Estimating the Incidence of Government Spending

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Abstract

This paper analyzes the economic incidence of sustained changes in federal government spending at the local level. We use a new identification strategy to isolate geographical variation in formula-based federal spending and develop three sets of results. First, we find that sustained changes in federal spending have significant effects on migration, income, wages, and rents, as well as on local government revenues and expenditures. Second, we show that the effects of a government spending shock are qualitatively different from those of a local labor demand shock. We develop a spatial equilibrium model to show that when workers value publicly-provided goods, a change in government spending at the local level will affect equilibrium wages through shifts in both the labor demand and supply curves. We test the reduced-form predictions of the model and show that workers value government services as amenities. Finally, we estimate workers' marginal valuation of government services and find that unskilled workers have a higher valuation of government services than skilled workers. We use these estimates to decompose the demand and supply components of a government spending shock and to evaluate the impacts on welfare that are produced by increasing government spending in a given area. Our estimates conclude that an additional dollar of government spending increases welfare by $1.45 in the median county.

Keywords: Government spending, distributional incidence, local public finance.

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1 Introduction

After the largest round of fiscal activism in the history of the United States, policymakers are now considering large and sustained changes in government spending.[1] While recent research provides new guidance on the impacts of government spending on short-run fluctuations, there are few empirical results of the long-term effects of government spending on economic welfare.[2] This paper informs this important policy debate by analyzing the economic incidence of sustained changes in government spending at the local level. A central implication of our analysis is that, if workers derive utility from goods and services provided by the government, reduced-form impacts on real wages are no longer sufficient statistics for measuring the effect of changes in government spending on economic welfare.

The role of government spending over the long term is to provide infrastructure, public goods, and public services that would be under-provided by private individuals due to a market failure.[3] However, increasing the local provision of public services may have opposing direct and indirect effects on workers' well-being. While an increase in the provision of public goods has a direct impact on workers' utility, there is downward pressure on workers' real wages as workers migrate to areas with higher provision of public goods, indirectly affecting workers' utility. In contrast to a labor demand shock, the economic incidence of a government spending shock is determined by changes in wages and rental costs as well as by workers' valuation of the goods and services provided by the government. This paper uses a novel identification strategy that provides new empirical evidence of the long-term effects of government spending, tests whether workers have positive valuations for publicly provided services, and quantifies the economic incidence of changes in government spending accounting for the direct effects of the provision of public services on workers' utility.

We formalize the intuition above in a spatial equilibrium model where government funds are used for three purposes. An increase in government spending can lead to (1) an increase in the provision of infrastructure, (2) an increase in the demand for local labor to provide public services, and (3) an increase in the public goods and services provided at the local level. The model shows that, through these different components, a government spending shock shifts both labor demand and supply functions. The simple logic behind the model can be understood in a supply and demand diagram. Figure 1 shows the long-run equilibrium in a local labor market where the supply of workers is driven exclusively by their decision to relocate into a given area. An increase in government spending leads to increases in infrastructure and direct hiring by the public sector, both of which lead to an increase in the demand for labor from D_0 to D_1. The workers hired by the public sector increase the provision of public services. To the extent that workers value these services, increasing their provision shifts the supply of workers from S_0 to S_2 leading to a reduction in the equilibrium wage. Importantly, the magnitude of the supply component depends on how much workers value the publicly provided services.

[1] Auerbach et al. (2010) review recent trends in activist fiscal policy.

[2] Ramey (2011) provides a recent survey of the literature on short-run effects on government spending and reviews recent cross-sectional approaches.

[3] The empirical analysis of this role of government spending has received relatively little attention from academic economists, except in the case of specific policies. For example, Busso et al. (2010) analyze a prominent place-based policy and Kline and Moretti (2011) analyze the long-term effects of the Tennessee Valley Authority. Cellini et al. (2010) estimate the valuation of investments in school facilities in California and Haines and Margo (2006) estimate the impact of railroads on local economic development prior to the U.S. Civil War.

This paper provides an empirical analysis of the effects of government spending on local labor and housing markets and develops three sets of results that culminate in the incidence analysis of economic welfare of skilled and unskilled workers. First, we use a novel strategy to identify sustained changes in federal formula-based spending programs that are potentially exogenous to local economic conditions.[4] We find large and significant long-run impacts of government spending on employment as well as aggregate income and find a sizable migration response. In contrast to studies of local labor demand shocks, we report larger wage gains for the skilled, a smaller skill mobility differential, and small impacts on housing prices.[5] Our analysis demonstrates that local public finances are impacted by federal government spending, with a dollar increase in federal spending crowding-out the per-capita collection of taxes and expenditures at the local level by \$0.21 and \$0.27, respectively.

Second, we provide a reduced-form test that discerns whether workers have a positive valuation of government services. A crucial implication of the model is that, if workers value publicly provided services, they would accept a smaller wage increase in order to relocate to areas with higher provision of government services. Moreover, to the extent that unskilled workers have a higher valuation for these services, they will accept a lower wage and have larger migratory response to this locality. Tests of these reduced-form predictions of the model find estimates that are consistent with a positive valuation of government services that is larger for unskilled workers. That workers are willing to accept a smaller increase in wages to relocate to areas with higher provision of public services indicates that they value these services as amenities.

Third, we estimate a fully specified model of labor and housing market equilibrium. We address problems of endogeneity by instrumenting the appropriate equations with a measure of exogenous shocks to local government spending in conjunction with a local labor demand shock first introduced by Bartik (1991). The model provides estimates of structural parameters that determine equilibrium in housing and labor markets, including workers' marginal valuation of government services. We find that unskilled workers have a large and statistically significant valuation for government services that is twice as large as that of skilled workers. These central parameters are then used to quantify margins of economic importance.

The structure of the model allows us to decompose the magnitudes of the supply and demand components of a government spending shock. We calculate that 53% of the migration response for the unskilled is due to the valuation of government services while only 19% of the migration margin is explained by the supply component for skilled workers. The decomposition of wage effects shows that a pure labor demand shock would yield an increase in wages that would be 46% larger for the unskilled and 32% larger for the skilled. These results reconcile the effects of a government spending shock with those of a pure labor demand shock and show that the demand component of the shock is biased toward skilled workers.

We use the model's estimates to study the welfare effects of two hypothetical policy experiments. First, we analyze the effects of increasing government spending by \$1,000 per person in the median county of the U.S. Our simulations show that ignoring workers' valuation of government services leads to an increase in social welfare valued at only \$650. In contrast, accounting for the direct effect on

[4] Suárez Serrato and Wingender (2011) provide an analysis of the short-run effects of government spending using a similar identification strategy. Table E.1 in Appendix E provides a list of formula-based spending programs.

[5] See, for example, Bartik (1991), Bound and Holzer (2000), and Notowidigdo (2011).

workers' utility from the provision of public services yields a benefit of $1,445 to social welfare. This exercise shows the importance of accounting for workers' valuation of government services in incidence calculations as this factor may determine whether increasing government spending is desirable or not. A second hypothetical experiment is to reallocate federal funds across localities depending on the skill composition of the local population. We study the implications of the differential valuations by skill group for the effectiveness of government spending to raise welfare in regions with different proportions of skilled and unskilled workers. We find that allocations of funds that are neutral to the local skill composition only arise from significantly regressive preferences and that government spending can be significantly more effective at raising welfare in areas with higher proportions of unskilled workers.

Our identification strategy builds on previous work by extending the methodology in Suárez Serrato and Wingender (2011). In this previous study, we introduced the census shock instrument as the difference between two population estimates and used these mistakes in population measurement to isolate cross-sectional variation in federal formula-based spending. By exploiting the dynamics of how the census shock affects federal spending, we identified yearly changes in government spending and provided new estimates of fiscal income and employment multipliers at the local level. The estimates of local fiscal multipliers help inform the debate of the effects of stimulus spending on economic activity in the short term.

In contrast to Suárez Serrato and Wingender (2011), this paper uses the census shock to identify sustained changes in government spending. The census shock instrument has the effect that, once all spending agencies adopt the new population estimates, it leads to an increase or decrease in government spending for the remainder of the decade. Our counterfactual experiment is the comparison of a locality with and without a sustained increase in government spending. The results in this paper are then informative for the policy debate on the long-run level of government spending.

Our focus on long-term outcomes has a number of advantages. First, using individual micro-data from U.S. censuses, we are able to analyze economic outcomes for different skill levels. Second, we control for changes in demographic characteristics and thus isolate variation in wages and housing prices that is composition-constant. This ensures that our results are not biased by demographic changes in the population. Finally, we are able to estimate impacts of government spending on a number of outcomes that might be unresponsive in the short run. These include changes in population, housing values, and wages. The combination of these various outcomes allows us to characterize the incidence of government spending across the skill distribution and provide a better understanding of the mechanisms behind the effects of a sustained government spending shock.

The rest of the paper is organized as follows. Section 2 relates our work to previous studies in this literature and Section 3 introduces the conceptual framework behind our analyses. Sections 4 and 5 describe the data and identification strategy, respectively. Section 6 presents estimates of the local effects of government spending on aggregate and per-capita outcomes. Section 7 tests the reduced-form predictions of the model and compares the impacts of government spending shocks with those of labor demand shocks. Section 8 provides structural estimates of workers' marginal valuation of government services and decomposes the supply and demand components of government spending. Section 9 conducts hypothetical policy experiments and calculates the impacts of government spending on welfare. Section 10 presents our conclusions.

2 Relation to Previous Literature

Our primary contribution is the incidence analysis of government spending across skill levels. We build on models that introduce a government sector to the spatial equilibrium model of Rosen (1979) and Roback (1982). Gyourko and Tracy (1989) show that fiscal conditions, including the provision of public goods, are important determinants of geographical differences in wages. Haughwout (2002) studies the role of public provision on private production while Haughwout and Inman (2001) provide a calibration analysis of several factors including local taxes and transfers to individuals. Our model combines the provision of public goods and infrastructure and adds the direct employment of workers by the government.[6] We show that these different functions of government can shift the labor supply and demand curves. Importantly, we identify workers' valuation of government services as a hedonic parameter that governs the relative size of the supply and demand components of a government spending shock and that directly contributes to calculations of economic incidence.[7] Our analysis thus adds to the understanding of local labor markets (e.g. Moretti (2011)) and, more generally, to the literature on public policies in urban economics (e.g. Glaeser (2008)).

In particular, the implication that workers' valuations of government services are a crucial component in the incidence analysis of government spending can be informative for the analysis of place-based policies (e.g. Kline (2010) and Glaeser and Gottlieb (2008)). Busso et al. (2010) find that Empowerment Zones improve local labor markets with modest deadweight costs. On a very long run scale, Kline and Moretti (2011) analyze the motivations of place-based policies as arising from potential agglomeration effects. However, Glaeser and Gottlieb (2008) place doubt that our current understanding of non-linearities in agglomeration economies can plausibly predict whether a given place-based policy may enhance welfare.

This paper is also related to a developed literature that analyzes how changes in labor demand translate into relative wage gains across the skill distribution. This literature focuses on the relative mobility of skilled and unskilled workers (e.g. Topel (1986)), the potential for skill-biased demand shocks (e.g. Katz and Murphy (1992) and Bound and Holzer (2000)), and the heterogenous response of migration and housing values to negative and positive shocks (e.g. Notowidigdo (2011)). The incidence of government policies has been analyzed using estimates from this literature by, among others, Bartik (1991). Our approach has the advantage that it more closely approximates the impact of a policy tool: in contrast to a labor demand shock that policymakers cannot influence. Indeed, our analytic framework and the estimates we report show that a government spending shock can have qualitatively different effects than a labor demand shock.

A recent literature analyzes how aspects of local economies interact with government policies in determining economic outcomes. Moretti (2009) shows that accounting for local prices is important in disentangling impacts of shocks on wages from the effects on welfare. Albouy (2009a) shows that the geographic distribution of the burden of taxation is subject to local prices that reflect productivity, quality of life, and housing sector inefficiencies. Similarly, Albouy (2009b) shows that adjusting for

[6]Note that the motivations for a government sector follow strict neoclassical lines. In Appendix B we derive the Samuelson (1954) condition for the optimal provision of public goods at the local level in a spatial equilibrium.

[7]In this, there is a parallel with the analysis of mandated benefits by Summers (1989) where a tax may affect labor demand but workers valuations of benefits may increase labor supply. Beeson and Eberts (1989) decompose the role of productivity and amenities in geographic wage differentials and find both components to be quantitatively important.

federal taxes has significant consequences for the the capitalization of amenities into land values. The paper most related to our current work is Albouy (2010). The focus there is the analysis of fiscal equalization across Canadian provinces from a fiscal federalism approach. Our work focuses on federal spending at the local level, but does not consider the role of intergovernmental transfers.[8] Finally, Notowidigdo (2011) suggests that progressive income transfer programs and a concave supply of housing interact with negative labor demand shocks to lessen the total decrease in income to the unskilled.[9]

Our model's implication that government services increase the local labor supply rests heavily on workers' valuation of these services. A central objective of the paper is then to estimate workers' valuation of government services. Recent studies have inferred the benefits of infrastructure projects and local policies by their effects on housing values. In a recent paper, Cellini et al. (2010) show that California underinvests in school infrastructure relative to the gains in housing values. On the other hand, Greenstone and Gallagher (2008) find that costs of environmental improvements may outweigh the increase in housing values at the margin.

This paper is also related to studies of local public finance that analyze the response of local governments to federal government actions. Using a similar identification strategy to ours, Gordon (2004) finds that increases in Title I funding lead to short-run decreases in the local funding for schools. Our analysis of local public finance finds similar crowd-out effects but is not able to distinguish whether the flypaper effect holds at the program level (see Hines and Thaler (1995)). In another recent paper, Boustan et al. (2010) find that increases in local public expenditures and revenues are associated with increases in inequality at the local level. This result is consistent with our estimates of the effects of a government spending shock on wage inequality. However, our framework might influence the interpretation of their results as increases in wage inequality might not translate into increases in welfare inequality due to workers' valuation of government services.

Finally, this paper is also related to recent papers that analyze the short-run effects of government spending. We use an identification strategy based on an instrumental variable proposed in Suárez Serrato and Wingender (2011) that uses mistakes in population predictions to isolate cross-sectional variation in government spending at the local level. Ramey (2011) surveys recent literature that identifies the impacts of government spending using a cross-sectional approach.[10] While cross-sectional approaches provide solid foundations for the identification of potentially exogenous variation in government spending, the interpretation of these estimated parameters is subject to the aggregation of general equilibrium effects as well as potentially countervailing monetary policies (Nakamura and Steinsson (2011)). Our model extends the results in this literature by using a cross-sectional approach to connect short- and long-run effects of government spending.[11] Further, while recent work by Mankiw and Weinzierl (2011) finds that short-run fiscal multipliers might over-estimate the welfare benefit from government spending in the short-run, our work shows that multipliers might under-estimate the welfare value of government provision of services in the long-run.

[8] This paper is also related to a broader literature on fiscal federalism (see, e.g., Oates (1999)).

[9] Glaeser and Gyourko (2005) show that the durable properties of housing stock can imply a concave housing supply function.

[10] Chodorow-Reich et al. (2011), Nakamura and Steinsson (2011), Shoag (2010), and Wilson (2011) for recent cross-sectional approaches and Auerbach and Gorodnichenko (2010) and Clemens and Miran (2010) for time series approaches.

[11] Baxter and King (1993) provide a theoretical analysis that formally relates the short-run and long-run multipliers.

3 Model

In this section we develop a spatial equilibrium model that differentiates between three different roles of government spending. The model takes the classic models of Rosen (1979) and Roback (1982), adding a government sector which provides infrastructure and public services, and which hires local workers to provide these services. The objectives of the model are to isolate the impacts of the different functions of government on labor and housing markets and to determine the equilibrium changes in wages and rents from a change in government spending. A crucial insight is that a government spending shock shifts both supply and demand functions, and that each of these components might have different impacts on wages, rents, and migration. Furthermore, the relative size of the supply shift is determined by workers' valuation of government services.

The model we present draws on recent work by Busso et al. (2010), Moretti (2011), and Notowidigdo (2011). In what follows, we use the symbol Δ to denote percentage changes. A detailed derivation of the model is presented in Appendix A. There are C localities in our model: each with a population of measure N_c. Total population is normalized to unity. The population in a given locality is divided into skilled and unskilled workers; with populations N_c^S and N_c^U, respectively. In our empirical analysis we classify workers as skilled if they have a college degree.

