

cost of $48,667 per job-year, this gain is equivalent to approximately $4.45 billion in additional program spending, achieved here through reallocation with no increase in the total budget.

Table 9. Employment effects of reallocating spending

Transfer	Additional job-years (thousands)	Employment gain (%)	Cost per job-year ($)
Baseline	0.0	0.0	48,667
5%	21.5	0.5	48,424
15%	64.4	1.5	47,945
25%	107.3	2.5	47,475
35%	150.3	3.5	47,015
50%	214.7	5.0	46,341

Notes: Transfers are shares of large-county spending reassigned to mid-sized counties. Gains are relative to the observed allocation, which generates 4.276 million job-years over 2009–2012. Small-county spending and the total program budget of $208.12 billion are fixed. All allocations use the same aggregate shock and monetary-policy rule. Cost is total program spending divided by program job-years.

Table 10. Equalizing spending per adult in large and small counties

	Spending ($ billion)		Additional
County type	Baseline	Equalization	job-years
Small	16.96	16.96	4,183
Mid-sized	85.11	107.69	320,947
Large	106.05	83.47	−233,711
Total	208.12	208.12	91,419

Notes: The experiment reduces cumulative spending per adult in large counties to the small-county level and moves the difference to mid-sized counties, holding small-county spending and the total budget fixed. Spending is allocated over 2009Q3–2012Q4. Additional job-years are measured relative to the baseline allocation over 2009–2012.

6.4 Sensitivity to the calibration

The baseline calibration restricts home bias, recruiting costs, and worker bargaining power to increase with county size. To test whether these restrictions drive the reallocation gains, I drop the cross-size ordering and calibrate each county group independently to its local employment-response target. For each group, I vary recruiting costs, home bias, and the bargaining weight. Since nine parameters target three coefficients, several parameter combinations match the same local responses. To make evaluation manageable I construct 50 alternative calibrations from these combinations and repeat the three-region reallocation experiment, which moves money from large to mid-sized counties, for each. The total budget, regional spending profiles, monetary-policy rule, and recovered aggregate shock sequence are unchanged.

Table 11. Calibration sensitivity of the spending reallocation

		50 alternatives	
Outcome, 2009–2012	Baseline	Median	Range
Additional job-years	150,281	167,200	134,212–192,935
Employment gain (%)	3.51	3.89	3.48–4.49
Cost per job-year, before ($)	48,667	48,380	47,950–57,506
Cost per job-year, after ($)	47,015	46,550	46,091–55,450

Notes: The reallocation transfers 35 percent of large-county spending to mid-sized counties. The alternatives are 50 calibrations that match the same local employment-response targets as the baseline without the cross-size ordering. The total budget is $208.1 billion in all calibrations. Additional job-years are measured relative to each calibration's original spending allocation, and the employment gain expresses them as a percentage of ARRA's job-years under that allocation. Before and after refer to the original and reallocated spending.

The reallocation raises aggregate employment in all 50 alternatives (Table 11). Additional employment ranges from 134,212 to 192,935 job-years, with a median of 167,200, compared with 150,281 in the baseline. These gains equal 3.48 to 4.49 percent of ARRA's job-years under the original allocation, and the baseline gain lies near the lower end of this range. Within the tested set, the employment gain from the reallocation does not depend on the size ordering imposed in the baseline calibration.

6.5 ARRA during normal times

I next examine how ARRA's employment effects depend on the monetary policy environment. In the baseline, the aggregate shocks ζ_t generate the recession, and the policy rate is at a binding zero lower bound. In this experiment, I switch off ζ_t. The policy rate responds to economic conditions under the monetary-policy rule. I refer to this case as normal times. In each environment, I measure ARRA's employment effect relative to the corresponding path without ARRA. Table 12 compares ARRA's employment effects under the two monetary policy environments. The employment response is almost cut in half.

Table 12. ARRA employment effects under alternative monetary policy, 2009–2012

Outcome, 2009–2012	ZLB baseline	Normal times
Total spending ($ billions)	208.1	208.1
Additional job-years (millions)	4.28	2.14
Cost per job-year ($)	48,700	97,100

Notes: Additional job-years are measured relative to the corresponding equilibrium without ARRA. Cost per job-year is total spending divided by additional job-years, computed from unrounded values.

7 Conclusion

The spatial allocation of stimulus is an important dimension of stabilization policy distinct from the size of the program. Using county-level variation in ARRA outlays, I find that local employment responses are largest in mid-sized counties with about 100,000 residents and substantially smaller in both small and large counties. The productive advantages of larger markets do not seem to translate into more effective stimulus in larger counties.

While small counties leak most of the demand they receive to other places, large counties turn the demand they retain into fewer jobs, consistent with greater worker bargaining power and higher recruiting costs. Mid-sized counties balance the two. I study these patterns in a multi-region New Keynesian model with trade and labor-market search frictions.

The model implies that reallocating a fixed stimulus budget can raise aggregate employment. I evaluate alternate allocations in the model. In one such reallocation I reduce spending per adult in large counties to the level in small counties and move the difference to mid-sized counties. Such an allocation would have added about 91,400 job-years over 2009–2012, a 2.1 percent increase over the observed allocation. At the baseline cost per job-year, this gain is equivalent to about $4.4 billion of additional spending. The gains remain positive across the alternative calibrations examined, including those that relax the requirement that home bias, workers' bargaining weight, and recruiting costs increase with county size.

In the model, the same program generates about half as many job-years when the policy rate rises in response to the fiscal expansion. The national return to spending thus depends on both local economic conditions and aggregate policy.

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Online Appendix

Where Does Fiscal Stimulus Create Jobs? Evidence from U.S. Counties

Sayantan Roy

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A Data and spending measurement

A.1 Estimation sample and variables

The estimation sample contains 3,047 counties. I form the population groups and the spline knots on these 3,047 counties. I apply no winsorization to the outcome in the main specification. Annual ratios use each year's adult population. Size groups and spline arguments use total 2008 population; exposure denominators and analytic weights use 2008 adult population. I divide adjusted gross income by the same-year labor force. The three education controls are the shares with less than high school, high school, and some college. Adult-population growth is $100(N_{i,2008}/N_{i,2000} - 1)$; I enter it linearly in the baseline with the same size interactions as the other controls.

Sector shares divide private goods- or service-sector employment by total covered employment; I treat suppressed counts as missing. Yagan (2019) uses the difference between 2009 and 2007 unemployment rates as the proxy for recession severity. I use the change in the unemployment rate from February 2007 to February 2009 to avoid overlapping with the start of the program; I include it to condition on the severity of the local recession.

A.2 Independent spending reconstruction

For the independent reconstruction, I use archived recipient reports for 2009Q3–2012Q4, including later revisions. I supplement the missing 2010Q2 grant snapshot from the September 2012 NBER/Fedspending archive. Each award contributes its latest valid cumulative report through the relevant quarter. A new valid prime report replaces the prime-and-subrecipient snapshot, while an absent award carries forward. I retain reported zeros and leave missing amounts missing.

Funds often pass through more than one recipient before they are spent (Figure A1). A federal agency awards a grant or contract to a prime recipient, such as a state agency, which can pass part of it to subrecipients, such as a county.

The prime report controls the award total. I assign compatible subrecipient amounts to their locations and deduct them before allocating the prime remainder. Unreconciled amounts remain in geographic residuals. I do not add vendor records as separate awards. Locations use reported places of performance, documented recipient-location fallbacks, and fixed 2010 Census geographic relationships. I allocate ZIP codes spanning counties by population in ZIP-code-tabulation-area–county intersections.

Grant amounts are recipient expenditure; contract amounts are award commitments because the archived contract reports contain no positive expenditure observations. Table 1 documents the

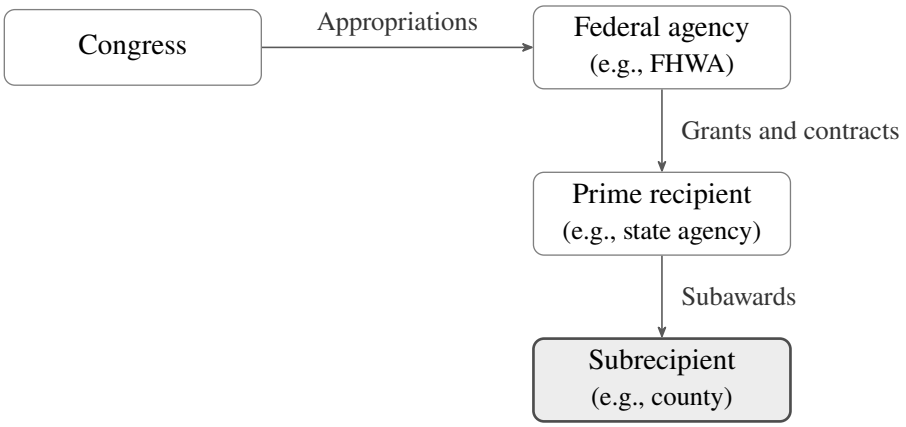


Figure A1. Flow of ARRA grant and contract funds

Notes: Adapted from Crucini and Vu (2021). The county measure of Dupor et al. (2023) assigns each dollar to the county of its ultimate recipient. FHWA is the Federal Highway Administration.

program composition. Figure A2 shows selected phrases from the award descriptions, Table A1 reports the funding associated with each phrase, and Table A2 lists four illustrative awards.

Figure A2. Activities described in ARRA awards

Notes: Selected phrases from the descriptions of the 90,420 grant and contract awards with positive funding in the 3,047 sample counties. Table A1 reports the amounts.

Table A1. Funding associated with phrases in award descriptions

Phrase	$bn	Share (%)	Phrase	$bn	Share (%)
Special education	11.39	5.41	Broadband service	0.80	0.38
Energy efficiency	8.59	4.08	Roof replacement	0.68	0.32
Public transportation	5.76	2.73	Clinical trials	0.59	0.28
Wastewater treatment	3.03	1.44	Biomedical research	0.50	0.24
Renewable energy	3.00	1.42	Waste disposal	0.40	0.19
Public housing	2.42	1.15	Teacher training	0.33	0.16
Child care	2.36	1.12	Solar panels	0.28	0.14
Drinking water	2.16	1.03	Bridge replacement	0.18	0.08
Law enforcement	1.99	0.95	Medical equipment	0.12	0.06
Head Start	1.78	0.84	Road reconstruction	0.10	0.05
Job training	1.56	0.74	Asphalt resurfacing	0.06	0.03
Primary care	0.97	0.46	Laboratory equipment	0.02	0.01

Notes: Funding allocated to the 3,047 sample counties from awards whose descriptions contain each phrase. Shares are percentages of the $210.69 billion reconstructed total in Table 1. An award can contain several phrases, so the rows overlap and do not sum to the total.

Table A2. Illustrative ARRA awards

Recipient	Activities supported	Amount ($ million)
New Jersey schools	Classroom technology and teacher training	11.96
Long Beach VA	Road and parking repairs	3.33†
Cambridge, MA	Boilers, lighting, outreach, and bike racks	1.11
Purdue University	Research on diet, genes, and bone health	0.75

Notes: Full award amounts. Grant amounts are reported expenditures; † marks a contract award value. Each award allocates funding to counties in the estimation sample.

B Additional county-level estimates

B.1 Identification checks

Table B1 reports the pre-period placebo. Spending does not predict the change in EPOP from 2007 to 2008 in the pooled model or in the mid-sized and large groups; the small-county coefficient is negative and significant at the 10 percent level.

Table B1. Pre-period placebo: change in EPOP from 2007 to 2008

	Estimate	p-value
Pooled	−0.002	0.97
	(0.058)	
Small	−0.154*	0.09
	(0.091)	
Mid-sized	0.035	0.55
	(0.059)	
Large	−0.120	0.49
	(0.173)	

Notes: The outcome is the change in EPOP from 2007 to 2008, in percentage points. The pooled row uses the pooled model and the group rows the grouped model of Table 5, with the same spending, instruments, thirteen controls, and 2008 adult weights (3,047 counties). The controls include 2008 EPOP and the change in the unemployment rate from February 2007 to February 2009. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figure B1 reports the permutation placebo. The shuffled coefficients are centered on zero, and the actual estimates lie in the right tail of both distributions.

Figure B2 shows the outcome of the 2008 presidential election by county size group. McCain won 79 percent of small counties and 66 percent of mid-sized counties, and Obama won 80 percent of large counties.

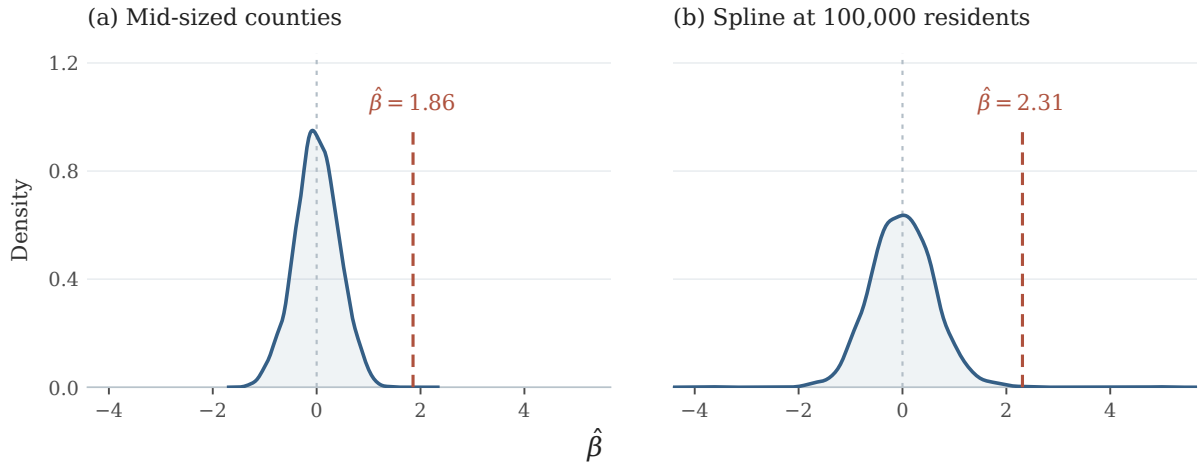


Figure B1. Spending permutation placebo: coefficients

Notes: The placebo shuffles spending and instruments jointly across all 3,047 counties in 1,999 permutations, holding outcomes, controls, weights, state and group assignments, and spline knots fixed. The panels show the distribution of the mid-sized-county coefficient (panel a) and of the spline effect at 100,000 residents (panel b) across the permutations. Curves are Gaussian kernel densities over all draws; dashed lines mark the actual estimates. The coefficients are in percentage-point-years of EPOP per log point of spending per 2008 adult.

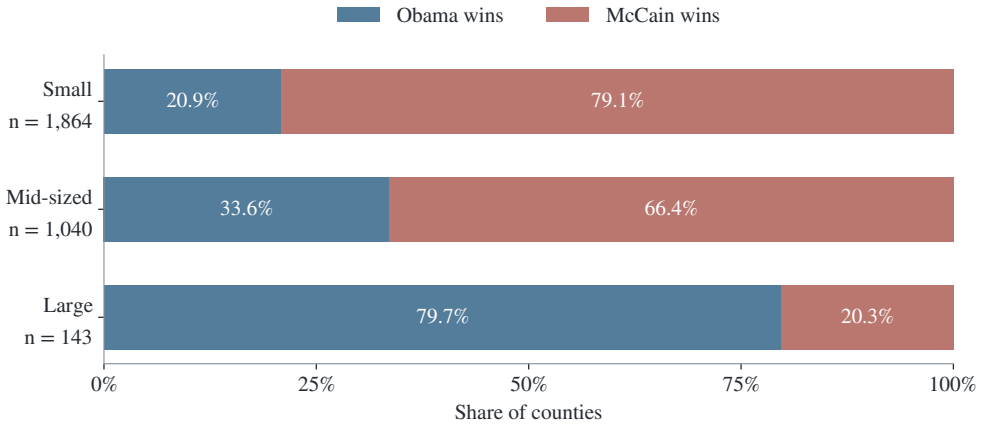


Figure B2. County outcomes of the 2008 presidential election

Notes: Share of counties in each size group won by each candidate in 2008; each county counts once. Source: MIT Election Data and Science Lab, via the Digital Scholarship Lab. All 3,047 sample counties are matched.

B.2 Fixed-population outcome

The fixed-population outcome is

$$Y_i^F = \frac{100}{N_{i,2008}} \sum_{t=2009}^{2012} (E_{it} - E_{i,2008}). \tag{B.1}$$

It holds the adult-population denominator fixed and measures cumulative employment changes per 100 baseline adults. Figure B3 reports its spline using the same treatment, instruments, controls,

and weights. Estimates at 10,000, 100,000, and one million residents are 0.49, 2.07, and −0.04 (Table B2).

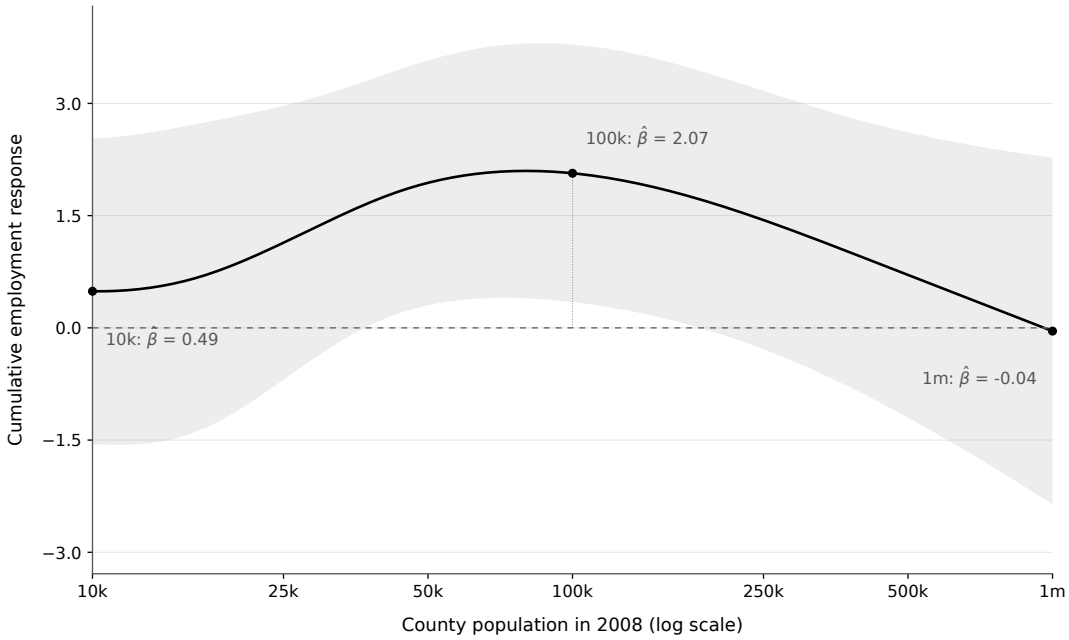


Figure B3. Fixed-population employment response

Notes: Specification as in Figure 1, replacing EPOP with cumulative 2009–2012 employment changes per 100 adults in 2008 (3,047 counties). Shading gives pointwise 95 percent state-clustered intervals, and the labeled points mark 10,000, 100,000, and one million residents. The display is restricted to 10,000–one million residents. Table B2 reports the estimates and tests.

Table B2. Fixed-population employment spline: estimates and tests

	Estimate
10,000 residents	0.49
	(1.04)
100,000 residents	2.07**
	(0.88)
1,000,000 residents	−0.04
	(1.18)
Kleibergen–Paap F	210.41

Notes: Spline response of cumulative 2009–2012 employment changes per 100 adults in 2008, evaluated at the stated populations. Specification as in Figure 1, for 3,047 counties. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

B.3 Specifications and sample restrictions

Table B3 re-estimates the grouped model with fewer group interactions, without state effects, and without controls. The mid-sized coefficient ranges from 1.86 to 2.11 and is significant at the 1 percent level in every specification.

Table B3. County EPOP responses across specifications

Specification	Small	Mid-sized	Large	Pooled
Preferred	0.65	1.86***	0.39	–
	(0.80)	(0.55)	(1.49)	
Additive state effects	0.44	1.97***	0.18	–
	(0.84)	(0.62)	(1.31)	
Common control slopes	0.48	2.03***	1.24	–
	(0.79)	(0.54)	(0.94)	
Additive/common	0.42	1.91***	0.58	–
	(0.90)	(0.64)	(0.99)	
No state effects	0.92	2.11***	−0.16	–
	(0.84)	(0.73)	(1.13)	
No controls or state effects	0.96	2.09***	1.30	–
	(1.03)	(0.59)	(2.17)	
Pooled	–	–	–	1.09*
				(0.61)

Notes: Grouped and pooled IV estimates of the cumulative 2009–2012 EPOP response to log spending per 2008 adult, for 3,047 counties with 2008 adult weights. Preferred is the grouped specification of Table 5, with state-by-group effects and group-specific control slopes. Additive state effects replaces the state-by-group effects with common state effects and group intercepts. Common control slopes keeps the state-by-group effects but restricts the control coefficients to be common across groups. Additive/common imposes both restrictions. No state effects keeps group intercepts and group-specific control slopes. No controls or state effects drops the controls and the state effects. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Excluding the 67 counties with zero instrument funding leaves the middle-population peak intact. In the grouped specification, the small-county coefficient is 0.83, compared with 0.65 in the baseline (Table B4). Winsorizing the outcome and spending and dropping the smallest counties also leave the peak in place: the mid-sized coefficient stays between 1.86 and 1.96, and the spline response at 100,000 residents stays between 2.32 and 2.39 (Table B5).