Government Sector

Federal spending in a given area c is determined by an aggregate statutory formula that assigns spending amounts as a function of population in that area and population characteristics, denoted by W_c. The amount of federal spending in area c, denoted by F_c, is given by:

$$F_c = f(W_c, \tilde{N}_c),$$

where $f(\cdot,\cdot)$ is the aggregate statutory formula. This formula allocates funds based on estimates of the local population:

$$\tilde{N}_c = N_c + CS_c,$$

where CS_c are mistakes in population measurement. Our identification strategy uses the cumulation of mistakes over a decade to isolate variation in F_c. Note that our identification depends on variation in CS_c and not on true population N_c.

These funds have three different uses:

1. Provision of infrastructure. A share g^z of government funds are allocated to purchasing infrastructure. For simplicity, we assume that infrastructure is imported and that the provision does not directly impact the local labor market. Infrastructure is an area-specific public good denoted $\bar{Z} = g^z F_c$.

2. Hiring local workers. Local workers are hired by the government to provide public services. A share g^U of funds is devoted to hiring unskilled workers while a share g^S of funds is devoted to hiring skilled workers. These shares are such that $g^z + g^S + g^U = 1$. Government demand (GD) for workers of type i is then given by:

$$L_c^{GD,i}(w_c^i) = \frac{g^i F_c}{w_c^i},$$

   where w_c^i is the type i-worker wage in area c.

3. Provision of public goods and services. The government produces public goods and services with Cobb-Douglass technology that combines both skilled and unskilled labor:

$$GS_c = (L_c^{GD,S})^{\theta}(L_c^{GD,U})^{1-\theta},$$

where $\theta = \frac{g^S}{g^S+g^U} \in (0,1)$. From this equation we also derive percentage changes in the provision of GS_c:

$$\Delta GS_c = \Delta F_c - (\theta \Delta w_c^S + (1-\theta)\Delta w_c^U),$$

which relates changes in government services to observed changes in spending and wages. The specific public nature of these goods and whether there are efficiency gains from public provision are not explored. We simply assume that some market failure or social preference justifies their governmental provision.[12]

An important feature of our model is that a government spending shock has demand and supply components. Government spending shifts the labor demand curve through the provision of infrastructure and the direct hiring of workers and may shift the labor supply curve through the provision of goods and services. Importantly, the size of the supply component depends on the worker's valuation of the services provided by the government.

In principle, this model of government spending can be viewed as a place-based policy, since the funds are allocated to localities (e.g. Glaeser and Gottlieb (2008)). While this might be accurate for some government spending programs, most formula programs allocate funds for the provision of services per individual. That these functions depend on characteristics of the population and are generally progressive makes them non-place-neutral. However, the intent of the policies is the provision of services to individuals and not the betterment of places where a given target population might be located.

Firms

Each locality has two types of firms that hire either skilled or unskilled workers. Firms have Cobb-Douglas technology given by:

$$y_c^i = B_c(L_c^i)^{\alpha_i}(\bar{Z}_c)^{1-\alpha_i},$$

for $i = S, U$ and where $\alpha_i \in (0,1)$.[13] $\bar{Z}$ is the infrastructure provided by the government and B_c is an aggregate productivity shock. Firms set marginal product of labor equal to the marginal wage so that labor demand from the private sector (PD) for type i is given by:

$$L_c^{PD,i}(w_c^i) = \frac{(\alpha_i B_c)^{1/(1-\alpha_i)}\bar{Z}_c}{(w_c^i)^{1/(1-\alpha_i)}}.$$

Total demand for skill i and county c is thus given by:

$$\begin{aligned} L_c^{D,i} &= L_c^{GD,i} + L_c^{PD,i} \\ &= \frac{g^i F_c}{w_c^i} + \frac{(\alpha_i B_c)^{1/(1-\alpha_i)}\bar{Z}_c}{(w_c^i)^{1/(1-\alpha_i)}}. \end{aligned}$$

[12] One example of a spending program governed by a statutory formula is Title I, education spending (see Gordon (2004)). In this case, the justification for public provision comes from the social returns to education documented by Moretti (2004) and Lochner and Moretti (2004); but see also Acemoglu and Angrist (2001).

[13] This assumption rules out imperfect substitution between workers of different skill types. While this simplifies the analysis, the estimates of the demand elasticity of labor in Section 8 are consistent with results from previous studies that allow for imperfect substitution between skills.

This equation shows that government funds F_c increase labor demand through direct hiring and by providing infrastructure. Note, however, that direct hiring of workers might crowd-out private labor demand as it increases wages. Log-linearizing this equation, we find that percentage changes in labor demand for skill i are given by:

$$\Delta L_c^{D,i} = \Delta \bar{Z}_c - \left(\kappa^{GD,i} + \frac{\kappa^{PD,i}}{(1-\alpha_i)}\right)\Delta w_c^i + \frac{\kappa^{PD,i}}{(1-\alpha_i)}\Delta B_c^i, \tag{1}$$

where $\kappa^{GD,i}$ is the share of employment by the government and $\kappa^{PD,i}$ is the share of employment by firms and are such that $\kappa^{PD,i} + \kappa^{GD,i} = 1$.

Transfer Payments

Following Notowidigdo (2011), we include income transfers in our incidence analysis to account for the fact that a progressive system of transfer payments will have differential impacts across the skill distribution. We separate transfer payments from our analysis of the government sector above in order to differentiate between transfers to individuals and the provision of services and infrastructure.[14] We also assume that skilled workers do not qualify for means-tested transfers.[15] We assume that the per-capita transfer to an unskilled individual in locality c, denoted by t_c, has a constant elasticity with respect to the local wage. That is:

$$t_c^i = \begin{cases} T_c(w_c^i)^\psi & \text{if } \; i = U \\ 0 & \text{if } \; i = S, \end{cases}$$

where T_c is a term capturing aggregate shocks to the funds allotted to provide income transfer assistance. Percentage changes in transfers to unskilled individuals are thus given by:

$$\Delta t_c^U = \Delta T_c + \psi \Delta w_c^U. \tag{2}$$

Housing Market

Supply of housing is assumed to be an increasing function of the population in a given locality c. Define the inverse supply of housing to be:

$$r_c = k_c G(H_c), \tag{3}$$

where H_c is the number of housing units, $G(\cdot)$ is an upward-sloping function and k_c represents a shock to the productivity of the housing sector as well as local regulatory and geographical constraints of housing production.[16] In the empirical analysis in Section 8 we consider two alternative housing supply functions that account for potential non-linearities in the housing supply function. The demand for housing is primarily determined by the location decision of workers; which we analyze in the following section.

[14] As shown by Suárez Serrato and Wingender (2011), transfers to individuals are not related to the government spending shock in our empirical analysis. Evidence to this effect is provided in Section 5.

[15] Tabulations from the 1980, 1990, 2000 U.S. Censuses and the 2009 ACS indicate that only 5% of the areas we analyze have positive welfare income for the skilled. The amounts are small relative to those received by the unskilled and are also small relative to the income of the skilled in these localities.

[16] Recent research in the housing market shows that heterogeneity in the supply of land and local regulations account for a large proportion of the difference in prices across metropolitan areas (see e.g. Gyourko (2009) and Saiz (2010)).

Workers

In a given period, workers are assumed to be immobile and supply one unit of labor inelastically. Workers are mobile in the long-run and select their location c to maximize their semi-indirect utility function:

$$\begin{aligned} u^i_{jc} &= \log(w^i_c + t^i_c) - s^{i,r}\log(r_c) + \log(A_c) + \phi^i \log(GS_c) + \sigma^i \varepsilon^i_{jc} \\ &= v^i_c + \sigma^i \varepsilon^i_{jc}. \end{aligned}$$

which takes into account the wage w^i_c for skill i, transfer payments t^i_c, rental costs r_c, amenities A_c, government services GS_c, and an idiosyncratic taste term for individual j.[17] The preference term $s^{i,r}$ corresponds to the share of income devoted to housing. Following the discrete choice literature, we refer to the v^i_c terms as mean utilities. The term A_c captures the value of amenities of a given locality and is interpreted as an aggregate shock to the tastes of workers. We allow workers of different skills to have different valuations of government services via the factor ϕ^i and to have different dispersions in the distribution of the idiosyncratic taste term. As noted by Busso et al. (2010) and Moretti (2011), the idiosyncratic term plays two important roles. First, taste heterogeneity implies that, in equilibrium, there are individuals that are inframarginal and thus capture rents. Second, given a shock to a locality c, the population will adjust as individuals who were previously inframarginal become supramarginal. The dispersion term σ^i captures heterogeneity in the mobility of different skill groups.

The population of a given area c is given by the number of workers for whom:

$$u^i_{jc} = \max_{c'} \;\; v^i_{c'} + \sigma^i \varepsilon^i_{jc'}.$$

We assume the idiosyncratic taste shocks ε^i_{jc} have a multinomial logit distribution.[18] The fraction of workers of skill i locating in c is given by:

$$N^i_c = \mathbb{P}r\left(u^i_{jc} = \max_{c'} \;\; \{u^i_{jc'}\}\right) = \frac{\exp(v^i_c/\sigma^i)}{\sum\limits_{c'}(\exp(v^i_{c'}/\sigma^i))}.$$

Taking logarithms, derivatives, and rearranging we find:

$$\frac{\Delta N^i_c}{(1-N^i_c)} = \frac{(1-s^{i,t})\Delta w^i_c + s^{i,t}\Delta t^i_c - s^{i,r}\Delta r_c}{\sigma^i} + \frac{\phi^i}{\sigma^i}\Delta GS_c + \frac{\Delta A_c}{\sigma^i},$$

where $s^{i,t}$ is the ratio or welfare transfer to total income. Define changes in real wages as the following quantity:

$$\Delta \text{Real Wage}^i_c = (1-s^{i,t})\Delta w^i_c + s^{i,t}\Delta t^i_c - s^{i,r}\Delta r_c.$$

Substituting, we have

$$\frac{\Delta N^i_c}{(1-N^i_c)} = \frac{\Delta \text{Real Wage}^i_c}{\sigma^i} + \frac{\phi^i}{\sigma^i}\Delta GS_c + \frac{\Delta A_c}{\sigma^i}, \tag{4}$$

[17]The semi-indirect utility combines prices of the relevant decision margins and quantities of government-provided services. As in Auerbach and Hines (2002), the value of a marginal unit of government services in the semi-indirect utility function equals the value of a marginal unit in the utility function evaluated at the optimal location for individual j.

[18]The logit assumption simplifies the derivation of the labor supply equation. However, as shown by Hotz and Miller (1993), given very general conditions on the distribution of the idiosyncratic terms, there is always a relation between the probability of a given choice and difference in mean utilities.

This equation defines the supply of labor for a given area as an upward-sloping function of the real wage. The inverse mobility parameter σ^i captures the slope of the labor supply function. The larger (smaller) the dispersion of the idiosyncratic taste terms ε the flatter (steeper) the supply of labor will be.[19]

The interpretation of the arbitrage condition in Equation (4) states that, holding everything else constant, workers are willing to move to area c to benefit from the increase in GS_c and are willing to accept a lower real wage following an increase in GS_c. A decline in real wages, moreover, can come about from a decrease in wages or an increase in rents. The latter effect may be driven by the migration of workers in response to the increase in GS_c. If skilled workers have a smaller valuation of government services, their wages will be less sensitive to increases in GS_c. Therefore, if a government spending shock increases the demand for labor and the provision of GS_c, we would observe a small skill mobility differential.

Aggregate welfare of workers of type i in the economy is given by:

$$V^i = \mathbb{E}_\varepsilon \left[\max_{c'} \ \{u^i_{jc'}\} \right].$$

We rely on the envelope theorem when conducting welfare calculations. Thus, there is no need to account for the potential that workers might re-optimize their location choice when evaluating the impacts of changes in prices or government services. A generalization of a result of Busso et al. (2010) shows that, independent of the distribution of the ε terms, changes in welfare are related to changes in mean utilities by the following relationship:[20]

$$\frac{dV^i}{dv^i_c} = N^i_c dv^i_c. \tag{5}$$

This equation can be interpreted as a reformulation of Roy's identity for a representative worker.[21] The economic interpretation of this equation is that an increase in mean utility in a locality c is equal to a direct utility transfer to each individual in that community. Thus, with empirical estimates of the valuation of government services, we could directly evaluate changes in welfare.

Using this relation, we derive the optimal provision of public goods by incorporating the results of Samuelson (1954) and Atkinson and Stern (1974) in a spatial equilibrium framework. Appendix B provides the details of the derivation of the following condition for the optimal provision of public goods in locality c:

$$\frac{\pi^S N^S_c \phi^S + \pi^U N^U_c \phi^U}{\bar{\lambda} GS_c} - \frac{\mu}{\bar{\lambda}} \left(MRT_{G,X} - \sum_{i=S,U} \sum_{c'} \tau^i_{c'} \frac{\partial N^i_{c'}}{\partial GS_c} \right) = 0, \tag{6}$$

[19] An alternative formulation would be to assume workers face mobility costs. This assumption would also yield an upward-sloping labor supply curve.

[20] This relation follows from:

$$\frac{dV^i}{dv^i_c} = \mathbb{E}_\varepsilon \left[\frac{d}{dv^i_c} \max_{c'} \ \{u^i_{jc'}\} \right] = \mathbb{E}_\varepsilon \left[\mathbb{I} \left[u^i_{jc} = \max_{c'} \ \{u^i_{jc'}\} \right] dv^i_c \right] = \mathbb{P}r \left(u^i_{jc} = \max_{c'} \ \{u^i_{jc'}\} \right) dv^i_c = N^i_c dv^i_c.$$

[21] Consider, for example, the effect of an increase in rents:

$$\frac{\partial V^i}{\partial r_c} = -N^i_c \frac{\partial v^i_c}{\partial r_c} = -N^i_c \frac{s^r}{r_c} = -N^i_c \frac{1}{w^i_c + t^i_c} = -N^i_c \times \text{MU Income}^i_c,$$

where, given the assumption of Cobb-Douglass utility, marginal utility of income is given by $\frac{1}{w^i + t^i}$.

where $MRT_{G,X} = \frac{f_{GS}}{f_X}$ is the marginal rate of transformation between the consumption good and the public good, $\bar{\lambda}_c$ is the average marginal utility of income for area c, τ_c^i is a unit labor tax, and π^i is the relative weight given by the social planner to the utility of workers of skill i. This expression is a reformulation of the Samuelson (1954) result, where the marginal benefit of individuals in area c is equated to the marginal rate of transformation minus the impact of the public good on revenue multiplied by the marginal cost of public funds $\left(\frac{\mu}{\lambda}\right)$. While this expression only holds at an optimum, it states two facts about the welfare analysis of an increase in government spending. First, as a consequence of the envelope theorem, the direct welfare increase does not take into account migration decisions. Second, whether increasing the provision of government services in a given area is desirable will depend on the fiscal impacts of migration as well as the marginal cost of public funds.

4 Data

This project uses county-level data to measure federal spending, local taxation and spending, and to construct the census shock instrumental variable. We use individual-level data from Census Bureau surveys to measure aggregate and skill-specific outcomes. Since county identifiers are not present in the publicly available micro-data, we aggregate counties into the smallest county groups that can be consistently identified in public-use data between 1980 and 2009.[22]

Of the over 3,000 counties in the contiguous United States, we obtain a balanced panel dataset of 493 county groups. We construct these county groups by aggregating consistent public-use micro-data areas (PUMAs); which are the smallest geographical areas that can be consistently identified in Census and ACS datasets (Ruggles et al., 2010). In some cases, a county group encompasses a whole state (e.g. Wyoming); in other cases there may be several county groups in a given metropolitan statistical area (MSA) (e.g. San Francisco Bay Area). This level of aggregation reflects two competing objectives: to maximize the power in our identification strategy by focusing on low levels of aggregation, and to analyze outcomes for different skill groups.

While our analyses focus on this level of aggregation due to data limitations, this constraint ensures that the results of our analysis are not driven by counties with small populations, as our county groups have at least 100,000 people. One limitation is that we cannot control for state-year fixed effects without ignoring some observations. In order to avoid this problem, we group bordering states with single county groups per state group and use these 42 groups to generate the fixed effects. The construction of the county groups, state groups, and the distribution of county groups by state is described in Appendix C.

Data on federal spending come from the Consolidated Federal Funds Report from 1980 to 2009 (Census Bureau (2010c)). Our analyses focus on the cumulative federal spending in a given county group over a decade relative to the spending amount at the start of the decade. In this paper we focus on non-defense spending that is allocated using statutory formulas. We divide this cumulative increase in spending by the number of years elapsed to interpret it as a yearly average increase. Data

[22] Appendix E provides detailed summary statistics of the data we use. Tables E.2 and E.3 provide summary statistics in levels and in percentage changes of each of these variables. Figure E.1 displays the composition of government spending by department.

on local public finances come from the Census of Governments for years 1982/1987, 1992/1997, and 2002/2007 (Census Bureau (2011)).[23]

We compute skill-specific outcomes using micro-data from the IPUMS samples of the 1980, 1990, and 2000 Censuses and the 2009 American Community Survey (Ruggles et al. (2010)). We define unskilled individuals as those without a college degree and limit our sample to the non-farm, non-institutional population of adults between the ages of 18 and 64. We create skill-specific mean values of log-wages, log-rents, and log-housing values, as well as aggregate values of population, employment, income, and earnings for every county group.

When comparing wages and housing values it is important that our comparisons refer to workers and housing units with similar characteristics. In order to adjust for changes in the characteristics of the population of a given county group, we create composition-adjusted values of mean wages, rents, and housing values.[24] To create composition-adjusted outcomes, we first de-mean the outcomes and the personal and household characteristics relative to the whole sample to create a constant reference group across states and years. We then compute the coefficients of the following linear regression model where we use census survey weights in estimation:

$$\tilde{y}_{ctsi} = \mu_{c,\tau} + \tilde{X}_{ctsi}\Gamma^{s,\tau} + \nu_c + \epsilon_{ctsi},$$

where $\tilde{y}_{ctsi}$ is observations i's de-meaned log-price in county group c, year t and state group s. $\tilde{X}_{ctsi}$ is observations i's de-meaned characteristics, ν_c is a county group fixed effect, and $\mu_{c,\tau}$ is a county group-year fixed effect. Allowing $\Gamma^{s,\tau}$ to vary by state and year allows for heterogeneous impacts of individual characteristics on outcomes. We run this regression separately for every state group described in Appendix C and for years $\tau = 1990, 2000$, and 2010. For each regression we include observations for years $t = \tau, \tau - 10$ so that the county group-year fixed effect corresponds to the average change in the price of interest for the reference population. Our analysis of adjusted prices uses the set of fixed effects $\{\mu_{c,t}\}$ as outcome variables. Additional details regarding our sample selection and the creation of composition-adjusted outcomes are available in Appendix D.

We use data on two additional outcomes that are not included in the survey data. First, due to potential bias in self-reporting of welfare income (see Meyer et al. (2009)), we compute aggregate income from transfer payments from the Bureau of Economic Analysis's Regional Economic Information System (BEA (2011)). We aggregate transfer data for the supplementary nutritional assistance, family assistance, and other income maintenance benefits at the county group level. Second, in addition to measuring migration using net changes in population, we use county migration files from the IRS (IRS (2011)) to analyze gross migration flows. These files are available from 1980 to 2009. While all other outcomes are measured in percentage changes, we use these flow data to compute the ratio of total migrants in a decade as a percentage of population. Molloy et al. (2011) discuss the relative benefits of using census and IRS data to measure migration.[25]

[23] The Annual Survey of Governments provides yearly data on local public finances for a sample of local governments. We analyze increases in local government spending and taxation on a five year scale to ensure we include every local government in the U.S.

[24] In what follows, we present results of our analyses using adjusted and unadjusted prices. We find that this adjustment increases the efficiency of our estimation but the composition bias goes against our main finding that, in contrast to the analysis of pure labor demand shocks, the net impact of government spending on wages is larger for skilled individuals.

[25] Since the migration questions asked in the census (moved in 5 years) and the ACS data (moved in one year) are not consistent, we omit this variable from our analysis.

Our strategy to identify changes in federal spending uses the census shock introduced in Suárez Serrato and Winge (2011). We replicate the procedure in that paper to generate the shock at the county-group level. We thus use two types of population measurement as well as components of population change, including data on migration, births, and deaths. The first type of population estimates is the official population count from the decennial census. The second type of population estimates is the contemporaneous (historically unrevised) data that is updated on an annual basis. Both population estimates come from the U.S. Census Bureau (Census Bureau (2010d)). Migration numbers come from the IRS migration files described above. Estimates on deaths and births come from Vital Statistics (CDC (2010)).

5 Census Shock and Identification

This paper uses an instrumental variables strategy to estimate the impacts of government spending on the local economy. Taking advantage of cross-sectional identifying variation, our estimates assuage endogeneity concerns that can bias an OLS approach. In particular, if government spending is more concentrated in areas with lower economic growth, an OLS comparison would provide estimates of the impacts of government spending that would be downwardly-biased. The instrument we use was first developed in Suárez Serrato and Wingender (2011) at the county level. Here we replicate the construction of the instrument at the county-group level.

The logic behind this identification strategy relies on two facts. First, that a large number of government spending programs allocate funds based on statutory formulas that depend on population counts. Blumerman and Vidal (2009) find that 140 programs that used such formulas in 2007 allocated \$440 billion, or 15% of federal outlays. Medicaid, Title I Education Grants, Community Development Block Grants, Mass Transportation Services Grants, and Social Services Block Grants are among the programs that use population-based formulas.

The second fact is that the Census Bureau switches between two population estimation methodologies: decennial census (C) estimates and postcensal (PC) (contemporaneous) estimates, which are produced annually.[26] The postcensal estimates are updated annually and use data on births ($B_{c,t}$), deaths ($D_{c,t}$), and migration ($M_{c,t}$) to update population counts so that:

$$Pop^{PC}_{c,t} = Pop^{PC}_{c,t-1} + (B_{c,t} - D_{c,t} + M_{c,t}).$$

One important aspect of this recursive formulation is that any mistake in population measurement in a given year will be carried forward in future population estimates. After a decade of such updates, the postcensal counts are replaced with the physical decennial census counts of the population. The census shock instrument is the log-difference in population between the census count and the administrative estimate for the year of the census:

$$CS_{c,\text{Census}} = \log Pop^{C}_{c,\text{Census}} - \log Pop^{PC}_{c,\text{Census}}.$$

Importantly, identification comes from mistakes in the measurement of population—not from population growth. In order to construct the instrument at the county-group level, we first aggregate both our measures of population as well as the components of change at the county group level. Following the methodology in Suárez Serrato and Wingender (2011), we define the census shock as the percentage difference between the postcensal and census population estimates for each census year.

[26] See Census Bureau (2001, 2010a,b).

As an example, Table 1 displays the census shock for Monterey, CA, in the past three censuses. Notice that the shock alternates across years and for some years the difference in population can be large at around 28,000 people. This is a log-difference of almost 7%. This table exemplifies aspects of the census shock that hold true in general: the shock is not serially correlated and can be large enough to capture meaningful changes in government spending. In addition, as shown in Suárez Serrato and Wingender (2011), the shock is not geographically correlated with only 6% of the variation explained by location effects.

To understand how our identification strategy differs from that in Suárez Serrato and Wingender (2011), consider the following first-stage regression equation:

$$\Delta F_{c,t} = \mu_{s,t} + \delta_t CS_{c,\text{Census}} + \epsilon_{c,t}, \tag{7}$$

where $\Delta F_{c,t}$ is the percentage change in federal spending, $\mu_{s,t}$ is a state group by year fixed effect, and where we allow a time-specific effect of the census shock on government spending. Figure 2 presents the dynamics of a 10% census shock on federal spending at a yearly level by graphing the cumulative sum of the yearly impacts: $\sum_{\tau=0}^{t} \delta_\tau$. Three features of these dynamics are noteworthy. First, since the final census population counts are released two years after the census is conducted, spending should be independent of the census shock before reference year three, which is indeed confirmed by the graph. Second, the shock leads to yearly variation in spending, as there is a lag in which different government agencies adopt these numbers. Finally, once the census shock has been incorporated into all spending formulas, there is a sustained level effect on spending.

The analysis in Suárez Serrato and Wingender (2011) exploits the dynamics of the adoption of the new population counts around reference years two through six to identify yearly changes in government spending. This paper takes advantage of the fact that once the new census numbers are fully incorporated into spending formulas, the level of government spending for a given area is affected for the next five years. The identification in this paper thus relies on the sustained changes in government spending across a decade. Intuitively, the impact of the census shock in a given decade can be thought of as the whole time-path of the line in Figure 2.

To provide further evidence that our identification strategy is identifying changes in spending from statutory formulas, we show that the shock is not related to spending programs that do not depend on population estimates. Figure 3 presents the cumulative effect of the census shock on Social Security income transfers, which do not depend on population estimates. In contrast to total spending, this graph shows that the census shock is not related to changes in Social Security transfers to individuals.

In Section 7 we compare the effects of a government spending shock with those of a pure labor demand shock. We use an identification strategy pioneered by Bartik (1991) in order to isolate shocks to labor demand.[27] Bartik's identification strategy uses an instrumental variable that takes national shocks, which are potentially exogenous to local economic conditions, and assigns different cross-sectional weights based on predetermined industrial composition of the local economy. The Bartik

[27] Blanchard and Katz (1992), Bound and Holzer (2000), and Notowidigdo (2011) are examples of papers that also use this identification strategy.

shock is constructed by interacting the national growth in employment in every industry with its predetermined share in a given area. Formally, we compute the shock as follows:

$$\text{Bartik}_{c,t} = \sum_i \Delta \text{Emp}_{US,t}^{\text{Industry}_i} \times \frac{\text{Emp}_{c,t-10}^{\text{Industry}_i}}{\text{Emp}_{c,t-10}},$$

where the sum aggregates all industries i. We calculate national employment changes as well as employment shares for each county group using micro-data from the 1980, 1990, and 2000 Censuses and the 2009 ACS. We use a consistent industry variable based on the 1990 Census that is updated to account for changes in industry definitions as well as new industries (Ruggles et al. (2010)).

In order to capture the increase in government spending that is induced by a mistake in the measurement of population over a given decade, we compute the percentage increase in aggregate spending in a given county group for that decade relative to the yearly level of spending at the start of the decade. Table 2 reports the first stage relationship between our shock and our measure of changes in government spending at the decade level. This table shows that our instrument is a strong predictor of government spending, verifying statutory requirements of federal spending programs. The main specification in column (1) will be used in all of the estimation results of the following section. The test for excluded instruments shows that our instrument is not subject to weak instrument problems (e.g. Bound et al. (1995)).

The exclusion restriction for our instrument is that the discrepancy in population estimates between the two methodologies is not related to factors that would, independently of federal spending, influence economic outcomes. Two factors are important in thinking about the plausibility of this assumption. First, it is important to recognize that variation in the census shock comes from cumulative mistakes over a decade and not from specific events around the year of the census. Second, given the dynamics of the government spending shock, an unobserved economic shock that occurs years before the census shock is released needs to be compatible with the flat profile of the shock on spending growth before the final census counts are released. Moreover, it is known from studies that analyze the speed with which population adjusts to economic shocks (e.g., Blanchard and Katz (1992)) that unobserved shocks are absorbed into the economy very rapidly. We thus find it unlikely that an unobserved shock three or four years prior to the census can be consistent with the results of Figure 2 and still be strong enough to resurface years later and be a major driver of our results. The timing of the release of the new census counts is thus a crucial feature of our identification strategy. Suárez Serrato and Wingender (2011) document further properties of this instrument, provide a formal framework for thinking about the source of variation in the instrument as resulting from measurement error, and estimate and test a measurement error model that is not rejected by overidentifying restrictions in the data.

6 Estimates of Local Effects of Government Spending

This section presents estimates of the long-term effects of government spending on local economic outcomes. We present results on various outcomes using the following specification:

$$\Delta y_{c,t} = \mu_{s,t} + \beta \Delta F_{c,t} + \epsilon_{c,t}, \tag{8}$$

where $\Delta y_{c,t}$ is the percentage increase in a given outcome, $\Delta F_{c,t}$ is the cumulative increase in federal spending over a given decade, and $\mu_{s,t}$ is a state group-year fixed effect. Our analysis of first-differenced data eliminates county-group fixed effects. The $\mu_{s,t}$ terms capture state-group-decade specific effects on the growth rates of outcomes. For each outcome we present OLS as well as instrumental variables estimations where changes in government spending are instrumented using the census shock as described in Section 5 and Table 2. As motivated in the previous section, the variation we analyze is that of a sustained increase in government spending over a decade. Our federal spending variable is normalized to a yearly level to represent a sustained percentage increase over the yearly level of spending.

Estimates of the long-term effects of government spending on aggregate outcomes are presented in Table 3. In this and future tables, each column presents estimates from three regressions corresponding to the aggregate outcome, the outcome for the skilled population, and the outcome for the unskilled population. The results in this table show impacts of government spending that are large and statistically significant. For example, a one percent increase in government spending in a given locality leads to a 1.8 percent increase in total income to that locality. The IV estimates are substantially larger than the OLS estimate, showing that the endogeneity of federal spending could lead to substantial bias in estimation. Moreover, the aggregate impacts on employment, earnings, and income are all larger for the skilled workers than for the unskilled workers. It is important to note that these aggregate estimates are a combination of growth in population as well as an increase in economic activity. The last column presents the impacts of government spending on population. Panel (b) shows that a one percent increase in government spending leads to an increase of 1.46 percent in the population of adults, as measured by our county-group estimates from micro-data. An important result from this table is that, while the high skilled are relatively more mobile, this differential is not as large as has been previously documented (e.g. Topel (1986) and Notowidigdo (2011)). We return to this point in detail in Section 7.[28]

The large impacts of government spending on population suggest that changes in population account for a significant fraction of the estimates in Table 3. Table 4 explores whether all of the increases in income and employment are due to changes in population by presenting impacts of economic outcomes at the per-capita level. The IV results show significant increases in earnings and income per-adult. These increases are larger for the unskilled population, who also see an increase in the employment per-adult ratio. The impact on welfare income per unskilled adult is statistically significant but much smaller than the aggregate impact. The impact on adjusted wages is statistically significant and suggests that the average increase over all workers from a sustained 10% increase in government spending is an increase in wages of 2.5%. In contrast to previous analyses of labor demand shocks (e.g. Bartik (1991), Bound and Holzer (2000), and Notowidigdo (2011)), we find that the wage impacts are larger for the high skilled who experience a relative gain in wages of 1.5% compared to unskilled workers. Comparing the impacts on average wages and adjusted wages we see that the composition adjustment leads to a smaller relative gain by the high-skilled.

Our last two sets of outcomes focus on the housing market and on local public finances. Table 5 presents the impacts of government spending on housing values. We find that an increase in

[28] Analyses of migration flows from IRS files provide similar results. Table E.5 in Appendix E presents results of impacts of government spending on migration flows aggregated over a decade as a percentage of initial population.

government spending is related to modest increases in housing values and rental prices. However, these effects are not statistically significant. The largest impact we find is an increase of 2.4% in home values for a 10% increase in government spending. Table 6 presents the response of local public finances to an increase in federal spending. We find that increase in federal government spending crowds-out spending by local government. While this is not evidence of the flypaper effect, it suggests that there is shifting of fiscal obligations from the local government to the federal government.[29]

All of the estimates presented in this section are in the form of elasticities. While this form is useful for welfare calculations, in order to interpret our estimates in dollar-terms we transform the elasticities into the median marginal effects. For example, the median impact of government spending on aggregate income is given by:

$$\frac{d\text{Income}_c}{dF_c} = \beta^{\text{Inc}} \text{med}\left(\frac{\text{Income}_c}{F_c}\right),$$

where $\text{med}\left(\frac{\text{Income}_c}{F_c}\right)$ is the median value of this ratio across all county groups in the U.S. For the employment effects, we calculate the cost per additional job by setting $d\text{Emp} = 1$ and reporting

$$\frac{1}{\beta^{\text{Emp}}} \text{med}\left(\frac{F_c}{\text{Emp}_c}\right).$$

Table 7 provides these numbers. The marginal effect on aggregate income of an additional dollar of spending is an increase in total income of \$3.95. The impact per-each adult, however, is only \$0.75. The cost per-job-created is \$12,400 dollars; while the cost of increasing the employment rate by 1% is \$121,300. Finally, the local public finance estimates suggest that an additional dollar of federal spending leads to a reduction in per-capital local public spending of \$0.27 and a decrease in local taxation of \$0.21.

7 Reduced-Form Tests of the Model

The results from the previous section suggest that the impacts of government spending on wages, migration, and housing values are qualitatively different from those found by studies that analyze local labor demand shock (see , e.g., Bartik (1991), Bound and Holzer (2000), and Notowidigdo (2011)). The model in Section 3 provides economic reasoning that reconciles these effects by noting that, while part of federal monies spent at the local level lead to an increase in labor demand, a fraction of these expenditures is used to provide public goods and services that may be valued by workers. This section tests the reduced form predictions of the model and provides evidence that amenities supplied by the government are at the source of the difference between the effects of a government spending shock and those of a labor demand shock.