Table B4. Sample and spending-tail sensitivity: grouped EPOP responses

Check	Counties	Small	Mid-sized	Large
Main	3,047	0.65	1.86***	0.39
		(0.80)	(0.55)	(1.49)
Positive IV only	2,980	0.83	1.86***	0.39
		(0.89)	(0.55)	(1.49)
Winsorized outcome and spending	3,047	0.67	1.96***	0.39
		(0.83)	(0.58)	(1.49)
Population above 1,000	3,027	0.65	1.86***	0.39
		(0.80)	(0.55)	(1.49)
Population at least 5,000	2,786	0.78	1.86***	0.39
		(0.88)	(0.55)	(1.49)

Notes: Grouped specification of Table 5. Group assignments and spline knots are fixed at their full-sample values. Positive IV only drops the 67 counties with no narrative funding. Winsorized caps both the outcome and spending at their 1st and 99th percentiles and leaves the instruments unchanged. The population checks keep counties above 1,000 or at least 5,000 residents. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table B5. Sample and spending-tail sensitivity: EPOP spline

Check	Counties	β(10k)	β(100k)	β(1M)
Main	3,047	0.05	2.31***	0.36
		(0.93)	(0.73)	(0.99)
Positive IV only	2,980	0.14	2.29***	0.35
		(1.01)	(0.73)	(1.00)
Winsorized outcome and spending	3,047	0.15	2.39***	0.39
		(0.94)	(0.75)	(1.00)
Population above 1,000	3,027	0.05	2.32***	0.35
		(0.92)	(0.73)	(0.99)
Population at least 5,000	2,786	0.33	2.33***	0.30
		(1.07)	(0.72)	(1.00)

Notes: Spline specification of Figure 1, evaluated at 10,000, 100,000, and one million residents. The checks are defined as in Table B4. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

B.4 Heterogeneity by other county characteristics

Tables B6 and B7 let the spending response vary with other county characteristics as well as with population. The response at 100,000 residents stays between 2.02 and 2.96 in every specification. Figure B4 shows that log population and log population density are closely related across counties (correlation 0.87).

Table B6. Response heterogeneity by other county characteristics: common control splines

Characteristics	β(100k)
Main	2.31***
	(0.73)
Goods share	2.44***
	(0.74)
High-school share	2.55***
	(0.82)
Elderly share	2.23***
	(0.71)
Goods + high school	2.69***
	(0.80)
Three composition shares	2.46***
	(0.76)
Population density	2.02**
	(0.91)
Composition + recession + density	2.96***
	(0.99)

Notes: The entries are the spending response at 100,000 residents. Main is the spline of Figure 1. In each other row, the spending response varies with splines in the stated county characteristics as well as with population, with common state effects and 3,047 counties. The stated characteristics also enter the controls as four-knot splines, centered at adult-weighted means, which replace the linear terms of characteristics that are already controls; the control splines are common across county populations. The response has no population-by-characteristic interactions. Density is total 2008 population per square mile of land. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table B7. Response heterogeneity by other county characteristics: population-interacted control splines

Characteristics	β(100k)
Main	2.31***
	(0.73)
Goods share	2.24***
	(0.74)
High-school share	2.56***
	(0.83)
Elderly share	2.06***
	(0.71)
Goods + high school	2.49***
	(0.81)
Three composition shares	2.08***
	(0.76)

Notes: As in Table B6, except that the control splines are interacted with the population spline. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

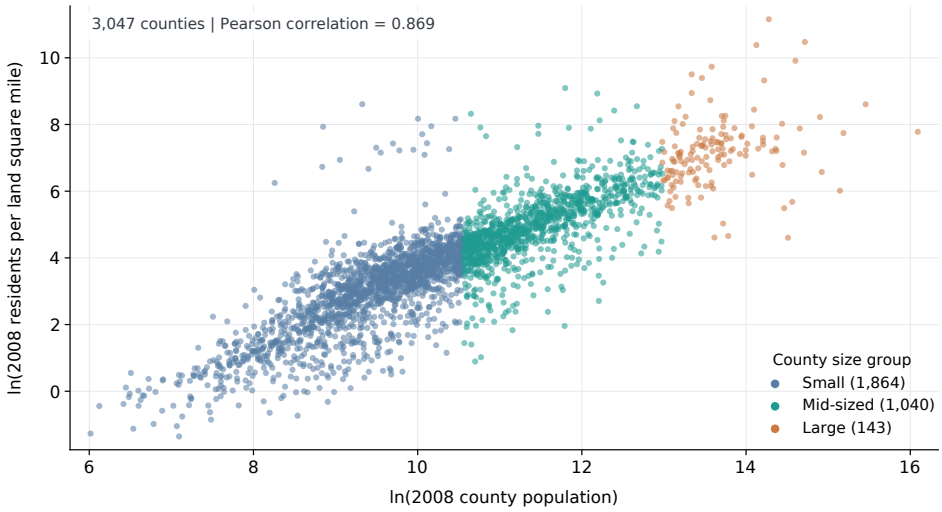


Figure B4. County population and population density

Notes: Log 2008 population and log population per square mile of land for the 3,047 sample counties, by size group. Both axes use natural logarithms. Points and the correlation are unweighted.

B.5 Migration

Table B8 reports cumulative migration responses over 2009–2011. Only the small-county in-migration coefficient is significant at the 5 percent level. The test that all three in-migration effects are zero has a p-value of 0.07; for out-migration the p-value is 0.15.

Table B8. Cumulative migration responses, 2009–2011

	In-migration	Out-migration
Small	0.123**	0.192
	(0.062)	(0.120)
Mid-sized	−0.144	0.163
	(0.105)	(0.118)
Large	0.284	−0.003
	(0.182)	(0.133)
All three effects zero: p	0.07	0.15

Notes: The outcomes are cumulative 2009–2011 deviations of annual in- and out-migration rates from their 2008 rates, where the rates are IRS domestic migrant exemptions divided by total population. The sample contains 3,036 counties (1,853 small, 1,040 mid-sized, and 143 large); eleven small counties lack migration data. Spending, the instruments, and the weights use 2008 adults. The 17 controls are the thirteen county controls and four pre-period migration levels and trends based on fixed 2008 population. All control slopes and the state effects are interacted with the size groups. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

B.6 Job-years per dollar

Table B9 reports the job-years per $1 million implied by the pooled and grouped estimates, with standard errors. Table B10 estimates job-years per $1 million directly, entering spending per adult

in levels and capping it at its 99th percentile. In the preferred specification, the direct estimate is 17.98 in mid-sized counties, against 9.58 in small and 3.70 in large counties.

Table B9. Implied job-years per $1 million of spending

	Job-years per $1 million
Pooled regression	12.3
	(6.8)
Small	9.1
	(11.2)
Mid-sized	20.5
	(6.1)
Large	4.3
	(16.4)
Grouped model, all counties	11.3
	(9.3)

Notes: Job-years over 2009–2012 per $1 million of spending implied by the log-spending coefficients of Table 5. For group g the conversion is $10{,}000\,\hat{\beta}_g \sum_{i\in g} N_{i,2008} / \sum_{i\in g} G_i$, the response to a proportional increase in spending evaluated at observed spending. The pooled row uses the pooled coefficient. The grouped-model row weights the group values by spending, and its standard error uses the full covariance of the grouped coefficients. Divide by four for average annual jobs. State-clustered standard errors (48 states) are in parentheses.

Table B10. Direct job-years per $1 million: spending in levels, capped at the 99th percentile

Specification	Small	Mid-sized	Large	Pooled
Preferred	9.58	17.98***	3.70	–
	(11.14)	(5.55)	(14.26)	
Additive state effects	6.90	19.26***	1.38	–
	(11.63)	(6.34)	(13.00)	
Common control slopes	7.26	19.83***	12.36	–
	(11.05)	(5.72)	(8.69)	
Additive/common	7.17	18.99***	5.70	–
	(12.32)	(6.67)	(9.76)	
No state effects	13.64	20.89***	−1.69	–
	(11.37)	(7.72)	(11.58)	
No controls or state effects	13.82	21.31***	13.69	–
	(14.03)	(6.73)	(21.47)	
Pooled	–	–	–	11.79*
				(6.40)

Notes: Each entry is 10 times the coefficient on spending per adult in thousands of dollars, which equals job-years over 2009–2012 per $1 million of spending; divide by four for average annual jobs. Spending per adult is capped at its 99th percentile. The specifications are defined as in Table B3. All models use 3,047 counties, the February 2007–2009 recession control, and 2008 adult weights. State-clustered standard errors (48 states) are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

C County characteristics by size

To build the concentration index, I impute establishment employment from CBP size classes, compute within-two-digit-industry concentration, and average using imputed industry-employment weights. Establishments under common ownership remain separate. Industry breadth counts six-digit industries with positive establishments. These constructions describe local structure without measuring structural bargaining power or actual supplier links.

Commuting closedness describes how tightly residence and workplace are connected within the county. I measure it in the 2008 LODES primary-job flows as $100 \cdot 2I_i/(R_i + W_i)$, where I_i counts jobs with residence and workplace in the county and R_i and W_i count resident and workplace jobs. The measure equals 100 when every employed resident works in the county and every local job is held by a resident. Closedness rises from 46.2 percent in small counties to 52.4 in mid-sized and 61.8 in large counties (Figure C1). In a small county more than half of all labor-market relationships cross the county line. A job created there might go to a commuter, whereas a job created in a larger county is much more likely to go to a resident.

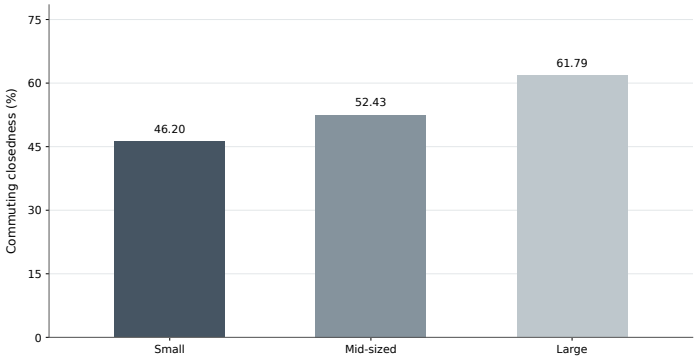


Figure C1. Commuting closedness by county size

Notes: 2008 LODES primary jobs, commuting closedness $100 \cdot 2I_i/(R_i + W_i)$. Means weighted by 2008 adult population over the counties with data: 1,862 small, 1,036 mid-sized, and 135 large counties.

Section 3.4 reports the establishment-size, skill, and sector measures. Figure C2 reports the pay gradient. The annualized pay measure sums quarterly private payroll divided by quarter-end private employment over four quarters. It reflects worker composition and hours as well as wage rates, and does not measure the wage of a new hire or vacancy-posting costs.

Placement agencies are more prevalent in larger counties. Their density rises from 0.36 per 1,000 establishments in small counties to 0.69 in mid-sized and 1.55 in large counties (Figure C3).

Table C1 collects the county characteristics reported in Section 3.4 and in this appendix.

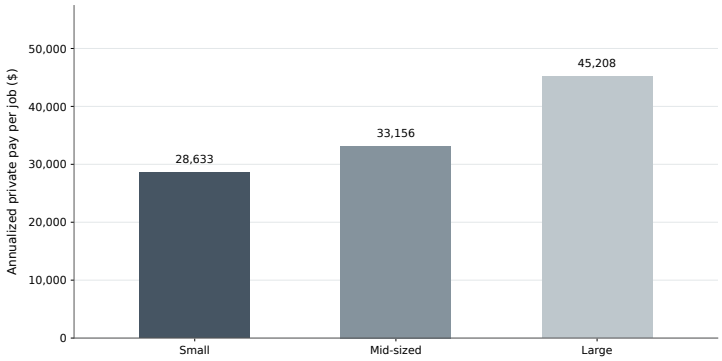


Figure C2. Private-sector pay by county size

Notes: Unweighted county medians of annualized private pay per job: the sum over four quarters of private payroll divided by quarter-end private employment, 2008 QCEW. Counties with usable data: 1,823 small, 1,028 mid-sized, and 143 large.

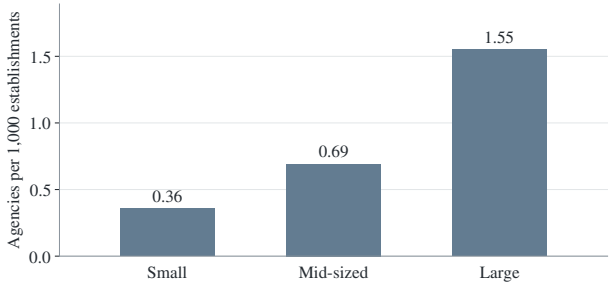


Figure C3. Recruiting intermediation by county size

Notes: Group totals of paid employment-placement agencies (NAICS 561310) divided by group totals of establishments, per 1,000 establishments, 2007 CBP.

Table C1. County characteristics by size group

	Small	Mid-sized	Large
Industries with a local establishment	187	485	815
Residents' spending at home (%)	60.0	66.2	72.1
Establishment concentration (index)	0.21	0.08	0.02
Employees per establishment	9.8	13.9	16.5
College share of adults 25+ (%)	12.8	17.2	27.7
Placement agencies per 1,000 establishments	0.36	0.69	1.55

Notes: Summary of Figures 2, 3, C3 and 4 to 6. Industry breadth and home-county spending are means weighted by 2008 adult population; concentration, establishment size, and the college share are unweighted county medians; placement agencies are a ratio of group totals. All groups come from the 3,047-county sample.

D Commuting-zone analysis

D.1 Commuting-zone estimates

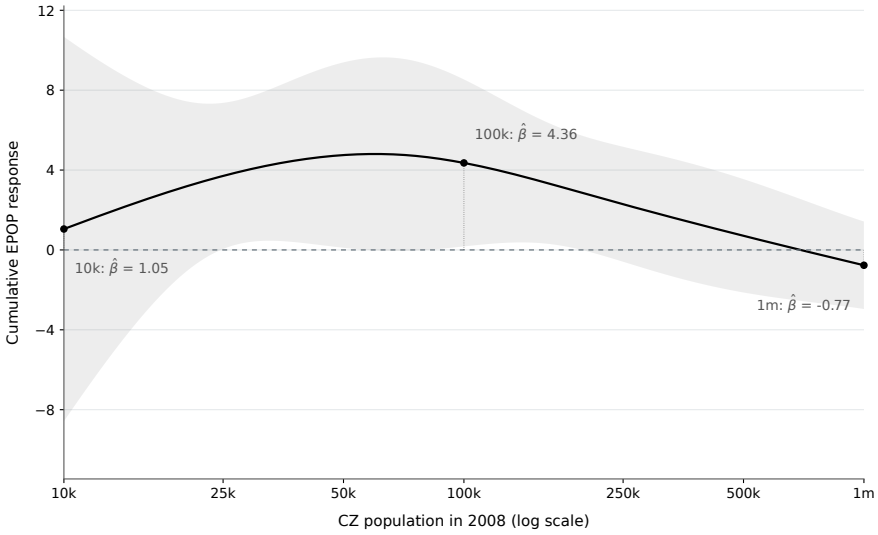
For CZ outcomes, I aggregate resident employment and annual adult population before computing EPOP and retain the existing ratio bounds. The 3,047 sample counties map to 689 commuting zones. Controls aggregate the corresponding numerators and denominators over the sample counties. I sum spending and instrument amounts over the sample counties and divide them by aggregate 2008 adult population, which also supplies the weights. I retain any CZs with no instrument funding. The population-share groups contain 425 small, 224 mid-sized, and 40 large CZs, and the four spline knots are set on all 689 CZs and held fixed across samples. The models include group intercepts or standalone spline terms, with no state effects.

Table D1. CZ employment responses under population-share groups

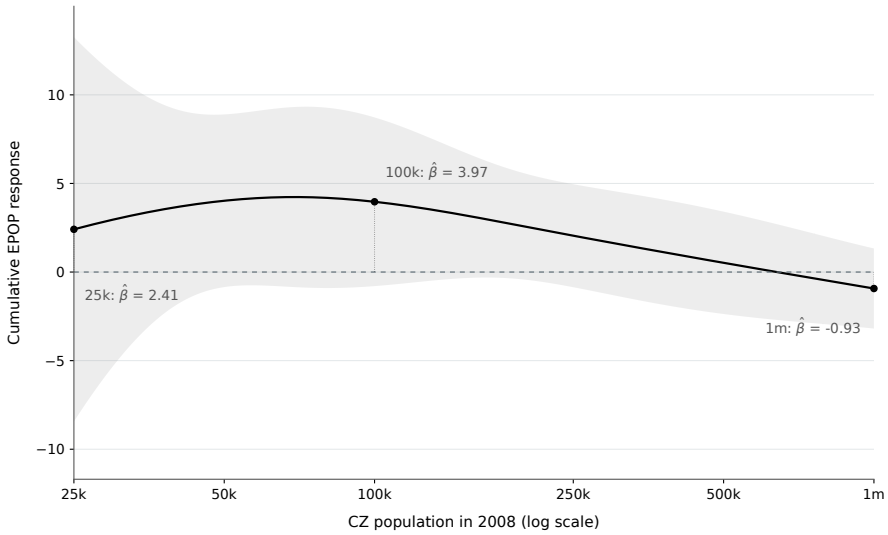
		EPOP		Fixed population	
Group	CZs	Interacted	Common	Interacted	Common
Small	425	3.89**	4.21***	5.19***	5.23***
		(1.53)	(1.61)	(1.69)	(1.71)
Mid-sized	224	−0.26	−0.48	−0.96	−1.31
		(1.14)	(1.02)	(1.28)	(1.14)
Large	40	−2.77	−2.17	−2.39	−2.00
		(1.81)	(1.75)	(1.78)	(2.03)
Equality p		0.01	< 0.01	< 0.01	< 0.01
Kleibergen–Paap F		25.93	30.81	25.93	30.81

Notes: The 689 CZs aggregate the 3,047 sample counties and are grouped by descending 2008 population shares of about 50, 40, and 10 percent. Spending is logged, and the excluded instrument is narrative funding per 2008 adult in levels; weights are 2008 adult population. Interacted columns let all thirteen control coefficients vary by group, and common columns hold them equal across groups. The recession control is the change in the CZ unemployment rate from February 2007 to February 2009, with each rate computed from summed monthly unemployed and labor-force counts. EPOP uses each year's adult population; the fixed-population outcome divides cumulative 2009–2012 employment changes by 2008 adults. The models include no state effects. HC0 standard errors are in parentheses. Equality p tests that the three group coefficients are equal. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figure D1 reports the continuous CZ estimates. Panel (a) uses CZs with more than 10,000 residents and panel (b) CZs with at least 25,000. In both samples the response rises to a peak below 100,000 residents and falls to slightly below zero at one million. The estimates are 4.36 at 100,000 residents and −0.77 at one million in panel (a), and 3.97 and −0.93 in panel (b). At the low end they are 1.05 at 10,000 residents in panel (a) and 2.41 at 25,000 in panel (b). The intervals are wide outside the middle of the range. The peak lies near the population of a typical small CZ, whose mean is 70,429 (Section D.2), consistent with the largest population-share coefficient in Table D1 belonging to small CZs.



(a) CZs with more than 10,000 residents (648 CZs)



(b) CZs with at least 25,000 residents (583 CZs)

Figure D1. Employment responses across commuting-zone population size

Notes: IV estimates of the CZ EPOP spline. The CZs aggregate the 3,047 sample counties; spending, the instrument, and adult population are summed over member counties, and weights are 2008 adult population.

D.2 Commuting-zone structure and population scale

Figures D2 to D6 compare CZ population-share groups with the mid-sized-county benchmark. Small CZs have a mean population of 70,429, compared with 115,083 for mid-sized counties, and their populations overlap substantially: 282 of the 425 small CZs fall within the population range of mid-sized counties. CZs contain more commuting relationships within their boundaries (Figure D2).

The industry breadth of small CZs is similar to that of mid-sized counties (Figure D3). Their establishment concentration is also similar, while their placement-agency density is closer to that of small counties (Figure D4). Their establishment size is closer to that of small counties as well (Figure D5). So is their pay (Figure D6). Table D2 collects the values.

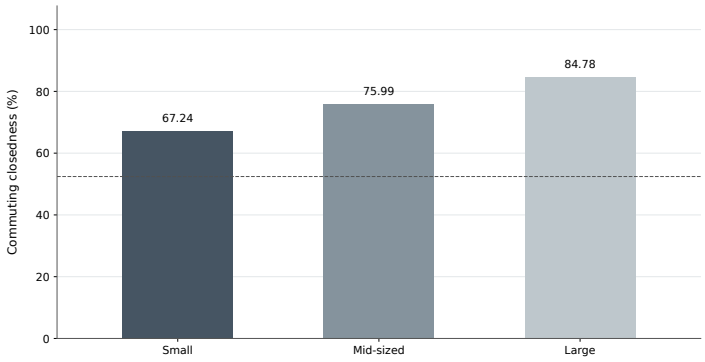


Figure D2. Commuting closedness at commuting-zone boundaries

Notes: Commuting closedness $200I/(R+W)$ from 2008 LODES primary jobs, where trips between counties of the same CZ count as internal. CZ groups as in Table D1. Means weighted by 2008 adult population; a CZ enters only if every member county has data (422 small, 222 mid-sized, and 39 large CZs). The dashed line marks the mid-sized-county mean on the same county sample.

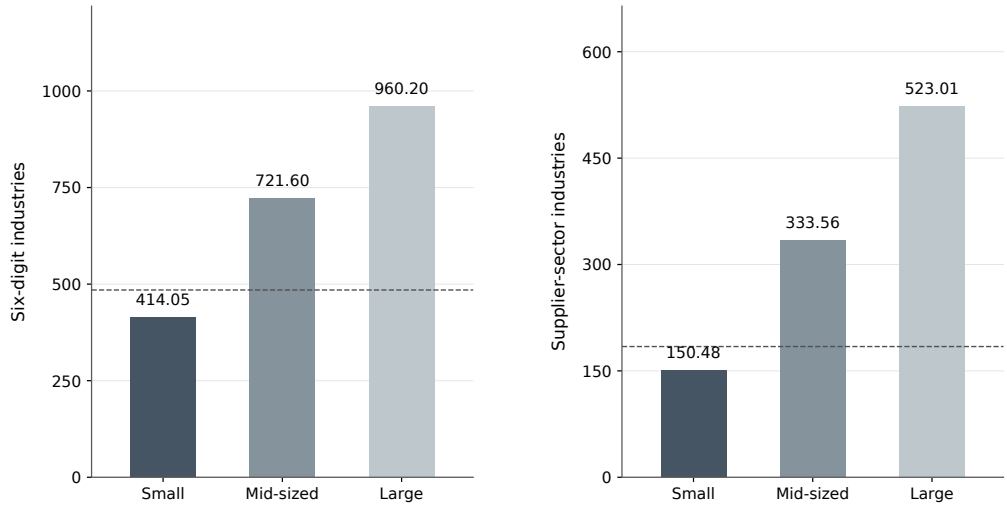


Figure D3. Industry breadth across commuting zones

Notes: Six-digit industries (left) and goods and logistics industries (right) with at least one establishment in the CZ, 2007 CBP; industry presence is the union across member counties. CZ groups as in Table D1. Means weighted by 2008 adult population (425 small, 224 mid-sized, and 40 large CZs). The dashed lines mark the mid-sized-county means. Industry presence does not measure purchasing links.