The main test of the model compares the responsiveness of population to increases in real wages that are elicited by a government spending shock and a labor demand shock. If a government spending shock was a pure labor demand shock, then the ratio at which workers migrate to take advantage of higher wages would be similar across shocks. If government spending created disamenities, however, workers would have to be compensated to absorb these undesirable government services and the elasticity of population with respect to real wages would be smaller. In contrast, large elasticities of

[29] See Hines and Thaler (1995) for a precise definition of the flypaper effect.

population with respect to wages are evidence that government services have an amenity component that is valued by workers as a small increase in wages leads to large changes in population. In order to formalize this argument, recall the labor supply equation from Equation 4:

$$\frac{\Delta N_c^i}{(1-N_c^i)} = \frac{\Delta \text{Real Wage}_c^i}{\sigma^i} + \frac{\phi^i}{\sigma^i}\Delta GS_c + \frac{\Delta A_c}{\sigma^i},$$

where

$$\Delta \text{Real Wage}_c^i = (1 - s^{i,t})\Delta w_c^i + s^{i,t}\Delta t_c^i - s^{i,r}\Delta r_c.$$

Consider first the effects of an increase in the demand for labor leading to increases in wages in a given local economy. Workers would migrate to this area in response to higher wages and the increase in population would lead to an increase in housing values and rents. The impact on real wages may be positive if there is imperfect mobility or if there is heterogeneity in the taste for different location-specific attributes.[30] In addition, to the extent that skilled workers are relatively more mobile, any increase in wages is more likely to be arbitraged away leading to smaller wage differentials and higher mobility responses.

Table 8 compares these predictions with those of a government spending shock. An increase in government spending increases labor demand but also increases the provision of government services. From the equation above, we see that both effects lead workers to migrate into the area but have opposing effects on wages; the net effect on wages could thus be positive or negative. While wages might not rise, the increase in demand and supply both lead to increases in population which would also raise housing values and rents. A larger increase in population in response to a smaller increase in wages will thus lead to a large elasticity of population with respect to real wages. To the extent that unskilled workers have a higher valuation of government services, the increase in the unskilled population will be larger and any increases in wages will be smaller. Consequentially, the population elasticity of real wages will be larger for the unskilled population.

In order to analyze the effects on real wages, we first calibrate the share of income from transfer payments and the expenditure share on housing costs. Expenditure shares from the Consumer of Expenditure Survey (CEX, see BLS (2011a)) report that the low skilled spend around 22% of their income on shelter while the skilled spend around 20%. Previous authors find that local housing costs can proxy for local price levels; motivating a larger expenditure share of housing of 30%.[31] Our main specification uses housing values in creating our real wage variable. We adjust housing values to match the standard deviation of gross rents since empirical evidence suggests that rents will rise less than one-to-one with increases in housing values (Albouy (2009b)).[32] Income tabulations using census data and welfare expenditures from aggregate welfare transfers show that the average per-unskilled

[30] In models with perfect mobility and no heterogeneity (e.g. Roback (1982)) the equilibrium impact on real wages is null.

[31] Albouy (2009b) presents a formal analysis of a two sector model with tradable and non-tradable goods and uses an expenditure share of housing costs that is larger than that of the CEX with the explicit aim of accounting for prices of non-tradable goods. Moretti (2009) also notes that in computing regional CPIs, housing costs have the highest weight in the index. The analyses in Notowidigdo (2011), Shapiro (2006), Albouy (2009b) use similar expenditure shares of housing.

[32] Estimates of labor supply using gross rents yield very similar results. See discussion in Section 8 and the results in Table 10.

adult income transfer is around \$900; which corresponds to a share of income of $s^{t,U} = 5\%$ of the average income per unskilled adult of around \$22,000.[33]

Consider now the impacts of the Bartik shock given in Panel (a) of Table 9. The first four columns present OLS estimates of the following estimating equation:

$$\Delta y_{c,t} = \mu_{s,t} + \beta \text{Shock}_{c,t} + \epsilon_{c,t}, \tag{9}$$

where $\Delta y_{c,t}$ is the percentage change in a given outcome and $\mu_{s,t}$ are state group by year fixed effects. The first row confirms the predictions of a labor demand shock leading to positive changes in wages, rents, and population. Relative to the increase in wages, the increase in housing values is large. Comparing estimates across skill levels, we see that the unskilled have a slightly larger increase in wages and a significantly smaller impact on population. The last column presents instrumental variable estimates of the impacts of real wages on population, where real wages are instrumented with a given shock by the equation above. The real wage elasticity of population is 1.58 for all workers but is only 1.02 for unskilled workers.

The impacts of census shock presented in Panel (b) show that the net effect on wages is positive, the effect on housing values is positive, though small, and the effect on population is very large. Furthermore, the lower effect on unskilled wages and the very similar effects on mobility across skill levels are both consistent with the notion that the unskilled have a higher valuation of government services. The last column of the table shows that the real wage elasticity of population is much larger for the census shock than for the Bartik shock. This is evidence that the services provided by the government are valued by workers; since workers are willing to migrate for a smaller increase in wages in order to consume these amenities.[34]

While the evidence presented above is consistent with the predictions of the model, it is worth noting that a government spending shock leads to large population responses but does not lead to large increases in housing prices. While a census shock does increase housing values, the ratio of the increase in home values to the increase in population is less than one for the census shock but the same ratio is greater than one for the Bartik shock. These estimates can be reconciled, however, if these shocks are tracing out different ranges of a non-linear supply of housing function. Glaeser and Gyourko (2005) show that properties of the production and depreciation of housing lead to large drops in housing values in areas with relative population decline but may have small increases in prices in areas of population growth.[35] Consistent with this hypothesis, the variation elicited by the Bartik shock has been previously interpreted as arising primarily from long-run declines in industries such as manufacturing (e.g. Bound and Holzer (2000)). In the next section we estimate a non-linear model of housing supply that reconciles these effects and is consistent with over-identifying restrictions in the data.[36]

[33] See Table E.2 in Appendix E for these tabulations. The analysis in Notowidigdo (2011) uses the same share for transfer income.

[34] An additional test using cross-sectional variation in the type of spending across localities is presented in Table E.6 in Appendix E.

[35] Notowidigdo (2011) explores how this concavity affects the incidence of local economic shocks.

[36] Table E.7 in Appendix E provides reduced-form evidence that the two shocks trace the housing supply function along different regions of its domain by analyzing the heterogeneity of the effects of both shocks in areas with high and low lagged population growth.

While these reduced-form tests suggest that the impacts of government spending are consistent with the model from Section 3, we are unable to quantify important economic margins using a reduced-form approach. First, one would like to decompose the portion of the increase in population and wages that is due to the supply and demand components of the government spending shock. A reduced-form approach would not be able to decompose these effects since we only observe changes in equilibrium values of employment and wages. Second, one would like to use empirical estimates of workers' marginal valuation of government services to evaluate hypothetical policy experiments that affect the level and allocation of government spending. However, we are prevented from conducting this analysis by the fact that we do not directly observe an increase in government services that could be used to identify the worker's marginal valuation for government services.

8 Structural Estimates

This section estimates workers' marginal valuation of government services and other structural parameters that allow us to quantify the increase in employment that is due to the labor demand component of the government spending shock. By isolating the demand component of a government spending shock, we reconcile our estimates with those of a pure labor demand shock. Our estimates of workers' marginal valuation of government services are then used in Section 9 to analyze hypothetical policy experiments.

We implement the model from Section 3 using the identification strategy from Section 5. Equilibrium in the model is characterized by six equations: Equations 1 and 4 determine the labor market equilibrium for the low and the high skilled, while Equation 2 determines income transfers, and Equation 3 determines the supply of housing for both skill levels. We further manipulate these equations to arrive at our estimating equations.[37]

Consider first the supply of labor of skill i given by:

$$\begin{aligned}\Delta N^i_{c,t} &= \mu^{LS,i}_{s,t} + \frac{(1-s^{i,t})\Delta w^i_{c,t} + s^{i,t}\Delta t^i_{c,t} - s^{i,r}\Delta r_{c,t}}{\sigma^i} + \frac{\phi^i}{\sigma^i}\Delta GS_{c,t} + \Delta e^{LS,i}_{c,t} \\ &= \mu^{LS,i}_{s,t} + \frac{\Delta \text{Real Wage}^i_{c,t}}{\sigma^i} + \frac{\phi^i}{\sigma^i}\Delta GS_{c,t} + \Delta e^{LS,i}_{c,t},\end{aligned}$$

where $\mu^{LS,i}_{s,t}$ is a state group-year specific component of the aggregate amenity shock and $\Delta e^{i,LS}_c$ is the remaining amenity shock.[38] We estimate this equation using composition-adjusted gross rents as well as composition-adjusted housing values and, in both cases, we use a housing expenditure share of 30% for both skill groups. We also continue to use a share of income from transfer payments of 5% for unskilled workers.[39]

Changes in government services are computed using the following relationship:

$$\Delta GS_c = \Delta F_c - (\theta \Delta w^S_c + (1-\theta)\Delta w^U_c),$$

[37] Detailed derivations are provided in Appendix A.

[38] For simplicity, we ignore the term $\frac{1}{(1-N^i_c)}$ in estimation. Estimations that include this term yield almost identical results as 99% of localities have shares of population less than 1%.

[39] See the discussion in Section 7 regarding the calibration of these shares.

where θ is the wage bill share of skilled workers. In order to calibrate θ, we use data from the Occupational Employment Survey (OES, see BLS (2011b)) to calculate public sector employment by occupation. We then use micro-data from the 1980, 1990, and 2000 Censuses and the 2009 ACS to calculate the proportion of skilled individuals in each of these occupations. We calculate that 30% of public employees have a college degree.[40] Finally, we use an average wage of \$13 for the unskilled and \$24 for the skilled to arrive at a value of $\theta = 0.4$.

To see the potential perils of estimating the labor supply equation using an OLS approach, recall that $\Delta e_c^{i,LS}$ is an amenity shock to locality c. Assuming that real wages are lower in areas with a positive amenity shock, that is $\mathbb{C}ov(\Delta e_{c,t}^{i,LS}, \Delta \text{Real Wage}_{c,t}^{i}) < 0$, implies that an OLS estimation would yield estimates of $\frac{1}{\sigma^i}$ that would be downwardly-biased. In turn, the estimates for σ^i would be upwardly biased. Similarly, if we assume that government services might automatically compensate areas with negative amenity shocks, that is $\mathbb{C}ov(\Delta e_c^{i,LS}, \Delta GS_{c,t}) < 0$, the estimate of the ratio $\frac{\phi^i}{\sigma^i}$ would also be downwardly biased. The bias on ϕ^i might lead to over or underestimates of the true parameter depending on which of the two biases above is stronger.

In order to avoid these potential issues, we instrument for changes in real wages using the Bartik shock and instrument for changes in government services using the census shock. We include quadratic terms of both shocks in our estimations and thus provide a test of overidentifying restrictions. Panel (a) of Table 10 presents OLS and IV estimates of these parameters using housing values to construct the measures of real wages. As expected, we find that OLS estimates of σ^i are significantly larger than the IV estimates. The IV estimates find inverse mobility parameters that are an order of magnitude smaller for both skill groups. The inverse mobility parameter is slightly larger for the unskilled; which is consistent with smaller population responses to a labor demand shock. The IV estimates of ϕ^i confirm our hypothesis that unskilled workers place a higher valuation on government services as their valuation is twice as large as that for the skilled. For the unskilled, the estimate of ϕ suggests that unskilled workers would accept a .45% decrease in wages in exchange for a 1% increase in government services. The model fails to reject the overidentifying restrictions at the 1% level.

Now consider the housing market. We begin by estimating a constant elasticity inverse housing supply equation given by:

$$\Delta r_{c,t} = \mu_{s,t}^{HD} + \eta \Delta H_{c,t} + \Delta e_{c,t}^{HD},$$

which states that a percentage increase in housing units in c leads to an increase of η-percent in rents and where we decompose the structural error into a state group-year specific component and the remaining shock to productivity in the housing sector: $\Delta e_{c,t}^{HD}$. Since a productivity shock in the housing market that lowers rents might lead to increases in population, an OLS estimation might yield estimates of η that are downwardly biased. Column 3 in Tables 10 present OLS and IV estimates of this parameter where both Bartik and census shocks are used to identify changes in housing units. As expected, the IV estimate is significantly larger than the OLS estimate. However, the overidentifying restrictions is rejected by the data at the 1% level. This result is not very surprising given the different responses of housing values to population that we observed in Section 6.

As prefaced in the previous section, the census shock and the Bartik shock would find different effects on housing values if the shocks are tracing out different ranges of a non-linear function. Previous

[40] It is noteworthy that this proportion is higher than the population average of 25%.

authors have motivated a concave housing supply function from durable properties of the housing market (e.g. Glaeser and Gyourko (2005)) and have estimated flexible non-linear models of housing supply (e.g. Notowidigdo (2011)). In order to reconcile the different effects on housing values, we estimate a non-linear inverse housing supply function of the form:

$$\Delta r_{c,t} = \mu_{s,t}^{HD,2} + \gamma \frac{(\exp\{\rho \Delta H_{c,t}\} - 1)}{\rho} + \Delta e_{c,t}^{HD,2}.$$

The generalized exponential function above includes the previous model as a special case when $\rho = 0$. Whenever $\rho \neq 0$, this function can be concave or convex. We estimate this model via GMM using both Bartik and census shocks for identification. Column 4 in Table 10 presents estimates of these parameters and shows that the model satisfies the overidentifying restrictions in the data. Figure 4 plots the estimated housing supply function; which confirms the intuition advanced above that the population elasticity of housing values is much larger in areas with relative population decline that in areas with relative growth in population. These results are consistent with the notion that the Bartik shock is tracing out the lower range of this curve while the census shock is tracing out the upper range of the curve.[41]

Consider now the relation between changes in income transfers and changes in wages given by the following equation:

$$\Delta t_{c,t}^{i} = \mu_{s,t}^{T} + \psi \Delta w_{c,t}^{i} + \Delta e_{c,t}^{T},$$

where μ_s^T is a state group-year specific component of the aggregate budget shock and Δe_c^T is the remaining aggregate shock to the budget allotted for income transfers. Since the aggregate budgeting shock Δe_c^T is unlikely to be correlated with local economic conditions and since the underlying relation is a mechanical transfer of income, we estimate this equation via OLS. Indeed, results in Table 10 confirm that we cannot reject the null hypothesis of exogeneity. This relation confirms the results of Notowidigdo (2011) as transfer to the unskilled rise with decreases in wages.

The last set of equations to consider are the labor demand equations. Equating the aggregate labor demand Equation 4 to the supply of labor by workers of skill i and rearranging yields:

$$\Delta N_{c,t}^{i} - \Delta \bar{Z}_{c,t} = \mu_{s,t}^{LD,i} - \left(\kappa^{GD,i} + \frac{\kappa^{PD,i}}{(1-\alpha_i)} \right) \Delta w_{c,t}^{i} + \xi \text{Bartik}_{c,t} + \Delta e_{c,t}^{LD,i},$$

where $\mu_{s,t}^{LD,i}$ is the state group-year fixed effect and $\Delta e_{c,t}^{LD,i}$ is the remaining aggregate productivity shock; both are derived from shocks to the productivity parameter B_c. We also control for shocks to productivity that arise from national shocks to industries and allocate the importance of these shocks to localities based on predetermined industry composition using the Bartik shock. Using a similar method to that used to calculate θ, we calculate the total employment by occupation in the private sector and calculate that $\kappa^{G,S} = 10\%$ of the skilled population and $\kappa^{G,U} = 8\%$ of the unskilled population are employed in the public sector. It is noteworthy that this proportion includes education and health sector workers that are employed by the government. Finally, while the model assumes that $\Delta \bar{Z}_{c,t} = \Delta F_{c,t}$, we take into account depreciation of public infrastructure and discount the cumulative investment at a rate of 10%.

To understand the identification of this equation and the assumptions behind the model, recall that government spending has supply and demand components. Our structural assumptions isolate

[41] See Table E.7 in Appendix E for reduced-form results that corroborate this hypothesis.

the supply component of the government spending shock by specifying the effects of infrastructure and public hiring of workers on the demand function. This ensures that the remaining variation in our instrument identifies variation in $\Delta w^i_{c,t}$ that arises from the supply component of the government spending shock. In contrast, an OLS estimation of this equation might be riddled with the problem that positive productivity shocks ($\Delta e^{LD,i}_{c,t}$) will be positively correlated with changes in wages. This might lead an OLS approach to overestimate the coefficient on wages and indeed might lead to an upward-sloping demand curve if the estimated value of $\alpha^i > 1$. The last two columns of Tables 10 present estimates of the output elasticity of supply for skilled and unskilled workers. As expected, the bias in OLS estimations lead to overestimations of these parameters that imply upward-sloping demand curves. The IV estimates we report imply that the labor demand curve for skilled workers is significantly steeper than that of unskilled workers. This fact has important consequences for the decomposition of the government spending shock into supply and demand components. Importantly, the overidentifying restrictions in both equations are not rejected in the data.