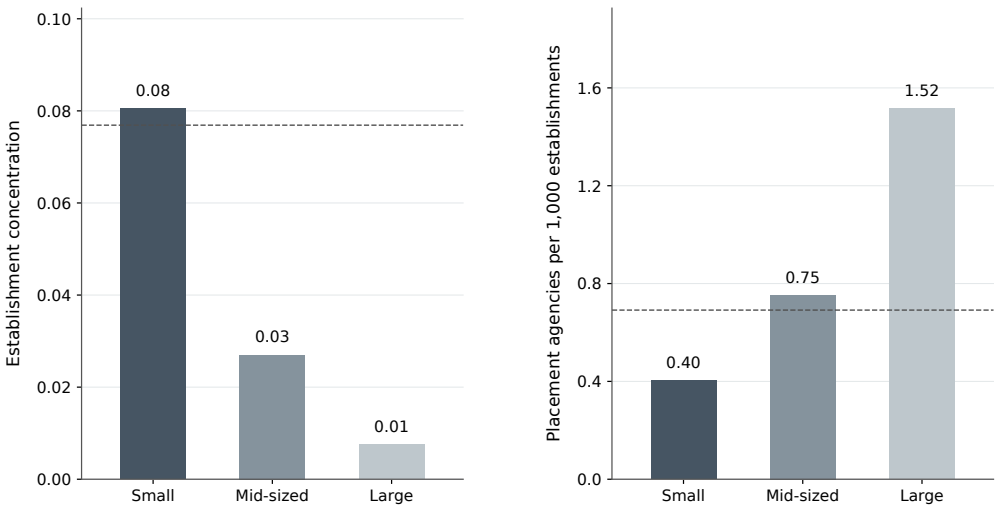


Figure D4. Establishment concentration and placement agencies across commuting zones

Notes: Left: median establishment concentration index after pooling CBP size-class counts within CZ and two-digit industry; the employment imputation follows the county method, and establishments under common ownership are not consolidated. Right: placement agencies (NAICS 561310) per 1,000 establishments, a ratio of group totals. 2007 CBP. CZ groups as in Table D1. The dashed lines mark the mid-sized-county values.

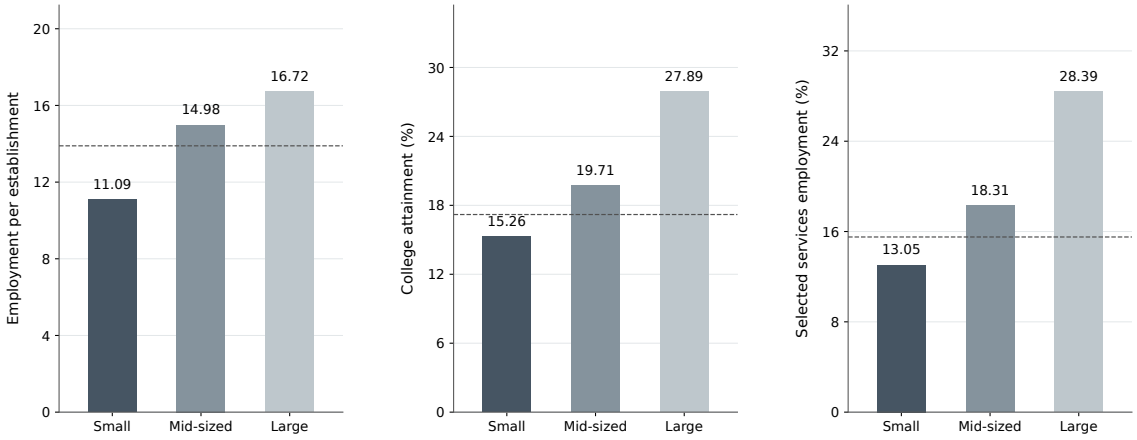


Figure D5. Establishment size and job composition across commuting zones

Notes: CZ medians of employment per establishment (2007 CBP, left), the share of adults aged 25 and older with a bachelor's degree (2000 Census, center), and information, finance, and professional and business services as a share of private employment (2006 QCEW, right). CZ groups as in Table D1. 425 small, 224 mid-sized, and 40 large CZs; 423 small CZs in the right panel. The dashed lines mark the mid-sized-county medians.

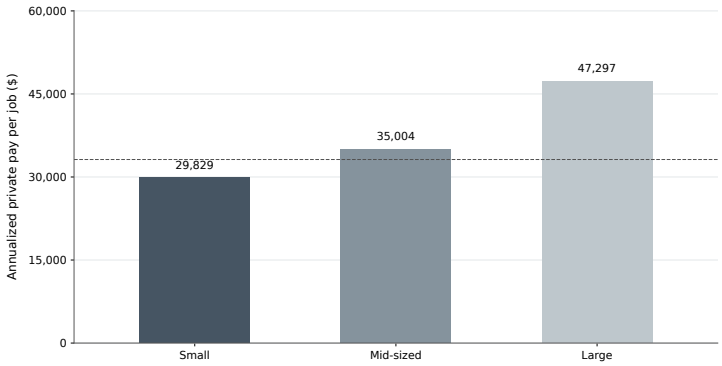


Figure D6. Private-sector pay across commuting zones

Notes: CZ medians of annualized private pay per job, 2008 QCEW; quarterly private payroll and quarter-end employment are summed within each CZ before forming ratios, and four quarters are required. CZ groups as in Table D1. CZs with data: 424 small, 224 mid-sized, and 40 large. The dashed line marks the mid-sized-county median.

Table D2. Commuting-zone characteristics and the mid-sized-county benchmark

	Commuting zones			Mid-sized
	Small	Mid-sized	Large	counties
Commuting closedness	67.24	75.99	84.78	52.43
Six-digit industries	414.05	721.60	960.20	484.80
Supplier industries	150.48	333.56	523.01	184.32
Establishment concentration	0.08	0.03	0.01	0.08
Placement agencies / 1,000	0.40	0.75	1.52	0.69
Employment / establishment	11.09	14.98	16.72	13.89
College attainment (%)	15.26	19.71	27.89	17.20
Selected services (%)	13.05	18.31	28.39	15.52
Annualized private pay ($)	29,829	35,004	47,297	33,156

Notes: Summary of Figures D2 to D6. Commuting closedness and industry counts are means weighted by 2008 adult population; placement agencies are a ratio of group totals; the other rows are medians. CZ groups as in Table D1; sources and coverage as in the figures.

E Agents' problems and first-order conditions

I state the problem of each agent and its first-order conditions. Every region has the same structure, so I drop the region subscript j where no confusion arises. Every allocation and parameter remains region specific. Section E.8 collects the complete set of equilibrium conditions.

E.1 The household's problem

E.1.1 Objective

The state of the household at the start of period t is its stock of employed members, e_{t-1}, and its holdings of nominal bonds, D_{t-1}. The household chooses market consumption c_t^m, bonds D_t, its labor force ℓ_t, and employment e_t to maximize

$$\mathcal{V}(e_{t-1}, D_{t-1}) = \max_{c_t^m, D_t, \ell_t, e_t} \Big\{ U(c_t^m, c_t^h) + \beta \, \mathbb{E}_t \big[\mathcal{V}(e_t, D_t) \big] \Big\}, \tag{E.1}$$

with $U(c_t^m, c_t^h) = Z_t \log c_t^m + \phi \, (c_t^h)^{1-\nu}/(1-\nu)$.

E.1.2 Constraints

Substituting the search pool into (4.2), employment evolves as

$$e_t = (1-\rho)(1-f_t)e_{t-1} + f_t \ell_t, \tag{E.2}$$

with f_t taken as given. Home output is

$$c_t^h = A^h \big[1 - (1-\Gamma) e_t - \Gamma \ell_t \big], \tag{E.3}$$

so the marginal product of home time is $\mathrm{MP}^h = A^h$. The budget constraint is

$$P_t c_t^m + R_t^{-1} D_t + P_t \frac{\phi_b}{2} \left(\frac{D_t}{P_t} - \frac{D_{ss}}{P_{ss}} \right)^2 = D_{t-1} + W_t e_t + P_t b(\ell_t - e_t) - P_t \tau_t + \Pi_t, \tag{E.4}$$

with real bonds $d_t \equiv D_t/P_t$ and $d_{ss} \equiv D_{ss}/P_{ss}$.

E.1.3 Lagrangian

The Lagrangian is

$$\begin{aligned}\mathcal{L} = {} & U(c_t^m, c_t^h) + \beta\,\mathbb{E}_t\big[\mathcal{V}(e_t, D_t)\big] \\ & + \lambda_t\left[D_{t-1} + W_t e_t + P_t b(\ell_t - e_t) - P_t\tau_t + \Pi_t - P_t c_t^m - R_t^{-1}D_t - P_t\frac{\phi_b}{2}\left(\frac{D_t}{P_t} - \frac{D_{ss}}{P_{ss}}\right)^2\right] \\ & + \Psi_t\big[(1-\rho)(1-f_t)e_{t-1} + f_t\ell_t - e_t\big]. \end{aligned} \tag{E.5}$$

E.1.4 First-order conditions

a. First-order condition for c_t^m

$$\lambda_t = \frac{U_{c_t^m}}{P_t} = \frac{Z_t}{P_t c_t^m}. \tag{E.6}$$

b. First-order condition for D_t. With the envelope condition $\partial\mathcal{V}/\partial D_{t-1} = \lambda_t$ and the nominal stochastic discount factor $Q_{t,t+1} \equiv \beta\lambda_{t+1}/\lambda_t$,

$$R_t^{-1} + \phi_b(d_t - d_{ss}) = \mathbb{E}_t\big[Q_{t,t+1}\big]. \tag{E.7}$$

c. First-order condition for e_t. With the envelope condition $\partial\mathcal{V}/\partial e_{t-1} = \Psi_t(1-\rho)(1-f_t)$,

$$\Psi_t = \lambda_t(W_t - P_t b) - U_{c_t^h}(1-\Gamma)\mathrm{MP}^h + \beta(1-\rho)\,\mathbb{E}_t\big[(1-f_{t+1})\Psi_{t+1}\big]. \tag{E.8}$$

d. First-order condition for ℓ_t

$$U_{c_t^h}\,\Gamma\,\mathrm{MP}^h = \lambda_t P_t b + \Psi_t f_t. \tag{E.9}$$

E.1.5 Conditions in real units

With $V_t^W \equiv \Psi_t/(P_t\lambda_t)$, $\mathrm{MRS}_t \equiv U_{c_t^h}/U_{c_t^m} = \phi Z_t^{-1} c_t^m (c_t^h)^{-\nu}$, $w_t \equiv W_t/P_t$, and $\pi_{t+1} \equiv P_{t+1}/P_t$, dividing (E.8) and (E.9) by $P_t\lambda_t = U_{c_t^m}$ gives the worker's surplus and the participation condition,

$$V_t^W = w_t - b - (1-\Gamma)\,\mathrm{MRS}_t\,\mathrm{MP}^h + (1-\rho)\,\mathbb{E}_t\big[Q_{t,t+1}\pi_{t+1}(1-f_{t+1})V_{t+1}^W\big], \tag{E.10}$$

$$\Gamma\,\mathrm{MRS}_t\,\mathrm{MP}^h = b + f_t V_t^W, \tag{E.11}$$

E.2 The wholesale firm's problem

E.2.1 Objective

The wholesale firm produces $X_t = A\,(s_j e_t)$ and sells it at the nominal price P_t^x, with $p_t^x \equiv P_t^x/P_t$. Its value at the start of period t is

$$F(e_{t-1}) = \max_{v_t, e_t} \left\{ s_j(P_t^x A - W_t)e_t - s_j P_t \kappa v_t + \mathbb{E}_t\left[Q_{t,t+1}F(e_t)\right] \right\} \quad \text{s.t.} \quad e_t = (1-\rho)e_{t-1} + q_t v_t, \tag{E.12}$$

where v_t is vacancies per resident, κ is the real cost per vacancy, and q_t is taken as given.

E.2.2 Lagrangian

$$\mathcal{L} = s_j(P_t^x A - W_t)e_t - s_j P_t \kappa v_t + \mathbb{E}_t\left[Q_{t,t+1}F(e_t)\right] + \lambda_t^F\left[(1-\rho)e_{t-1} + q_t v_t - e_t\right]. \tag{E.13}$$

E.2.3 First-order conditions

Let $V_t^F \equiv \lambda_t^F/(s_j P_t)$ be the real value of a filled job per worker.

a. First-order condition for v_t

$$V_t^F = \frac{\kappa}{q_t}. \tag{E.14}$$

b. First-order condition for e_t. With the envelope condition $F_e(e_{t-1}) = (1-\rho)\lambda_t^F$,

$$V_t^F = p_t^x A - w_t + (1-\rho)\,\mathbb{E}_t\left[Q_{t,t+1}\pi_{t+1}V_{t+1}^F\right]. \tag{E.15}$$

Combining (a) and (b) gives the job-creation condition (4.9). Aggregate real profits of the wholesale sector are

$$\Pi_t^{WH} = p_t^x X_t - s_j w_t e_t - s_j \kappa v_t. \tag{E.16}$$

E.3 Nash bargaining

The wage maximizes $(V_t^W)^\eta (V_t^F)^{1-\eta}$, where the surpluses are (E.10) and (E.15).

a. First-order condition for w_t

$$(1-\eta)V_t^W = \eta\, V_t^F. \tag{E.17}$$

b. Wage. Substituting the surpluses, with $V_{t+1}^F = \kappa/q_{t+1}$, into (E.17) gives the wage

$$w_t = \eta\, p_t^x A + (1-\eta)\left[b + (1-\Gamma)\,\mathrm{MRS}_t\,\mathrm{MP}^h\right] + \eta(1-\rho)\,\mathbb{E}_t\left[Q_{t,t+1}\pi_{t+1}f_{t+1}\frac{\kappa}{q_{t+1}}\right]. \tag{E.18}$$

E.4 The final good firm's problem

E.4.1 Objective

A competitive final good firm in region j takes as given the price P_j of the final good and the price $p_k(a)$ of each variety $a \in [0,1]$ from region k. It solves

$$\max_{Y_j,\{y_{jk}(a)\}} P_j Y_j - \sum_k \int_0^1 p_k(a)\, y_{jk}(a)\, da \quad \text{s.t.} \quad Y_j = \Big[\sum_{k=1}^N \xi_{jk}^{1/\varepsilon} \int_0^1 y_{jk}(a)^{\frac{\varepsilon-1}{\varepsilon}} da\Big]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{E.19}$$

with trade weights $\xi_{jk} \geq 0$, $\sum_k \xi_{jk} = 1$, home bias ξ_{jj}, and elasticity $\varepsilon > 1$. I drop time subscripts in this subsection.

E.4.2 First-order conditions

a. First-order condition for Y_j. The multiplier on the technology equals the price of the final good, P_j.

b. First-order condition for $y_{jk}(a)$

$$y_{jk}(a) = \xi_{jk} \left(\frac{p_k(a)}{P_j}\right)^{-\varepsilon} Y_j. \tag{E.20}$$

Substituting the demands into the technology gives the price index

$$P_j^{1-\varepsilon} = \sum_k \xi_{jk} \int_0^1 p_k(a)^{1-\varepsilon}\, da. \tag{E.21}$$

These are the two parts of (4.10), and the firm makes zero profit.

c. The price index under Calvo pricing. A fraction $1-\delta$ of firms in each origin reset their price to p_{kt}^*, and non-resetters are a random draw of last period's firms. Because δ is common across regions and the trade weights are constant, (E.21) becomes

$$1 = (1-\delta) \sum_k \xi_{jk} \big(p_{kt}^{\#} Q_{kj,t}\big)^{1-\varepsilon} + \delta\, \pi_{jt}^{\varepsilon-1}, \tag{E.22}$$

where $p_{kt}^{\#} \equiv p_{kt}^*/P_{kt}$ and $Q_{kj,t} = P_{kt}/P_{jt}$ evolves as $Q_{kj,t} = Q_{kj,t-1}\pi_{kt}/\pi_{jt}$.

E.5 The intermediate firm's problem

E.5.1 Demand and cost

Summing (E.20) across destinations, weighted by population, a firm a in origin k faces

$$y_{kt}(a) = \left(\frac{p_{kt}(a)}{P_{kt}}\right)^{-\varepsilon} \mathcal{D}_{kt}, \qquad \mathcal{D}_{kt} = \sum_{j=1}^{N} s_j \, \xi_{jk} \, Q_{jk,t}^{\varepsilon} \, Y_{jt}. \tag{E.23}$$

The demand shifter $\mathcal{D}_{kt}$ is (4.11); it is an aggregate quantity that scales with the population of the destinations. The firm turns one unit of the wholesale good into one unit of its variety, so real marginal cost is $\text{RMC}_{kt} = p_{kt}^{x}$.

E.5.2 Objective

A firm that resets at t chooses p_{kt}^{*} to maximize the expected discounted nominal profits earned while the price is in place,

$$\max_{p_{kt}^{*}} \; \mathbb{E}_t \sum_{h \geq 0} \delta^h \, Q_{t,t+h}^{k} \Big[(p_{kt}^{*})^{1-\varepsilon} - P_{k,t+h}^{x} (p_{kt}^{*})^{-\varepsilon} \Big] P_{k,t+h}^{\varepsilon} \mathcal{D}_{k,t+h}, \qquad Q_{t,t+h}^{k} = \beta^h \frac{\lambda_{k,t+h}}{\lambda_{kt}}. \tag{E.24}$$

E.5.3 First-order condition

a. First-order condition for p_{kt}^{*}. The relative reset price is

$$p_{kt}^{\#} = \frac{\varepsilon}{\varepsilon - 1} \frac{K_{kt}}{F_{kt}}, \tag{E.25}$$

a markup over a weighted average of expected real marginal costs, where the numerator and denominator follow

$$K_{kt} = \mathcal{D}_{kt} \text{RMC}_{kt} + \delta \, \mathbb{E}_t \big[Q_{t,t+1}^{k} \pi_{k,t+1}^{1+\varepsilon} K_{k,t+1} \big], \tag{E.26}$$

$$F_{kt} = \mathcal{D}_{kt} + \delta \, \mathbb{E}_t \big[Q_{t,t+1}^{k} \pi_{k,t+1}^{\varepsilon} F_{k,t+1} \big]. \tag{E.27}$$

E.5.4 Aggregation

Integrating the input requirement over firms, wholesale output equals demand weighted by price dispersion $\Delta_{kt} \equiv \int_0^1 [p_{kt}(a)/P_{kt}]^{-\varepsilon} da$,

$$A_k \, s_k e_{kt} = \Delta_{kt} \mathcal{D}_{kt}, \qquad \Delta_{kt} = (1-\delta) \big(p_{kt}^{\#} \big)^{-\varepsilon} + \delta \, \pi_{kt}^{\varepsilon} \Delta_{k,t-1}. \tag{E.28}$$

Real output $\bar{Y}_{kt} \equiv \int_0^1 (p_{kt}(a)/P_{kt})\, y_{kt}(a)\, da$ and aggregate real profits of the region's firms satisfy

$$\bar{Y}_{kt} = (1-\delta)\mathcal{D}_{kt}\big(p_{kt}^{\#}\big)^{1-\varepsilon} + \delta\,\frac{\mathcal{D}_{kt}}{\mathcal{D}_{k,t-1}}\,\pi_{kt}^{\varepsilon-1}\bar{Y}_{k,t-1}, \qquad \Pi_{kt}^{agg} = \bar{Y}_{kt} - s_k w_{kt} e_{kt} - s_k \kappa_k v_{kt}, \quad \text{(E.29)}$$

where the payment for wholesale output cancels between the two sectors. Nominal profit income per resident in (E.4) is $\Pi_{kt} = P_{kt}\Pi_{kt}^{agg}/s_k$.

E.6 Exogenous processes

The economy is driven by government purchases and the preference shifter in (4.15). Steady-state purchases $G_{j,ss}$ are 20 percent of steady-state output. Program spending ΔG_{jt} is zero outside 2009Q3–2012Q4; inside that window it is the county's observed spending converted into model units by (5.3). The preference shifter satisfies $\log Z_{jt} = \log Z_{j,ss} + \zeta_t$, with innovations common to all regions and no autoregressive component. ζ_t covers 2007Q4–2015Q4, and I recover it so that national EPOP in the standard economy matches the data given observed spending; innovations are zero afterward.

E.7 Fiscal and monetary policy

The federal authority's nominal outlays per resident of the union are $\sum_k s_k P_{kt} G_{kt} + \sum_k s_k P_{kt} b_k u_{kt}$. Each region pays its population share of these outlays, so the nominal tax per resident is the common amount T_t in (4.13), and the real tax in region j is $\tau_{jt} = T_t/P_{jt}$. The central bank sets the nominal rate by the rule (4.14), subject to the zero lower bound.

E.8 The complete system

Collecting the conditions derived above, an equilibrium is a set of paths that satisfy, for every region j and date t, the household conditions

$$\lambda_{jt} = \frac{Z_{jt}}{P_{jt} c_{jt}^{m}}, \qquad Q_{j,t,t+1} = \beta\frac{\lambda_{j,t+1}}{\lambda_{jt}}, \qquad \mathrm{MRS}_{jt} = \phi Z_{jt}^{-1} c_{jt}^{m} (c_{jt}^{h})^{-\nu}, \quad \text{(E.30)}$$

$$c_{jt}^{h} = A_j^{h}\big[1 - (1-\Gamma)e_{jt} - \Gamma\ell_{jt}\big], \qquad R_t^{-1} + \phi_b(d_{jt} - d_{j,ss}) = \mathbb{E}_t\big[Q_{j,t,t+1}\big], \quad \text{(E.31)}$$

$$\Gamma\,\mathrm{MRS}_{jt}\,\mathrm{MP}_j^{h} = b_j + f_{jt}V_{jt}^{W}, \quad \text{(E.32)}$$

$$V_{jt}^{W} = w_{jt} - b_j - (1-\Gamma)\,\mathrm{MRS}_{jt}\,\mathrm{MP}_j^{h} + (1-\rho)\,\mathbb{E}_t\big[Q_{j,t,t+1}\pi_{j,t+1}(1-f_{j,t+1})V_{j,t+1}^{W}\big], \quad \text{(E.33)}$$

$$c_{jt}^{m} + R_t^{-1}d_{jt} + \frac{\phi_b}{2}(d_{jt} - d_{j,ss})^2 = \frac{d_{j,t-1}}{\pi_{jt}} + w_{jt}e_{jt} + b_j(\ell_{jt} - e_{jt}) - \tau_{jt} + \frac{\Pi_{jt}^{agg}}{s_j}; \quad \text{(E.34)}$$