Figure 5 presents the decomposition of the government spending shock into supply and demand components. This figure uses the reduced-form results from Section 6 and the estimates of the slopes of the supply and demand curve from Table 10. This graph quantifies two main results of the analysis. First, the supply component of the government spending shock is larger for the unskilled than for the skilled. We calculate that 53% of the migration response for the unskilled is due to the valuation of government services while only 19% of the migration margin is explained by the supply component for skilled workers. The decomposition of the wage effects shows that a pure labor demand shock would yield an increase in wages that would be 46% larger for the unskilled and 32% larger for the skilled. These results are a consequence of the relatively steeper labor demand curve for the skilled and the larger valuation of the government services by the unskilled. These factors allow the model from Section 3 to successfully explain the smaller mobility differential. The second result is that while the fall in wages due to the supply component is larger for the unskilled, the bulk of the increase in the skill wage differential is due to the fact that government spending seems to have a larger structural demand component for the skilled.[42]

9 Welfare Effects of Hypothetical Policy Experiments

A central concept in this paper is that workers' valuations of government services are critical parameters in evaluating the welfare effects of changes in government spending. This section uses the estimates from the previous section to conduct two types of hypothetical policy experiments. The first experiment analyzes the welfare effects of increasing government spending by $1,000 in the median county-group in the U.S. under three different scenarios. The second experiment analyzes the relative effectiveness of government spending in raising welfare in areas with higher and lower shares of skilled workers. These experiments demonstrate the importance of including workers' valuation of government services in welfare calculations and the role of the relative benefits to skilled and unskilled workers in determining the allocation of spending across localities.

Consider now the hypothetical experiment of increasing government spending. Take the county group with the median expenditure of federal funds per adult of $10,235 and consider increasing

[42] We explore the robustness of this decomposition in the Appendix E. Of the parameters used in this decomposition, the slope of the labor demand curve carries the most uncertainty. Table E.8 compares the decomposition for a range of parameters of α^i. We find that these conclusions are not sensitive to small changes in this parameter.

expenditures per adult by $1,000 dollars. This corresponds to a percentage increase of 9.77%. The increase in government spending leads to increases in wage earnings for both the skilled and the unskilled which we evaluate at average wages of $24 and $13, respectively, and at 160 monthly hours for 12 months. We continue to assume a rent-share of earnings of 30%. We also assume a marginal tax rate of 30% for the skilled and 15% for the unskilled and use the national share of skilled workers of 25%. The following calculations use estimates from the linear inverse housing supply function.[43]

We measure changes in worker welfare using Equation 5 and evaluate changes in utility at the marginal utility of income to arrive at a dollar value. We measure the net-benefit to the economy from the additional spending and compare the results to published estimates of the marginal cost of public funds.[44] The dollar-valued change in worker welfare is then given by:

$$\begin{aligned} \frac{dV^i}{dv^i_c}\frac{1}{\lambda^i_c} &= N^i_c \frac{dv^i_c}{\lambda^i_c} \\ &= N^i_c \left(dw^i_c + dt^i_c - dr^i_c + \phi^i (w^i_c + t^i_c) \frac{dGS_c}{GS_c} \right), \end{aligned} \tag{10}$$

where w^i_c now denotes after-tax wages. In addition, we include the increase in rental costs as benefits to owners of housing and increases in tax collections in our net-benefit calculation.

We conduct this experiment under three scenarios depicted in Figure 6. The first experiment corresponds to the extant view that government spending has the same effects as a labor demand shock. This experiment assumes workers place zero value on government services (i.e. $\phi^S = \phi^U = 0$) and evaluates Equation 10 using the estimated changes on wages, rents, and migration from Section 6. This experiment is depicted in Panel (a) of Figure 6 as a change from A to C along an implied labor supply curve that does not depend on government spending. Column (1) in Table 11 evaluates this experiment and shows that, while skilled workers benefit from this change, the increase in wages for the unskilled is overtaken by the increase in housing costs. On average, $1,000 of spending only increase welfare by $650; showing that the view that government spending has the same effects of a labor demand shock leads to small impacts on welfare that are significantly below the original amount spent.

The purpose of the second exercise is to quantify the potential for government spending to stimulate local economies in the long run. This experiment uses the decomposition in Section 8 and evaluates the effects on welfare from the demand component of the government spending shock; while still setting workers' valuation of government services to zero. Panel (b) of Figure 6 depicts this experiment as a change from A to B. Column (2) in Table 11 presents the outcome of this experiment. While both skilled and unskilled workers benefit from this increase in demand, skilled workers benefit substantially more than unskilled workers. The total benefit is larger than in the first experiment but

[43] Similar calculations would hold for the non-linear inverse housing supply function. These changes in rental costs, however, would vary according to the estimated non-linear relationship. As rental costs are included in the net-benefit calculation, this factor does not affect the bottom-line conclusions. Moreover, the increases in rental costs could be thought of as an upper bound as government spending shocks have been shown to have small impacts on housing values in Section 6.

[44] The effects of taxation on economic efficiency can be analytically characterized within our model. We rely on published estimates of the marginal cost of public funds to conduct welfare analysis, however, since a realistic picture of the distortionary effects of taxation would incorporate impacts on the units of labor to supply; which our model does not incorporate.

the net benefits are still below the original $1,000. Thus, while government spending can increase the demand for labor in the long run, this motivation might not be sufficient to warrant government intervention.

The third experiment incorporates the insights of the model and evaluates the total effects of government spending on welfare including the estimated valuations of government services. Panel (c) of Figure 6 depicts this experiment as a change from A to C incorporating shifts in the labor demand and supply curves. Column (3) in Table 11 shows that including the valuation of government services in the analysis leads to substantially different conclusions. Relative to the first experiment, this experiment shows that ignoring the shift in supply that accompanies the provision of services can lead to large underestimations of the welfare effects of government spending. This analysis finds that an increase in $1,000 dollars of government spending per person leads to a net gain of $1,445 dollars in economic welfare; or net benefits of $1.45 per dollar spent. In order for this policy experiment to increase welfare, however, the net benefit would have to exceed the marginal cost of public funds (MCPF). Ballard et al. (1985) report a preferred estimate of the MCPF of 1.33 with a MCPF arising from labor taxes of 1.23.[45]

The second set of experiments analyze the relative effectiveness of raising welfare through the provision of public goods and services in areas with different skill compositions. Given the result in Section 8 that unskilled workers have a significantly higher marginal valuation of government services, one would expect that structuring government spending to disproportionately affect areas with a high proportion of unskilled workers would be a cost-efficient way to increase social welfare. To formalize this notion, consider the marginal benefit term of the optimal provision of public goods formula in Equation 6, rearranged here as:

$$\left[\phi^S \frac{N_c^S}{N_c} + \phi^U \left(1 - \frac{N_c^S}{N_c}\right) \frac{\pi^U}{\pi^S}\right] \times \left[\frac{GS_c}{N_c}\right]^{-1}.$$

We are interested in analyzing how the marginal benefit of spending depends on the fraction of skilled workers in a given locality: $\frac{N_c^S}{N_c}$. Consider then the ratio of a marginal increase in welfare due to government spending in an area with a given $\frac{N_c^S}{N_c}$ to the marginal increase in welfare in an area with equal share of skilled and unskilled; given by:

$$\frac{\phi^S \frac{N_c^S}{N_c} + \phi^U \left(1 - \frac{N_c^S}{N_c}\right) \frac{\pi^U}{\pi^S}}{\phi^S \frac{1}{2} + \phi^U \frac{1}{2} \frac{\pi^U}{\pi^S}}, \tag{11}$$

where we've held spending per-capita $\left(\frac{GS_c}{N_c}\right)$ constant across the two localities. This ratio depends on three factors: (1) share of skilled in a given area $\frac{N_c^S}{N_c}$, (2) relative social value of marginal utilities $\frac{\pi^U}{\pi^S}$, and (3) workers' valuations of government services ϕ^i.

[45] Fullerton (1991) compares different approaches to estimating the MCPF and Dahlby (2008) provides a recent review of this literature. Ballard et al. (1985) provide an extended range of estimates of the MCPF from 1.17 to 1.56; where the upper values depend on underlying parameters included "mainly to illustrate the sensitivity of the results to changes in these parameters." The adjustment of Atkinson and Stern (1974) to the result of Samuelson (1954), however, may not be necessary if the change in the provision of public goods is accompanied by a change in redistributive taxation, as in Kaplow (1996, 2006). Finally, note that out comparison of net benefits with the MCPF ignores the role of externalities from government spending that are not internalized by workers in their private valuations.

Table 12 evaluates Equation 11 at the estimated values of ϕ^S and ϕ^U for a range of values of both $\frac{\pi^U}{\pi^S}$ and $\frac{N_c^S}{N_c}$. The first column shows that the social planner must have regressive preferences that place almost twice as much value on the marginal utility of the skilled than the unskilled in order for the provision of services to be neutral to the share of skilled workers. The third column shows that for a neutral valuation of marginal utilities, corresponding to a utilitarian social welfare function, increasing spending in an area with 25% of skilled workers is 15% more efficient at raising social welfare than spending in an area with 50% of skilled workers. These estimates can also be used to evaluate other experiments. For example, assuming $\frac{\pi^U}{\pi^S} = 1.5$ (fourth column), consider the relative impact on welfare from allocating funds from an area with 75% of skilled workers to an area with 25% of skilled workers. Spending in the 25%-area would be 63% more effective at raising welfare since $1.24/0.76 = 1.63$.

The policy simulations in this section show that accounting for workers' valuation of government services has significant implications for the measurement of welfare effects in response to changes in government spending. To the extent that the marginal cost of public funds is lower than 1.45, there is scope for increasing government spending and, consequently, the provision of public goods and services. Moreover, while characterizing the optimal provision of public goods for all localities might be unfeasible, the fact that unskilled workers have a significantly higher valuation of government services implies that allocating funds to areas with smaller shares of skilled workers can more effectively raise welfare.

10 Conclusions

Using the census shock introduced in Suárez Serrato and Wingender (2011), we isolate potentially exogenous variation in the long-run allocation of federal spending and provide new estimates of the effects that a sustained change in government spending has on the local economy. We find that sustained spending changes have broad effects on employment and income, even after a decade. While most of the changes appear to be caused by shifts in population, our research finds significant increases in wage rates that are noticeably larger for the skilled population. In addition, there is a statistically significant effect on the employment to population ratio for the unskilled workforce. Our analyses of local public finances find that a crowd-out effect of $0.21 in local public spending occurs in response to an additional dollar of federal spending.

Economists' thinking about the impacts of government policies at the local level has long been guided by the study of local demand shocks. Contrary to this line of research, we find that a government spending shock has substantially different effects on wages, migration, and housing prices. These differences can be reconciled by showing that government spending has both labor demand and labor supply components. We develop and test a model where workers' valuation of government services leads to changes in the local supply of workers. Consistent with our hypotheses, workers appear to be willing to relocate to areas with higher government services for relatively lower wages, showing that workers value government services as amenities.

The central contribution of this paper is the measurement of economic incidence from sustained changes in government spending. We show that, when workers derive utility from government services, the effects on welfare from a change in government spending are determined by changes in wages and rental costs, as well as by the direct effects of public goods on workers' utility. Since these effects are not observed directly, we use variation from two exogenous shocks to quantify workers' valuation of government services. We find that unskilled workers have a significantly larger valuation of these services; such that ignoring workers' valuation leads us to grossly underestimate the welfare gains of the unskilled. Accounting for the direct effect of government services on workers' utility is shown to have significant consequences for the measurement of the economic benefits from government spending. Indeed, it can be a crucial factor in determining whether additional government spending has a social net-benefit. Our results show that a dollar increase in government spending leads to an increase of $1.45 in social welfare. Estimates of the marginal cost of public funds below this number suggest that an increase in spending would raise aggregate welfare.

An important consequence of our results is that, while government spending might lead to increases in wage inequality, welfare inequality can decrease if unskilled workers hold a higher valuation for government services. This potentially counterintuitive result arises from our modeling innovation of including a government sector in the hedonic framework of spatial equilibrium and helps guide the interpretation of recent results in local public finance (e.g. Boustan et al. (2010)). Our results help guide policymakers who are assessing the long run provision of government services by showing that cuts in the funding of programs that favor areas with larger shares of unskilled workers will most likely increase welfare inequality. Finally, our results suggest that fiscal multipliers might undervalue the welfare effects of government spending, since multipliers might not reflect the valuation that workers place on public services provided by the government.

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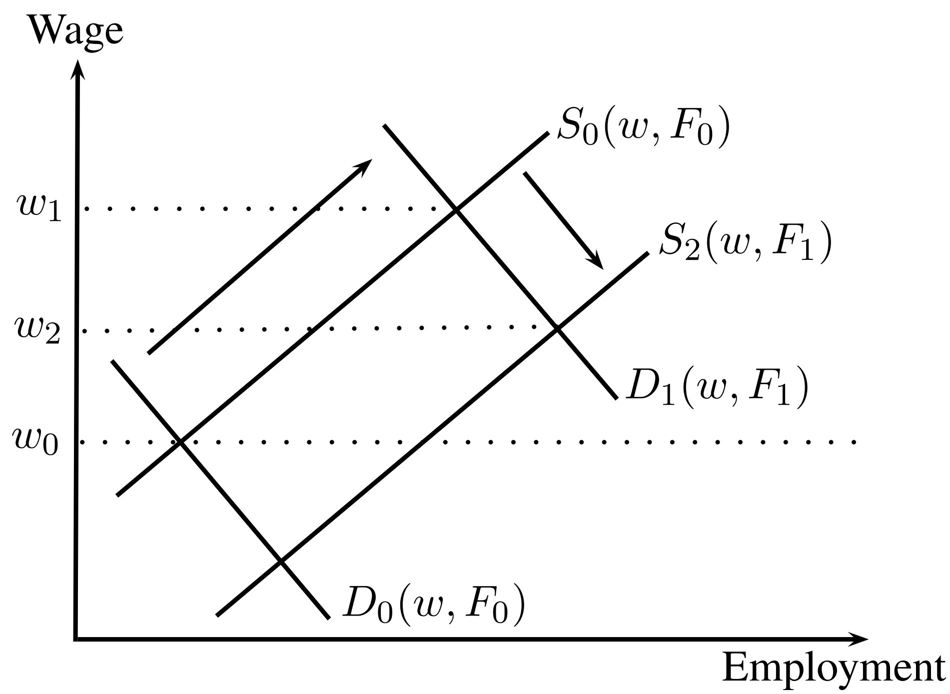
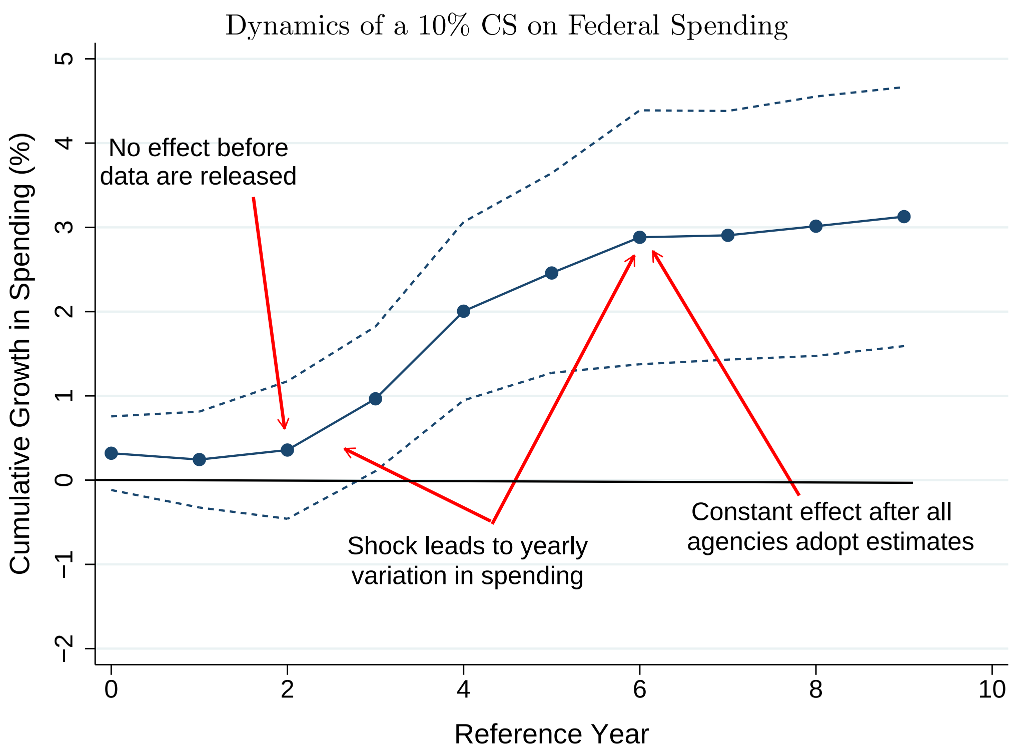
Figure 1: Supply and Demand Components of a Government Spending Shock