the labor-market conditions

$$\mathcal{S}_{jt} = \ell_{jt} - (1-\rho)e_{j,t-1}, \qquad e_{jt} = (1-\rho)e_{j,t-1} + f_{jt}\mathcal{S}_{jt}, \tag{E.35}$$

$$\theta_{jt} = \frac{v_{jt}}{\mathcal{S}_{jt}}, \qquad f_{jt} = \omega_j \theta_{jt}^{1-\gamma_j}, \qquad q_{jt} = \omega_j \theta_{jt}^{-\gamma_j}, \tag{E.36}$$

$$\frac{\kappa_j}{q_{jt}} = p_{jt}^x A_j - w_{jt} + (1-\rho)\,\mathbb{E}_t\left[Q_{j,t,t+1}\pi_{j,t+1}\frac{\kappa_j}{q_{j,t+1}}\right], \tag{E.37}$$

$$w_{jt} = \eta_j\, p_{jt}^x A_j + (1-\eta_j)\left[b_j + (1-\Gamma)\,\mathrm{MRS}_{jt}\,\mathrm{MP}_j^h\right] + \eta_j(1-\rho)\,\mathbb{E}_t\left[Q_{j,t,t+1}\pi_{j,t+1}f_{j,t+1}\frac{\kappa_j}{q_{j,t+1}}\right]; \tag{E.38}$$

the pricing conditions

$$p_{jt}^{\#} = \frac{\varepsilon}{\varepsilon - 1}\frac{K_{jt}}{F_{jt}}, \tag{E.39}$$

$$K_{jt} = \mathcal{D}_{jt}\, p_{jt}^x + \delta\,\mathbb{E}_t\left[Q_{j,t,t+1}\pi_{j,t+1}^{1+\varepsilon}K_{j,t+1}\right], \qquad F_{jt} = \mathcal{D}_{jt} + \delta\,\mathbb{E}_t\left[Q_{j,t,t+1}\pi_{j,t+1}^{\varepsilon}F_{j,t+1}\right], \tag{E.40}$$

$$\Delta_{jt} = (1-\delta)\left(p_{jt}^{\#}\right)^{-\varepsilon} + \delta\,\pi_{jt}^{\varepsilon}\Delta_{j,t-1}, \tag{E.41}$$

$$\bar{Y}_{jt} = (1-\delta)\mathcal{D}_{jt}\left(p_{jt}^{\#}\right)^{1-\varepsilon} + \delta\,\frac{\mathcal{D}_{jt}}{\mathcal{D}_{j,t-1}}\,\pi_{jt}^{\varepsilon-1}\bar{Y}_{j,t-1}; \tag{E.42}$$

the trade and price-level conditions

$$1 = (1-\delta)\sum_k \xi_{jk}\left(p_{kt}^{\#}\,Q_{kj,t}\right)^{1-\varepsilon} + \delta\,\pi_{jt}^{\varepsilon-1}, \tag{E.43}$$

$$\mathcal{D}_{jt} = \sum_k s_k\,\xi_{kj}\,Q_{kj,t}^{\varepsilon}\,Y_{kt}, \qquad Q_{kj,t} = Q_{kj,t-1}\frac{\pi_{kt}}{\pi_{jt}}; \tag{E.44}$$

and the market-clearing and income conditions

$$Y_{jt} = c_{jt}^m + G_{jt} + \kappa_j v_{jt} + \frac{\phi_b}{2}(d_{jt} - d_{j,ss})^2, \qquad A_j\, s_j e_{jt} = \Delta_{jt}\mathcal{D}_{jt}, \tag{E.45}$$

$$\Pi_{jt}^{agg} = \bar{Y}_{jt} - s_j w_{jt} e_{jt} - s_j \kappa_j v_{jt}. \tag{E.46}$$

The budget constraint (E.34) is (E.4) divided by P_{jt}. The union-wide objects satisfy the federal budget (4.13), with $\tau_{jt} = T_t/P_{jt}$, the policy rule (4.14), and bond clearing $\sum_j s_j P_{jt} d_{jt} = 0$.

E.9 Steady-state targets

Given the employment rate, participation rate, and filling probability $(e_{j,ss}, \ell_{j,ss}, q_{j,ss})$, the steady state of (4.2) and (4.3) implies

$$\mathcal{S}_{j,ss} = \ell_{j,ss} - (1-\rho)e_{j,ss}, \qquad f_{j,ss} = \frac{\rho e_{j,ss}}{\mathcal{S}_{j,ss}}, \qquad \theta_{j,ss} = \frac{f_{j,ss}}{q_{j,ss}}, \qquad \omega_j = \frac{f_{j,ss}}{\theta_{j,ss}^{1-\gamma_j}}. \tag{E.47}$$

The first identity counts as searchers the participants who are not in surviving matches. The second sets the finding rate at which hires replace the jobs that separate each quarter, and the last two recover tightness and matching efficiency. The steady-state participation, bargaining, and job-creation conditions then determine (κ_j, b_j, ϕ_j) jointly with wages and relative prices. The recruiting-cost target pins down κ_j, and the benefit and the value of home production make the worker's outside option consistent with the bargaining and participation conditions.

F Proof of Proposition 1

F.1 Setting and notation

The county economy is the N-region economy of Section 4 with one region per county, population shares s_i, and trade weights given by (4.19). Its equilibrium conditions are (E.30)–(E.46), with j ranging over counties, together with the federal budget (4.13), the policy rule (4.14), and bond clearing.

Counties are partitioned into K groups. Group $k \in \mathcal{K} = \{1, \ldots, K\}$ contains the counties in $\mathcal{I}_k$ and has population share

$$S_k = \sum_{i \in \mathcal{I}_k} s_i.$$

The block economy is the K-region economy with population shares S_k and trade weights Ξ given by (4.20). A superscript b marks block-economy objects.

Under the assumptions, every county in group k has the same population share $\bar{s}_k$; the same preferences, technology, labor-market parameters, and pricing friction; the same per-capita paths of G and Z; and the same initial intensive states and price distributions.

I distinguish two kinds of variables, listed in Table F1. Intensive variables are per resident or are prices and values. Extensive variables are regional totals, and they scale with a region's population.

Table F1. Intensive and extensive variables

	Class	Variables
Intensive	Quantities per resident	c^m, c^h, ℓ, e, $\mathcal{S}$, u, n, v, d, Y
	Prices	P, π, p^x, w, $p^\#$, Δ, τ
	Values	λ, Q, MRS, V^W, V^F
	Matching rates	θ, f, q
Extensive	Regional totals	X, $\mathcal{D}$, K, F, $\bar{Y}$, Π^{agg}

Definition 2. A county equilibrium is *symmetric within groups* if, at every date and for any two counties i and i' in the same group, every intensive variable takes the same value in i as in i'.

Two lemmas first show how the county trade weights aggregate to the block weights. Section F.3 shows that the common group values of a within-group symmetric county equilibrium solve the block economy, and Section F.4 shows the converse. I drop time subscripts where no confusion arises.

F.2 Aggregating the trade weights

Lemma 1 (Destination weights)**.** *For any county $i \in \mathcal{I}_k$ and any group r,*

$$\sum_{i' \in \mathcal{I}_r} \xi_{ii'} = \Xi_{kr}. \tag{F.1}$$

Proof. Take first $r \neq k$. Every $i' \in \mathcal{I}_r$ is a different county from i, so by the off-diagonal rule in (4.19) and $s_i = \bar{s}_k$,

$$\sum_{i' \in \mathcal{I}_r} \xi_{ii'} = \sum_{i' \in \mathcal{I}_r} (1 - \xi_k) \frac{s_{i'}}{1 - \bar{s}_k} = (1 - \xi_k) \frac{S_r}{1 - \bar{s}_k} = \Xi_{kr}.$$

Now take $r = k$. The sum contains the own-county term $\xi_{ii} = \xi_k$ and the terms for the other counties of the group, whose population shares sum to $S_k - \bar{s}_k$. Hence

$$\sum_{i' \in \mathcal{I}_k} \xi_{ii'} = \xi_k + \sum_{\substack{i' \in \mathcal{I}_k \\ i' \neq i}} (1 - \xi_k) \frac{s_{i'}}{1 - \bar{s}_k} = \xi_k + (1 - \xi_k) \frac{S_k - \bar{s}_k}{1 - \bar{s}_k} = \Xi_{kk}. \qquad \square$$

Summing (F.1) over r confirms that the block weights form a row-stochastic matrix,

$$\sum_r \Xi_{kr} = \xi_k + (1 - \xi_k) \frac{(S_k - \bar{s}_k) + \sum_{r \neq k} S_r}{1 - \bar{s}_k} = \xi_k + (1 - \xi_k) = 1.$$

Lemma 2 (Source weights)**.** *For any county $i \in \mathcal{I}_k$ and any group r, the population-weighted weight that the counties of group r place on county i's goods is*

$$\sum_{i' \in \mathcal{I}_r} s_{i'} \, \xi_{i'i} = \frac{s_i}{S_k} \, S_r \, \Xi_{rk}. \tag{F.2}$$

Proof. Take first $r \neq k$. Each $i' \in \mathcal{I}_r$ places the weight $\xi_{i'i} = (1 - \xi_r) s_i / (1 - \bar{s}_r)$ on county i, so

$$\sum_{i' \in \mathcal{I}_r} s_{i'} \, \xi_{i'i} = (1 - \xi_r) \frac{s_i}{1 - \bar{s}_r} \, S_r = \frac{s_i}{S_k} \, S_r \left[(1 - \xi_r) \frac{S_k}{1 - \bar{s}_r} \right] = \frac{s_i}{S_k} \, S_r \, \Xi_{rk},$$

where the last step uses the off-diagonal block weight in (4.20). Now take $r = k$ and separate county i's own weight from those of the other counties in its group:

$$\sum_{i' \in \mathcal{I}_k} s_{i'} \, \xi_{i'i} = s_i \, \xi_k + \sum_{\substack{i' \in \mathcal{I}_k \\ i' \neq i}} s_{i'} (1 - \xi_k) \frac{s_i}{1 - \bar{s}_k} = s_i \left[\xi_k + (1 - \xi_k) \frac{S_k - \bar{s}_k}{1 - \bar{s}_k} \right] = \frac{s_i}{S_k} \, S_k \, \Xi_{kk}. \qquad \square$$

F.3 From the county economy to the block economy

Let a within-group symmetric equilibrium of the county economy be given. For each group k, write $c_k^m, \ell_k, e_k, \ldots$ and $P_k, \pi_k, \ldots$ for the common values of its counties' intensive variables. Define the block extensive variables by summing over the group,

$$\mathcal{Z}_k^b = \sum_{i \in \mathcal{I}_k} \mathcal{Z}_i \qquad \text{for } \mathcal{Z} \in \{X,\ \mathcal{D},\ K,\ F,\ \bar{Y},\ \Pi^{agg}\},$$

and set the block intensive variables equal to the common group values. I verify in six steps that these objects satisfy every condition in Section E.8 for the K-region economy with shares S_k and weights Ξ.