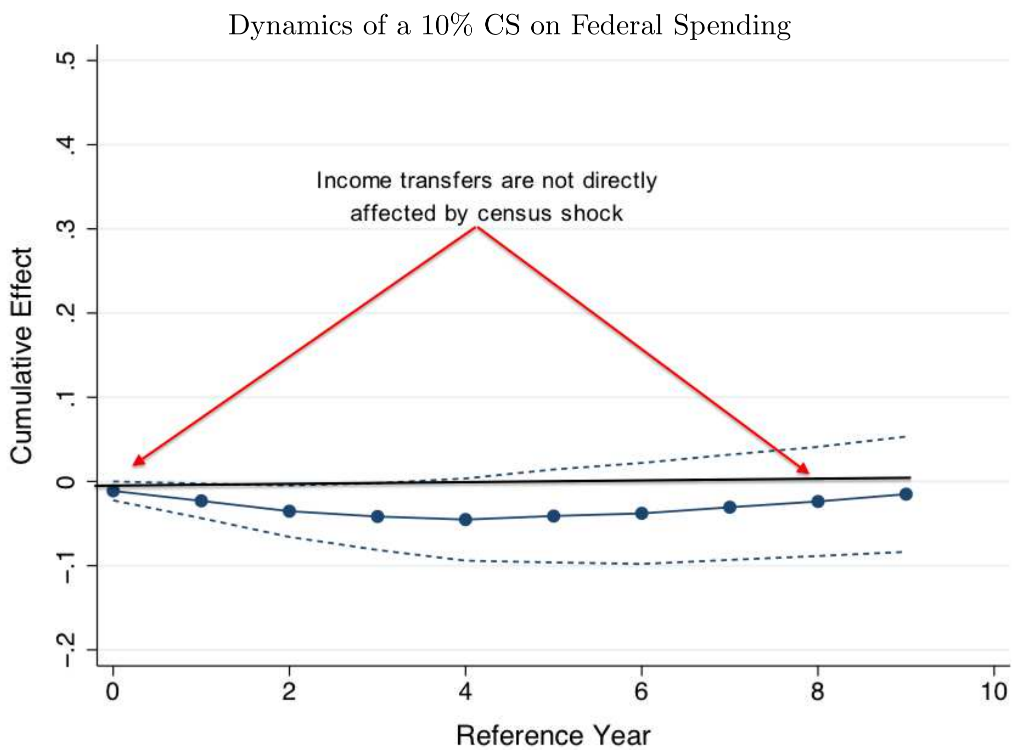
Notes: This figure shows the differences between a labor demand shock and a government spending shock. The graph plots the long-run equilibrium in a local labor market where the supply of workers is driven exclusively by migration. An increase in government spending from F_0 to F_1 shifts the demand through the provision of infrastructure and though direct hiring of workers by the government. This shift alone would increase wages to w_1; an equilibrium corresponding to a pure labor demand shock. An increase in government services, however, shifts the supply to $S_2(w, F_1)$; leading to the equilibrium outcome of w_2. The magnitude of the supply shift depends on workers' valuation of government services.

Figure 2: Cumulative Impact of CS on Federal Spending



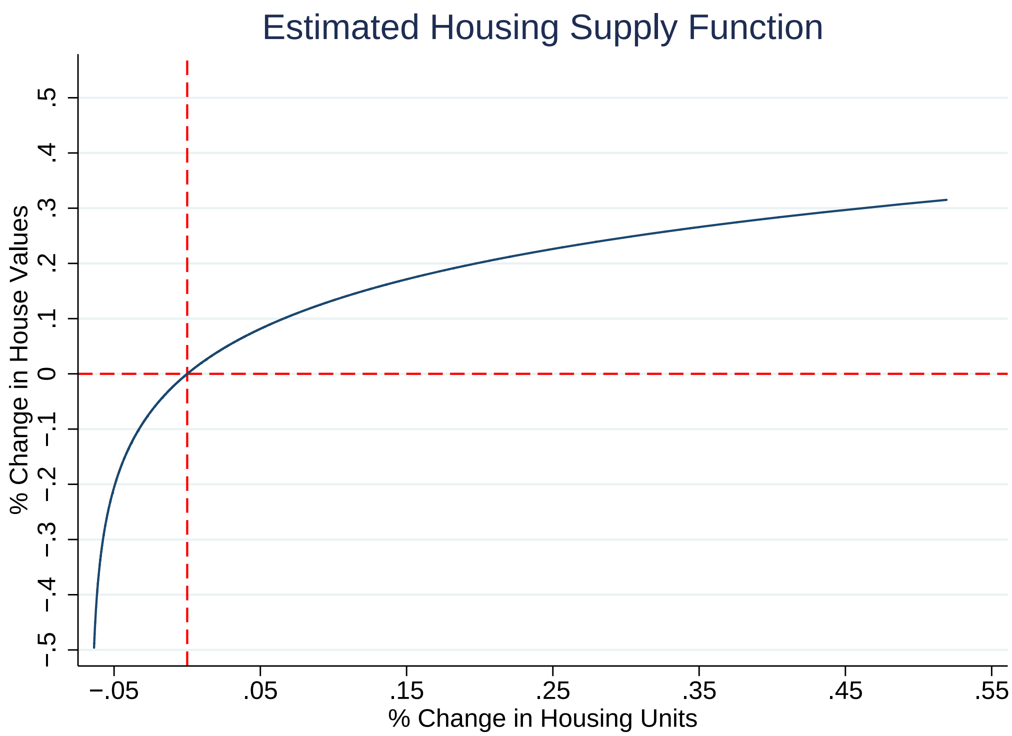
Notes: This figure presents the cumulative effect of a census shock on government spending using data at the county level as in Suárez Serrato and Wingender (2011). For a given year t, the graph plots $\sum_{\tau=0}^{t} \delta_t$ where the terms δ_t are the coefficients from Equation 7. This graph describes the dynamics of a 10% census shock on federal spending and shows three features: (1) there is no effect before the census shock is released, (2) between years two and five the shock leads to yearly variation in spending, and (3) once the census shock has been incorporated into all spending formulas, there is a sustained level effect on spending. Suárez Serrato and Wingender (2011) use yearly variation between years two and five while this paper analyzes the impact of the whole time path of spending.

Figure 3: Cumulative Impact of CS on Social Security Income Transfers



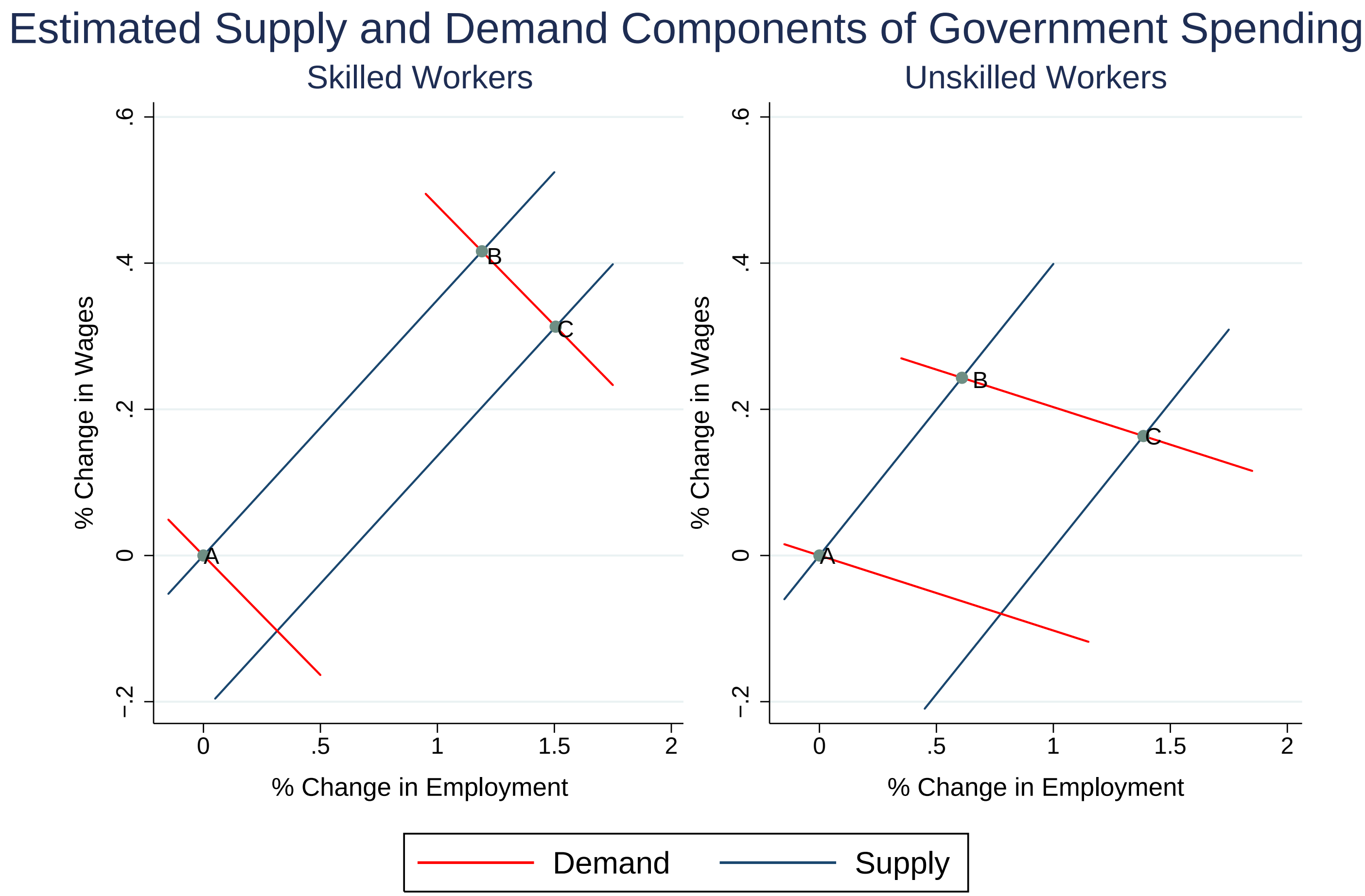
Notes: This figure presents the cumulative effect of a census shock on Social Security payments to individuals using data at the county level as in Suárez Serrato and Wingender (2011). This graph describes the dynamics of a 10% census shock on Social Security payments to individuals. For a given year t, the graph plots $\sum_{\tau=0}^{t} \delta_t$ where the terms δ_t are the coefficients from Equation 7. This graph shows that our identification strategy is not directly affecting transfers to individuals but is rather eliciting variation in spending from statutory formula programs.

Figure 4: Estimated Housing Supply Function



Notes: This figure presents the estimated housing supply function from Section 8. This function describes the heterogeneous effects of changes in housing units on housing values motivated by Glaeser and Gyourko (2005). Small effects of government spending on housing values from Section 6 suggest that the census shock instrument might be tracing the function along higher values of its domain. The Bartik shock produces larger effects and might be tracing this function along lower values of its domain. Further reduced-form evidence to this effect is provided in Table E.7.

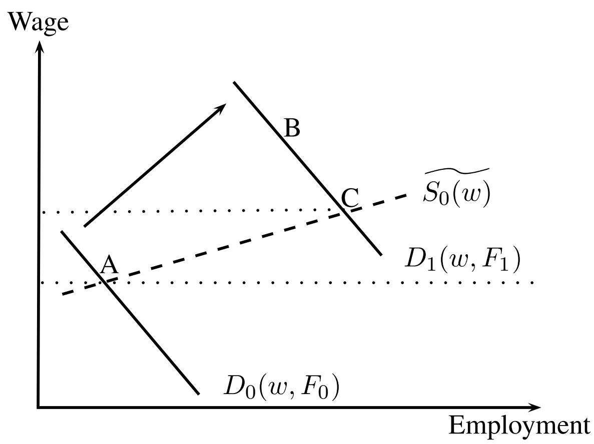
Figure 5: Estimated Supply and Demand Components of Government Shock



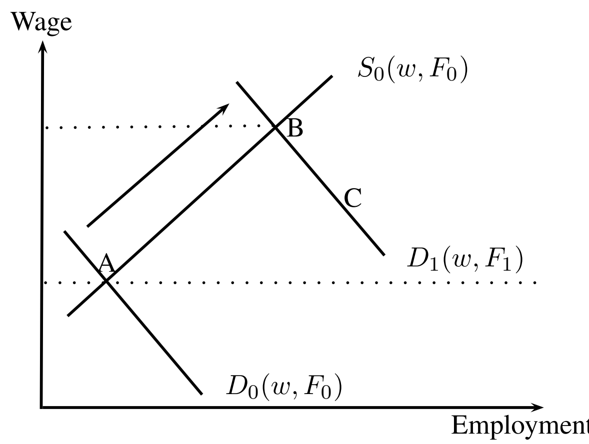
Notes: This figure presents the estimated local labor supply and demand curves from Section 8. Demand and supply curves shift in response to a 1% increase in government spending. The equilibrium outcomes C depict the estimates from Section 6 while points B are derived using estimates of slopes of the local labor supply and demand curves from Section 8. A larger demand shift for skilled workers shows that the demand component of a government spending shock is skill-biased; while a larger supply shift for unskilled workers is a consequence of their higher valuation for government services. 53% of the migration response for the unskilled is due to the valuation of government services while only 19% of the migration margin is explained by the supply component for skilled workers. The decomposition of the wage effects shows that a pure labor demand shock would yield an increase in wages that would be 46% larger for the unskilled and 32% larger for the skilled. Table E.8 explores the robustness of these decompositions.

Figure 6: Hypothetical Policy Experiments

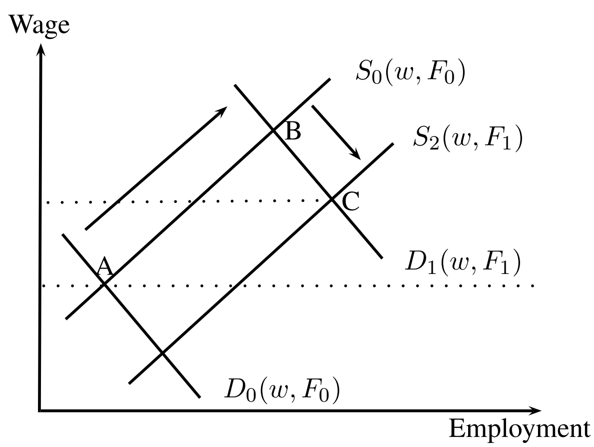
(a) Experiment #1: Effects of Spending Ignoring Valuation of Government Services



(b) Experiment #2: Demand Component of Shock Ignoring Valuation of Government Services



(c) Experiment #3: Total Effects of Spending Including Valuation of Government Services



Notes: This graph depicts the hypothetical experiments evaluated in Section 9. Panel (a) assumes workers place zero value on government services (i.e. $\phi^S = \phi^U = 0$) and evaluates Equation 10 using the estimated changes on wages, rents, and migration from Section 6. Panel (b) depicts the demand component of the government spending shock; while still setting workers' valuation of government services to zero. Panel (c) incorporates the insights of the model and evaluates the total effects of government spending on welfare including the estimated valuations of government services. The welfare effects from each of these experiments are analyzed in Table 11.

Table 1: Population and Instrument for Monterey County, CA

Year	Post-Censal Pop (000's)	Census Pop (000's)	CS: % Diff
1980	286	290	1.62
1990	362	357	-1.43
2000	374	402	6.87

Notes: Census population from U.S. Census (Census Bureau, 2010d), post-censal population reconstructed using post-censal population estimated from U.S. Census (Census Bureau, 2010d), components of change from IRS migration files (IRS, 2011), and data from Vital Statistics (CDC, 2010). This table is an example that shows that population counts at the local level can have large errors and are not serially correlated.

Table 2: First Stage Regressions on Federal Spending and Employment

	(1) Federal Spending	(2) Federal Spending
Census Shock	0.497***	0.493***
	(0.141)	(0.142)
Bartik		0.026
		(0.092)
Observations	1,479	1,479
F-Stat Instr	12.46	12.03

Notes: All columns report OLS results from estimating the effects of census shock (in percentage differences) on cumulative percentage changes in federal spending. The $F-$statistic from a significance test of the census shock variable is presented below the coefficients for each equation. Spending data come from Census Bureau (2010c). See Section 5 for details on the construction of the census shock and Appendices D and C for more detail. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$

Table 3: Aggregate Labor Outcomes

(a) OLS Results

	(1) Employment	(2) Earnings	(3) Income	(4) Welfare Income	(5) Population
All Workers					
Federal Spending	0.277***	0.273***	0.268***		0.262***
	(0.041)	(0.046)	(0.045)		(0.037)
Skilled Workers					
Federal Spending	0.300***	0.309***	0.306***		0.296***
	(0.049)	(0.053)	(0.052)		(0.047)
Unskilled Workers					
Federal Spending	0.266***	0.258***	0.255***	0.243***	0.248***
	(0.038)	(0.042)	(0.041)	(0.049)	(0.034)
Observations	1,479	1,479	1,479	1,479	1,479

(b) IV Results

	(1) Employment	(2) Earnings	(3) Income	(4) Welfare Income	(5) Population
All Workers					
Federal Spending	1.629***	1.972***	1.803***		1.463***
	(0.350)	(0.443)	(0.419)		(0.314)
Skilled Workers					
Federal Spending	1.506***	1.992***	1.888***		1.335***
	(0.423)	(0.517)	(0.497)		(0.397)
Unskilled Workers					
Federal Spending	1.385***	1.517***	1.351***	2.104***	1.265***
	(0.333)	(0.400)	(0.385)	(0.588)	(0.294)
Observations	1,479	1,479	1,479	1,479	1,479

Notes: Panel (a) presents OLS results and Panel (b) presents IV results. Each column present the results of three regressions corresponding to aggregate values and values specific to skilled and unskilled workers. Each of these coefficients corresponds to β from Equation 8. Both outcomes and federal spending are in log-differences so coefficients can be interpreted as elasticities. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. Data come from IPUMS 1980, 1990, and 2000 census extracts and the 2009 ACS (Ruggles et al., 2010). Spending data come from the CFFR (Census Bureau, 2010c). Final sample is a balanced panel of 493 county groups. See Section 4 and Appendices D and C for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table 4: Per-Capita Labor Outcomes

(a) OLS Results

	(1) Employment	(2) Earnings	(3) Income	(4) Welfare Income	(5) Wage	(6) Adj. Wage
All Workers						
Federal Spending	0.015*	0.012	0.006		0.018	0.007
	(0.009)	(0.018)	(0.017)		(0.011)	(0.009)
Skilled Workers						
Federal Spending	-0.019	-0.023	-0.029		0.018	0.019*
	(0.021)	(0.023)	(0.022)		(0.012)	(0.011)
Unskilled Workers						
Federal Spending	0.029**	0.026	0.020	-0.005	0.010	0.005
	(0.014)	(0.023)	(0.023)	(0.040)	(0.011)	(0.010)
Observations	1,479	1,479	1,479	1,479	1,479	1,479

(b) IV Results

	(1) Employment	(2) Earnings	(3) Income	(4) Welfare Income	(5) Wage	(6) Adj. Wage
All Workers						
Federal Spending	0.167*	0.509***	0.340**		0.290***	0.251***
	(0.092)	(0.176)	(0.154)		(0.106)	(0.091)
Skilled Workers						
Federal Spending	0.294	0.637***	0.468**		0.431***	0.313**
	(0.214)	(0.222)	(0.201)		(0.160)	(0.130)
Unskilled Workers						
Federal Spending	0.364***	0.707***	0.538**	0.839*	0.132	0.163*
	(0.139)	(0.241)	(0.221)	(0.488)	(0.096)	(0.087)
Observations	1,479	1,479	1,479	1,479	1,479	1,479

Notes: Panel (a) presents OLS results and Panel (b) presents IV results. Each column present the results of three regressions corresponding to aggregate values and values specific to skilled and unskilled workers. Each of these coefficients corresponds to β from Equation 8. Both outcomes and federal spending are in log-differences so coefficients can be interpreted as elasticities. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. Data come from IPUMS 1980, 1990, and 2000 census extracts and the 2009 ACS (Ruggles et al., 2010). Spending data come from the CFFR (Census Bureau, 2010c). Final sample is a balanced panel of 493 county groups. See Section 4 and Appendices D and C for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table 5: Housing Market Outcomes

(a) OLS Results

	(1) Gross Rent	(2) Adj. Gross Rent	(3) Home Value	(4) Adj. Home Value
All Workers				
Federal Spending	0.016	-0.007	0.046*	0.014
	(0.016)	(0.019)	(0.027)	(0.028)
Skilled Workers				
Federal Spending	0.023	-0.008	0.039	0.015
	(0.021)	(0.022)	(0.027)	(0.026)
Unskilled Workers				
Federal Spending	0.020	0.007	0.059**	0.031
	(0.015)	(0.018)	(0.027)	(0.028)
Observations	1,479	1,479	1,479	1,479

(b) IV Results

	(1) Gross Rent	(2) Adj. Gross Rent	(3) Home Value	(4) Adj. Home Value
All Workers				
Federal Spending	0.139	0.117	0.248	0.207
	(0.143)	(0.158)	(0.261)	(0.247)
Skilled Workers				
Federal Spending	0.223	0.120	0.203	0.081
	(0.194)	(0.208)	(0.246)	(0.240)
Unskilled Workers				
Federal Spending	0.071	0.038	0.198	0.134
	(0.142)	(0.158)	(0.264)	(0.247)
Observations	1,479	1,479	1,479	1,479

Notes: Panel (a) presents OLS results and Panel (b) presents IV results. Each column present the results of three regressions corresponding to aggregate values and values specific to skilled and unskilled workers. Each of these coefficients corresponds to β from Equation 8. Both outcomes and federal spending are in log-differences so coefficients can be interpreted as elasticities. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. Data come from IPUMS 1980, 1990, and 2000 census extracts and the 2009 ACS (Ruggles et al., 2010). Spending data come from the CFFR (Census Bureau, 2010c). Final sample is a balanced panel of 493 county groups. See Section 4 and Appendices D and C for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table 6: Local Government Outcomes Per Capita

(a) OLS Results

	(1) Taxes	(2) Property Tax	(3) Local Expenditures	(4) Operating Budget
All Workers				
Federal Spending	-0.030	-0.159	-0.226	-0.211
	(0.176)	(0.127)	(0.147)	(0.140)
Observations	1,479	1,479	1,479	1,479

(b) IV Results

	(1) Taxes	(2) Property Tax	(3) Local Expenditures	(4) Operating Budget
All Workers				
Federal Spending	-3.242**	-1.641**	-2.363**	-2.223**
	(1.332)	(0.828)	(1.083)	(0.959)
Observations	1,479	1,479	1,479	1,479

Notes: Panel (a) presents OLS results and Panel (b) presents IV results. Each column present the results of three regressions corresponding to aggregate values and values specific to skilled and unskilled workers. Each of these coefficients corresponds to β from Equation 8. Both outcomes and federal spending are in log-differences so coefficients can be interpreted as elasticities. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. Local public finance data come from the COG (Census Bureau, 2011) and federal spending data come from the CFFR (Census Bureau, 2010c). Final sample is a balanced panel of 493 county groups. See Section 4 and Appendices D and C for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table 7: Marginal Effects of Government Spending

	(1) Income	(2) Income Per Adult	(3) Employment	(4) Employment Per Adult	(5) Taxes Per Adult	(6) Expenditures Per Adult
Marginal	3.954***	0.746**	12.399***	121.291*	-0.211**	-0.267**
Effect	(0.919)	(0.337)	(2.665)	(66.709)	(0.086)	(0.122)
Observations	1,479	1,479	1,479	1,479	1,479	1,479

Notes: This table presents marginal effects based on IV estimates from Tables 3, 4, and 6. Marginal effects are evaluated at the median value of the spending-per outcome ratio to transform elasticities into the median marginal effects. For example, the median impact of government spending on aggregate income is given by

$$\frac{d\text{Income}_c}{dF_c} = \beta^{\text{Inc}}\text{med}\left(\frac{\text{Income}_c}{F_c}\right),$$

where $\text{med}\left(\frac{\text{Income}_c}{F_c}\right)$ is the median value of this ratio. For the employment effects, we calculate the cost per additional job by setting $d\text{Emp} = 1$ and reporting

$$\frac{1}{\beta^{\text{Emp}}}\text{med}\left(\frac{F_c}{\text{Emp}_c}\right).$$

See Section 6 for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table 8: Predictions of a Government Spending Shock in Spatial Equilibrium

	Wages	Rents	Real Wage	Population	Real Wage Elasticity of Population
Labor Demand	+	+	+	+	
Unskilled Workers	Larger		Larger	Smaller	Smaller
Government Spending	+/−	+	+/−	+	Large
Unskilled Workers	Smaller		Smaller	Similar/Larger	Larger

Notes: This table presents the reduced-form predictions of the spatial equilibrium model from Section 3. A labor demand shock leads to increases in wages, rents, real wages, and population. If unskilled workers are less mobile, we expect they will have large wage gains and a smaller population response. The real wage elasticity of population would also be smaller for the unskilled. A government spending shock could be consistent with increases or decreases in wages and real wages. If unskilled workers have higher valuations of government services, they are willing to accept a lower was so the effect on their wages will be smaller (if positive) and the effect on population will be larger than in response to a demand shock and will thus be similar or larger to the migration response of skilled workers. Finally, the real wage elasticity of population will be larger. These predictions are analyzed in Section 7.

Table 9: Reduced Form Effects by Shock

(a) Bartik Shock

	(1) Adj. Wage	(2) Adj. Home Val.	(3) Real Wages	(4) Population	(5) IV Population
All Workers					
Bartik	0.444***	0.981***	0.291***	0.462***	
	(0.033)	(0.094)	(0.029)	(0.069)	
Real Wage					1.584***
					(0.251)
Skilled Workers					
Bartik	0.356***	0.855***	0.200***	0.494***	
	(0.035)	(0.089)	(0.033)	(0.098)	
Real Wage					2.463***
					(0.587)
Unskilled Workers					
Bartik	0.367***	0.898***	0.194***	0.199***	
	(0.036)	(0.094)	(0.032)	(0.071)	
Real Wage					1.024***
					(0.360)
Observations	1,479	1,479	1,479	1,479	1,479

(b) Census Shock

	(1) Adj. Wage	(2) Adj. Home Val.	(3) Real Wage	(4) Population	(5) IV Population
All Workers					
Census Shock	0.124***	0.103	0.109**	0.727***	
	(0.047)	(0.118)	(0.045)	(0.190)	
Real Wage					6.698***
					(2.166)
Skilled Workers					
Census Shock	0.156***	0.040	0.148***	0.663***	
	(0.059)	(0.120)	(0.056)	(0.247)	
Real Wage					4.474**
					(1.987)
Unskilled Workers					
Census Shock	0.081*	0.067	0.091**	0.629***	
	(0.047)	(0.121)	(0.046)	(0.173)	
Real Wage					6.870**
					(2.941)
Observations	1,479	1,479	1,479	1,479	1,479

Notes: This tables presents reduced form regressions of each of the outcomes on the two instrumental variables. Each column present the results of three regressions corresponding to aggregate values and values specific to skilled and unskilled workers. Each of these coefficients corresponds to β from Equation 9. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. Data come from IPUMS 1980, 1990, and 2000 census extracts and the 2009 ACS (Ruggles et al., 2010). Spending data come from the CFFR (Census Bureau, 2010c). Final sample is a balanced panel of 493 county groups. See Section 4 and Appendices D and C for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table 10: Estimates of Structural Parameters

	(1) Labor Supply Unskilled		(2) Labor Supply Skilled		(3) Housing Supply	(4) Non-linear Housing Supply		(5) Welfare Transfers	(6) Labor Demand Unskilled	(7) Labor Demand Skilled
	Mobility: σ^U	Valuation of GS: ϕ^U	Mobility: σ^S	Valuation of GS: ϕ^S	Elasticity of Supply: η	γ	ρ	Elasticity of Transfers: ψ	Output Elasticity: α^U	Output Elasticity: α^S
(a) Housing Values										
OLS	1.882***	0.401***	2.552***	0.536***	0.192***			-1.006***	2.828***	3.593***
	(0.261)	(0.056)	(0.631)	(0.127)	(0.038)			(0.093)	(0.558)	(1.006)
IV	0.399***	0.502***	0.350***	0.267***	0.813***	0.067	6.936***		0.903***	0.674**
	(0.108)	(0.131)	(0.082)	(0.092)	(0.203)	(0.058)	(1.693)		(0.186)	(0.300)
Overid P-Val		0.220		0.020	0.010		0.771		0.396	0.840
Endog P-Val								0.100		
(b) Gross Rents										
OLS	3.694***	0.714***	5.197**	1.009**	0.192***			-1.006***	2.828***	3.593***
	(0.898)	(0.162)	(2.207)	(0.401)	(0.038)			(0.093)	(0.558)	(1.006)
IV	0.342***	0.391***	0.376***	0.228*	0.407***	0.137	13.842***		0.903***	0.674**
	(0.099)	(0.114)	(0.109)	(0.117)	(0.101)	(0.118)	(3.381)		(0.186)	(0.300)
Overid P-Val		0.071		0.010	0.010		0.768		0.396	0.840
Endog P-Val								0.100		

Notes: This table presents estimates of the structural parameters of the model in Section 8. Control and instrumental variables for each equation are specified in Section 8. Estimates are grouped by estimating equation. All equations except (4) estimate linear functions using OLS and 2SLS approaches. For these equations we conduct a test of overidentifying restrictions that is robust to heteroskedastic errors (Wooldridge, 2002). Equation (4) estimates a non-linear function via GMM where the second step weighing matrix is computed assuming heteroskedastic errors. The overidentification test for this equation is based on the χ^2 statistic of the objective function. Equation (5) is not subject to endogeneity concerns and is only estimated via OLS. The test of endogeneity fails to reject the null hypothesis of exogeneity. State group by year fixed effects included. Standard errors clustered at the county group level in parentheses. See Section 4 and Appendices D and C for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$

Table 11: Cost-Benefit Analysis of $1,000 of Government Spending

	(1) Effects of Spending Ignoring Value of Services		(2) Demand Component of Shock Ignoring Value of Services		(3) Total Effect of Spending Including Value of Services	
	% Increase	Dollar Value	% Increase	Dollar Value	% Increase	Dollar Value
1- Policy Experiment						
Median Spending Per Adult		$10,235		$10,235		$10,235
Additional Spending Per Person	9.77%	$1,000	9.77%	$1,000	9.77%	$1,000
2- Skilled Workers						
Annual Wage Earnings	3.06%	$1,409	4.10%	$1,891	3.06%	$1,409
Taxes (30%)		-$423		-$567		-$423
Annual Rent	6.45%	-$624	2.77%	-$268	6.45%	-$624
Government Services	7.54%	$0	6.65%	$0	7.54%	$649
Welfare Per Skilled Worker		$363		$1,056		$1,012
3- Unskilled Workers						
Annual Wage Earnings	1.59%	$398	2.34%	$585	1.59%	$398
Taxes (15%)		-$60		-$88		-$60
Transfer Payments	-1.59%	-$20	-2.34%	-$29	-1.59%	-$20
Rent	6.45%	-$410	2.77%	-$176	6.45%	-$410
Government Services	7.54%	$0	6.65%	$0	7.54%	$843
Welfare Per Unskilled Worker		-$92		$292		$751
4- Net Benefit						
Weighted Skilled Welfare (25%)		$91		$264		$253
Weighted Unskilled Welfare (75%)		-$69		$219		$563
Decrease in Transfers		$15		$22		$15
Housing Owner Welfare		$325		$139		$325
Increase in Taxes		$290		$267		$290
Net Benefit		$650		$912		$1,445

Notes: This table calculates the welfare effects of three hypothetical policy experiments discussed in Section 9. Column (1) assumes workers place zero value on government services (i.e. $\phi^S = \phi^U = 0$) and evaluates Equation 10 using the estimated changes on wages, rents, and migration from Section 6. Column (2) depicts the demand component of the government spending shock; while still setting workers' valuation of government services to zero. Column(3) incorporates the insights of the model and evaluates the total effects of government spending on welfare including the estimated valuations of government services. These experiments are described pictographically in Figure 6.