Step 1: the price level

County $i \in \mathcal{I}_k$ satisfies (E.43),

$$1 = (1-\delta) \sum_{i'} \xi_{ii'} \left(p_{i'}^{\#}\, Q_{i'i}\right)^{1-\varepsilon} + \delta\, \pi_i^{\varepsilon-1},$$

where the sum runs over all counties. For $i' \in \mathcal{I}_r$, symmetry gives $p_{i'}^{\#} = p_r^{\#}$ and $Q_{i'i} = P_r/P_k = Q_{rk}$. Grouping the terms by the origin's group and applying Lemma 1,

$$1 = (1-\delta) \sum_r \Big[\sum_{i' \in \mathcal{I}_r} \xi_{ii'} \Big] \left(p_r^{\#}\, Q_{rk}\right)^{1-\varepsilon} + \delta\, \pi_k^{\varepsilon-1} = (1-\delta) \sum_r \Xi_{kr} \left(p_r^{\#}\, Q_{rk}\right)^{1-\varepsilon} + \delta\, \pi_k^{\varepsilon-1}.$$

The last expression is the price-level condition of block k. The real exchange rates between groups evolve with the common group inflation rates, as (E.44) requires.

Step 2: demand

The county demand shifter is

$$\mathcal{D}_i = \sum_{i'} s_{i'}\, \xi_{i'i}\, Q_{i'i}^{\varepsilon}\, Y_{i'}.$$

For $i' \in \mathcal{I}_r$, symmetry gives $Y_{i'} = Y_r$ and $Q_{i'i} = Q_{rk}$. Grouping by the destination's group and applying Lemma 2,

$$\mathcal{D}_i = \sum_r \Big[\sum_{i' \in \mathcal{I}_r} s_{i'}\, \xi_{i'i} \Big] Q_{rk}^{\varepsilon}\, Y_r = \frac{s_i}{S_k} \sum_r S_r\, \Xi_{rk}\, Q_{rk}^{\varepsilon}\, Y_r.$$

The sum on the right is the block demand shifter $\mathcal{D}_k^b$ of (E.23), with shares S_r and weights Ξ_{rk}. Hence

$$\mathcal{D}_i = \frac{s_i}{S_k}\,\mathcal{D}_k^b.$$

Each county receives demand in proportion to its population share within the group, and summing over $i \in \mathcal{I}_k$ returns $\mathcal{D}_k^b$, consistent with the definition above. The same argument applied to the variety demand (E.23) shows that a county's varieties face the block demand scaled by s_i/S_k.

Step 3: wholesale market clearing

County i satisfies $A_k\, s_i e_i = \Delta_i D_i$. Substituting $e_i = e_k$, $\Delta_i = \Delta_k$, and $\mathcal{D}_i = (s_i/S_k)\mathcal{D}_k^b$, and cancelling s_i,

$$A_k\, S_k e_k = \Delta_k\, \mathcal{D}_k^b,$$

which is the block condition. Summing $X_i = A_k s_i e_k$ over the group gives $X_k^b = A_k S_k e_k$.

Step 4: pricing, output, and profits

The recursions for K_i and F_i in (E.40) are linear in $(K_i, F_i, \mathcal{D}_i)$, and their coefficients $(p_i^{\mathrm{x}}, \delta, Q_i, \pi_i)$ are common within the group. Since $\mathcal{D}_i = (s_i/S_k)\mathcal{D}_k^b$, the pair

$$K_i = \frac{s_i}{S_k}\,K_k^b, \qquad F_i = \frac{s_i}{S_k}\,F_k^b$$

satisfies the county recursions if and only if (K_k^b, F_k^b) satisfies the block recursions. The reset price is a ratio,

$$p_i^{\#} = \frac{\varepsilon}{\varepsilon - 1}\,\frac{K_i}{F_i} = \frac{\varepsilon}{\varepsilon - 1}\,\frac{K_k^b}{F_k^b},$$

so it is the same in every county of the group and equals the block reset price. The dispersion recursion (E.41) involves only $p^{\#}$, π, and δ, so the common county values satisfy the block recursion.

The output recursion (E.42) is linear in $(\bar{Y}_i, \mathcal{D}_i)$ and depends on demand growth only through $\mathcal{D}_{i,t}/\mathcal{D}_{i,t-1} = \mathcal{D}_{k,t}^b/\mathcal{D}_{k,t-1}^b$. Hence $\bar{Y}_i = (s_i/S_k)\bar{Y}_k^b$. Aggregate profits then satisfy

$$\Pi_i^{agg} = \bar{Y}_i - s_i w_k e_k - s_i \kappa_k v_k = \frac{s_i}{S_k}\,\Pi_k^{agg,b},$$

so profit income per resident, $\Pi_i^{agg}/s_i = \Pi_k^{agg,b}/S_k$, is the same in every county of the group and equals its block value.

Step 5: households, the labor market, and wages

Conditions (E.30)–(E.38) involve only a region's own per-resident quantities, prices, values, and parameters, its profit income per resident, the real tax, and the common nominal rate R_t. The real tax $\tau_i = T_t/P_i$ is common within the group because $P_i = P_k$, and profit income per resident is common by Step 4. In a within-group symmetric equilibrium all of these are the same for every county in the group, so the common values satisfy the same equations. Those equations are the block-economy versions of (E.30)–(E.38) for region k. The goods-market condition in (E.45) is per resident and carries over unchanged.

Step 6: policy and national aggregates

The federal tax, bond clearing, and the arguments of the policy rule are population-weighted sums over counties. Grouping the terms,

$$T_t = \sum_i s_i P_i \big[G_i + b_k u_i\big] = \sum_k S_k P_k \big[G_k + b_k u_k\big],$$
$$0 = \sum_i s_i P_i d_i = \sum_k S_k P_k d_k,$$
$$\sum_i s_i \frac{\pi_i}{\pi_{i,ss}} = \sum_k S_k \frac{\pi_k}{\pi_{k,ss}}, \qquad \sum_i s_i \frac{\bar{Y}_i}{\bar{Y}_{i,ss}} = \sum_k S_k \frac{\bar{Y}^b_k}{\bar{Y}^b_{k,ss}},$$

where the last equality holds because $\bar{Y}_i$ and its steady-state value both scale by s_i/S_k. The county objects (R_t, T_t) therefore satisfy (4.13) and (4.14) for the block economy, and bond clearing holds. National employment satisfies

$$e^{\mathrm{U}}_t = \sum_i s_i e_i = \sum_k S_k e_k.$$

The initial conditions and exogenous paths of the block economy are the common group values by hypothesis, and normalizing a county's price level normalizes its group's.

Every condition in Section E.8 therefore holds for the block economy. Group-level intensive allocations and national population-weighted outcomes coincide across the two economies.

F.4 From the block economy to the county economy

Let a block equilibrium be given. Assign to every county $i \in \mathcal{I}_k$ the block's intensive variables, set the extensive variables by proportional scaling,

$$\mathcal{Z}_i = \frac{s_i}{S_k}\,\mathcal{Z}^b_k \qquad \text{for } \mathcal{Z} \in \{X,\ \mathcal{D},\ K,\ F,\ \bar{Y},\ \Pi^{agg}\},$$

and give each county the trade weights (4.19). The resulting county allocation is symmetric within groups by construction. It satisfies the county-economy conditions for the reasons established above, read in reverse.

The county price-level condition holds because Lemma 1 converts the block condition of Step 1 into the county condition. The county demand equation holds because Lemma 2 converts the block demand shifter into $\mathcal{D}_i = (s_i/S_k)\mathcal{D}_k^b$, which is the assigned value. Wholesale clearing holds because $A_k\, s_i e_k = \Delta_k (s_i/S_k)\mathcal{D}_k^b$ is the block condition multiplied by s_i/S_k.

The pricing and output recursions hold by the linearity argument of Step 4, and the reset price and dispersion recursions are unchanged. The household, labor-market, wage, and goods-market conditions and the boundary conditions hold because they are the same equations evaluated at the same values. The federal tax, bond clearing, and the policy rule hold because the population-weighted county sums equal the block sums, as in Step 6. The assigned initial states are admissible because the proposition assumes common initial intensive states and price distributions within each group.

The two constructions are inverse to each other. Aggregating the county equilibrium constructed from a block equilibrium returns that block equilibrium, and constructing a county equilibrium from the aggregate of a within-group symmetric county equilibrium returns the original. The only freedom is the labeling of varieties within a county, which the Armington aggregator treats symmetrically. This proves the proposition. □

F.5 The small-county approximation

Let Ξ^0 denote the approximate weights in (4.21). The differences from the exact weights are

$$\Xi^0_{kk} - \Xi_{kk} = \frac{(1-\xi_k)\,\bar{s}_k\,(1-S_k)}{1-\bar{s}_k}, \qquad \Xi_{kr} - \Xi^0_{kr} = \frac{(1-\xi_k)\,\bar{s}_k\,S_r}{1-\bar{s}_k} \quad (r \neq k).$$

Both vanish as individual county population shares go to zero. These expressions bound the errors in the trade weights. The errors in equilibrium responses also depend on the sensitivity of the equilibrium and on the monetary-policy regime.

G Sensitivity to the external calibration

In the type calibration, I attribute differences in responses to the focal county's own parameters. The attribution holds only if the response depends little on how I calibrate the rest of the country. To check, I change one external parameter at a time, keeping the standard focal-county inputs. Figure G1 reports the benchmark and two alternatives each for external productivity, bargaining, and recruiting costs. Changing external productivity by 20 percent changes the local coefficient by at most 7.8 percent, and the labor-market variations change it by at most 1.0 percent. The local response is governed by the county's own structure, and a common external calibration is adequate for computing it.

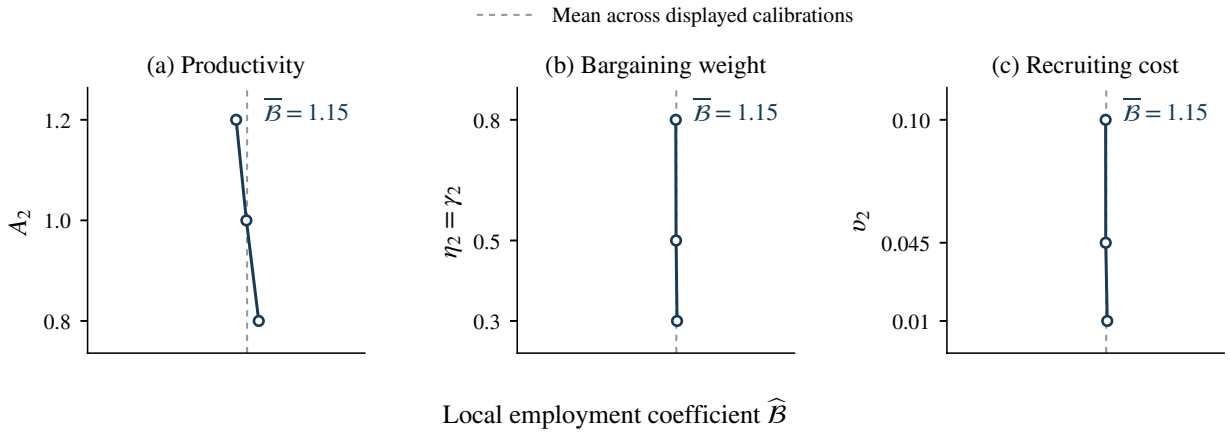


Figure G1. Sensitivity to the external calibration

Notes: The standard external inputs are $A_2 = 1$, $\eta_2 = \gamma_2 = 0.5$, and $\upsilon_2 = 4.5$ percent. Each panel varies only its vertical-axis parameter, using the same 250 counties and standard focal-region inputs. The steady state is resolved at each calibration.