Table 12: Relative Effectiveness of Spending by Fractions of Skilled Workers

Share of Skilled: $\frac{N_c^S}{N_c}$	Relative Social Value of Marginal Utilities $\frac{\pi^U}{\pi^S}$				
	0.53	0.67	1.00	1.50	1.88
10%	1.00	1.09	1.24	1.38	1.45
25%	1.00	1.06	1.15	1.24	1.28
50%	1.00	1.00	1.00	1.00	1.00
75%	1.00	0.94	0.85	0.76	0.72
90%	1.00	0.91	0.76	0.62	0.55

Notes: This table evaluates the relative effectiveness of the provision of public goods at raising welfare according to two factors: (1) share of skilled in a given area $\frac{N_c^S}{N_c}$ and (2) relative social value of marginal utilities $\frac{\pi^U}{\pi^S}$. The table presents the ratio of a marginal increase in welfare due to government spending in an area with a given $\frac{N_c^S}{N_c}$ to the marginal increase in welfare in an area with equal share of skilled and unskilled. That is:

$$\frac{\phi^S \frac{N_c^S}{N_c} + \phi^U \left(1 - \frac{N_c^S}{N_c}\right) \frac{\pi^U}{\pi^S}}{\phi^S \frac{1}{2} + \phi^U \frac{1}{2} \frac{\pi^U}{\pi^S}}.$$

The first column shows that the social planner must have regressive preferences that place almost twice as much value on the marginal utility of the skilled than the unskilled in order for the provision of services to be neutral to the share of skilled workers. The third column shows that for a neutral valuation of marginal utilities, corresponding to a utilitarian social welfare function, increasing spending in an area with 25% of skilled workers is 15% more efficient at raising social welfare than spending in an area with 50% of skilled workers. These estimates can also be used to evaluate other experiments. For example, assuming $\frac{\pi^U}{\pi^S} = 1.5$ (fourth column), consider the relative impact on welfare from allocating funds from an area in with 75% of skilled workers to an area with 25% of skilled workers. Spending in the 25%-area would be 63% more effective at raising welfare since $1.24/0.76 = 1.63$.

Appendix: Not For Publication

A Model Derivation

This appendix provides a detailed derivation of the model in Section 3 and arrives are the estimating equations used in Section 8. In what follows, we use the symbol Δ to denote percentage changes.

Government Sector

Government demand of workers of skill i is given by:

$$L_c^{GD,i} = \frac{g^i F_c}{w_c^i},$$

where g^i is the share of government funds used to hire workers of skill i. To derive percentage changes in government demand for labor, take logarithms and derivatives to get

$$\begin{aligned} L_c^{GD,i} &= \frac{g^i F_c}{w_c^i} \\ \log L_c^{GD,i} &= \log g^i + \log F_c - \log w_c^i \\ \Delta L_c^{GD,i} &= \Delta F_c - \Delta w_c^i. \end{aligned}$$

The provision of government services is given by :

$$GS_c = (L_c^{GD,S})^{\theta}(L_c^{GD,U})^{1-\theta},$$

where $\theta = \frac{g^S}{g^S+g^U}$. To derive changes in the provision of services, evaluate the production function for government services at the optimal values of labor demand and take derivatives as follows:

$$\begin{aligned} GS_c &= (L_c^{GD,S})^{\theta}(L_c^{GD,U})^{1-\theta} \\ GS_c &= \left(\frac{g^S F_c}{w_c^S}\right)^{\theta}\left(\frac{g^U F_c}{w_c^U}\right)^{1-\theta} \\ \log GS_c &= \theta \log g^S + (1-\theta)\log g^U + \log F - (\theta \log w_c^S + (1-\theta)\log w_c^U) \\ \Delta GS_c &= \Delta F_c - (\theta \Delta w_c^S + (1-\theta)\Delta w_c^U). \end{aligned}$$

Transfer Payments

Transfer payments are assumed to have a constant elasticity with respect to wages and are given by:

$$t_c^i = \begin{cases} T_c(w_c^i)^{\psi} & \text{if } i = U \\ 0 & \text{if } i = S, \end{cases}$$

where T_c is a term capturing aggregate shocks to the funds allotted to provide income transfer assistance. We capture the state group-year specific component of this shock using fixed effects and estimate the equation:

$$\Delta t_{c,t}^i = \mu_{s,t}^T + \psi \Delta w_{c,t}^i + \Delta e_{c,t}^T,$$

where $\mu_{s,t}^T$ is a state group-year specific component of the aggregate budget shock and Δe_c^T is the remaining aggregate shock to the budget allotted for income transfers.

Housing Market

We analyze a skill-integrated housing market where the inverse housing supply function is given by:

$$r_c = k_c G(H_c),$$

where H_c is the number of units of housing and r_c is the per-unit rental prices in area c. The term k_c models productivity in the housing sector in area c as well as local regulatory and geographical constraints of housing production. We take two approaches to specifying the inverse housing supply equation. First, we consider a constant elasticity function given by:

$$\begin{aligned} r_c &= k_c H_c^{\eta} \\ \Delta r_c &= \eta \Delta H_c + \Delta k_c \end{aligned}$$

We estimate:

$$\Delta r_{c,t} = \mu_{s,t}^{HD} + \eta \Delta H_{c,t} + \Delta e_{c,t}^{HD},$$

where we decompose the term k_c into a state group-year specific component and the remaining shock to productivity in the housing sector: Δe_c^{HD}.

The second approach models percentage changes in the inverse housing supply equation in a flexible, non-linear form:

$$\Delta r_{c,t} = \mu_{s,t}^{HD,2} + \gamma \frac{(\exp\{\rho \Delta H_{c,t}\} - 1)}{\rho} + \Delta e_{c,t}^{HD,2}.$$

This specification follows previous studies that motivate a concave housing supply function from durable properties of the housing market (e.g. Glaeser and Gyourko (2005)) and have estimated flexible non-linear models of housing supply (e.g. Notowidigdo (2011)). The generalized exponential function above includes the previous model as a special case when $\rho = 0$. Whenever $\rho \neq 0$, this function can be concave or convex.

Labor Market

Workers maximize the following Cobb-Douglas utility function

$$(1 - s^{i,r}) \log(x_i) + s^{i,r} \log(h_i) + \phi^i \log(GS_c) + \log(A_c) + \sigma \varepsilon_{jc}^i,$$

where x_i is a consumption good, h_i is housing, GS_c are the government services provided by the government, $s^{i,r}$ is the ratio of rents to earnings, A_c are amenities of a given locality, and ε_{jc}^i is an individual location-specific preference term. In a given period, workers are assumed to be immobile and supply one unit of labor inelastically. Workers are mobile in the long-run and select their location c to maximize their semi-indirect utility function

$$\begin{aligned} u_{jc}^i &= \log(w_c^i + t_c^i) - s^{i,r} \log(r_c) + \log(A_c) + \phi^i \log(GS_c) + \sigma^i \varepsilon_{jc}^i \\ &= v_c^i + \sigma^i \varepsilon_{jc}^i. \end{aligned}$$

To derive the labor supply curve, first write the proportion of individuals in community c:

$$N_c^i = \mathbb{P}r\left(u_{jci} = \max_{c'} \quad u_{jc'}^i\right) = \frac{\exp(v_c^i/\sigma^i)}{\sum_{c'}(\exp(v_{c'}^i/\sigma^i))}.$$

Next take logarithms and manipulate as follows:

$$\begin{aligned}
\log N_c^i &= \frac{v_c^i}{\sigma^i} - \log\left(\sum_{c'} \exp(v_{c'}^i/\sigma^i)\right) \\
\frac{dN_c^i}{N_c^i} &= \frac{dv_c^i}{\sigma^i} - \frac{dv_c^i}{\sigma^i}\frac{\exp(v_c^i/\sigma^i)}{\sum_{c'}(\exp(v_{c'}^i/\sigma^i))} \\
\frac{dN_c^i}{N_c^i(1-N_c^i)} &= \frac{dv_c^i}{\sigma^i} = \frac{1}{\sigma^i}\left(\frac{dw_c^i + dt_c^i}{w_c^i + t_c^i} - s^{i,r}\frac{dr_c}{r_c} + \phi^i\frac{dGS_c}{GS_c} + \frac{dA_c}{A_c}\right) \\
\frac{\Delta N_c^i}{(1-N_c^i)} &= \frac{(1-s^{i,t})\Delta w_c^i + s^{i,t}\Delta t_c^i - s^{i,r}\Delta r_c}{\sigma^i} + \frac{\phi^i}{\sigma^i}\Delta GS_c + \frac{\Delta A_c}{\sigma^i}
\end{aligned}$$

where $s^{i,t}$ is the ratio or welfare transfer to total income. The third line assumes that a change in government spending in county group c does not impact outcomes in any other locality. Define changes in real wages as the following quantity:

$$\Delta \text{Real Wage}_c^i = (1-s^{i,t})\Delta w_c^i + s^{i,t}\Delta t_c^i - s^{i,r}\Delta r_c.$$

We decompose the aggregate amenity shock $\frac{\Delta A_c}{\sigma^i}$ into state group-year specific shocks by including a state group-year fixed effects and estimate the following equation:

$$\Delta N_{c,t}^i = \alpha_{s,t} + \frac{\Delta \text{Real Wage}_{c,t}^i}{\sigma^i} + \frac{\phi^i}{\sigma^i}\Delta GS_{c,t} + \Delta e_{c,t}^{LS,i},$$

where we ignore the term $\frac{1}{(1-N_c^i)}$ in estimation and where $\Delta e_{c,t}^{i,LS}$ is the remaining aggregate amenity shock.[46]

To derive the changes in labor demand we first analyze the impacts on the firm's demand for labor. To derive percentage changes in private demand, take logarithms, and derivatives to get

$$\begin{aligned}
L_c^{PD,i} &= \frac{(\alpha_i B_c)^{1/(1-\alpha_i)}\bar{Z}_c}{(w_c^i)^{1/(1-\alpha_i)}} \\
\Delta L_c^{PD,i} &= \frac{1}{(1-\alpha_i)}(\Delta B_c^i - \Delta w_c^i) + \Delta \bar{Z}_c.
\end{aligned}$$

We now compute total demand as follows:

$$\begin{aligned}
dL^{D,i} &= dL^{GD,i} + dL^{PD,i} \\
\frac{dL^{D,i}}{L^{D,i}} &= \frac{dL^{GD,i}L^{GD,i}}{L^{GD,i}L^{D,i}} + \frac{dL^{PD,i}L^{PD,i}}{L^{PD,i}L^{D,i}} \\
\Delta L^{D,i} &= \kappa^{GD,i}\Delta L^{GD,i} + \kappa^{PD,i}\Delta L^{PD,i},
\end{aligned}$$

[46] We omit this term for simplicity of exposition. Estimations that include this term yield almost identical results as 99% of localities have shares of population less than 1%.

where $\kappa^{GD,i}$ is the share of employment by the government and $\kappa^{PD,i}$ is the share of employment by firms and are such that $\kappa^{PD,i}+\kappa^{GD,i}=1$. Finally, we substitute for percentage changes in government and firm labor demand to derive percentage changes in total demand:

$$\begin{aligned}\Delta L^{D,i} &= \kappa^{GD,i}\Delta L^{GD,i}+\kappa^{PD,i}\Delta L^{PD,i}\\ \Delta L^{D,i} &= \kappa^{GD,i}\left(\Delta F_c-\Delta w_c^i\right)+\kappa^{PD,i}\left(\frac{1}{(1-\alpha_i)}(\Delta B_c^i-\Delta w_c^i)+\Delta\bar{Z}_c\right)\end{aligned}$$

Equating changes in labor demand to changes in labor supply and rearranging we get

$$\begin{aligned}\Delta N_c^i &= \kappa^{GD,i}\left(\Delta\bar{Z}_c-\Delta w_c^i\right)+\kappa^{PD,i}\left(\frac{1}{(1-\alpha_i)}(\Delta B_c^i-\Delta w_c^i)+\Delta\bar{Z}_c\right)\\ \Delta N_c^i &= \kappa^{GD,i}\left(\Delta\bar{Z}_c-\Delta w_c^i\right)+\kappa^{PD,i}\left(\frac{1}{(1-\alpha_i)}(\Delta B_c^i-\Delta w_c^i)+\Delta\bar{Z}_c\right)\\ \Delta N_c^i &= \Delta\bar{Z}_c-\left(\kappa^{GD,i}+\frac{\kappa^{PD,i}}{(1-\alpha_i)}\right)\Delta w_c^i+\frac{\kappa^{PD,i}}{(1-\alpha_i)}\Delta B_c^i.\end{aligned}$$

In estimation, we control for shocks to productivity that arise from national shocks to industries and allocate the importance of these shocks to localities based on previous industry composition using the Bartik shock:

$$\Delta N_{c,t}^i-\Delta\bar{Z}_{c,t} = \mu_{s,t}^{LD,i}-\left(\kappa^{GD,i}+\frac{\kappa^{PD,i}}{(1-\alpha_i)}\right)\Delta w_{c,t}^i+\xi\text{Bartik}_{c,t}+\Delta e_{c,t}^{LD,i}.$$

$\mu_{s,t}^{LD,i}$ is the state group-year fixed effect and $\Delta e_c^{LD,i}$ is the remaining aggregate productivity shock. Both are derived from shocks to the productivity parameter B_c. Finally, while the model assumes that $\Delta\bar{Z}_c=\Delta F_c$, we take into account depreciation of public infrastructure and discount the cumulative investment at a rate of 10%.

B Optimal Provision of Public Goods

This derivation adapts the results of Samuelson (1954) and Atkinson and Stern (1974) to a spatial equilibrium context using the methods in Auerbach and Hines (2002) and Busso et al. (2010). The consumer's problem is to maximize:

$$\begin{aligned} u_c^i(x_j, h_j, GS_c, A_c, l_j,) &= (1-s^{i,r})\log(x_j) + s^{i,r}\log(h_j) + \phi^i \log(GS_c) + \log(A_c) + \sigma\varepsilon_{jc}^i, \\ &\quad \text{subject to } \; x_j + r_c h_j = (w_c^i - \tau_c^i) l_j + y_j \\ &\quad l_j = 1, \end{aligned}$$

where we assume labor has a unit tax τ_c^i and the consumption good x is the numeraire. Labor is restricted to one unit.

Indirect utility is given by:

$$\begin{aligned} u_{jc}^i &= \log(w_c^i - \tau_c^i) - s^{i,r}\log(r_c) + \log(A_c) + \phi^i \log(GS_c) + \sigma^i \varepsilon_{jc}^i \\ &= v_c^i + \sigma^i \varepsilon_{jc}^i. \end{aligned}$$

Social welfare is given by:

$$\pi^S V^S + \pi^U V^U,$$

where π^i is the relative weight given by the social planner to the utility of workers of skill i. The social planner selects the allocation of public goods and taxes $\{GS_c, \tau_c^S, \tau_c^U\}_c$ to maximize social welfare:

$$\pi^S V^S + \pi^U V^U - \mu g(X, H, L^S, L^U),$$

where μ is a Lagrange multiplier, $g(X, H, L^S, L^U)$ is the economy's resource constraint, $X = \sum_j x_j$, $H = \sum_j h_j$, $L^i = N^i$, and where:

$$V^i = \mathbb{E}\left[\max_c \{u_c^i\}\right].$$

Given constant-returns to scale technology, there are no profits; so $y_j = 0$. However, the prices of goods, including wages and rents, may be affected by the allocation of government services. The first order condition with respect to a marginal change in τ_c^i is given by:

$$-\frac{N_c^i}{w_c^i - \tau_c^i} + \mu\left(N_c^i + \sum_{c'} \tau_{c'}^i \frac{\partial N_{c'}^i}{\partial \tau_c^i}\right) = 0.$$

The first order condition with respect to GS_c is given by:

$$\frac{\pi^S N_c^S \phi^S + \pi^U N_c^U \phi^U}{GS_c} - \mu\left(f_{GS} + \sum_{i=S,U}\sum_{c'} f_{N_{c'}^i}\frac{\partial N_{c'}^i}{\partial GS_c} + f_X \sum_{c'}\frac{\partial X_{c'}}{\partial GS_c} + \sum_{c'} f_{H_{c'}}\frac{\partial H_{c'}}{\partial GS_c}\right) = 0.$$

Let λ_c^i denote the marginal utility of income for skill i in locality c and let:

$$\bar{\lambda}_c = \frac{N_c^S}{N_c}\lambda_c^S + \frac{N_c^U}{N_c}\lambda_c^S.$$

Total consumption in the economy is given by:

$$\sum_{c'} X_{c'} = \sum_{i=S,U} \sum_{c'} (w_{c'}^i - \tau_{c'}^i) N_{c'}^i - \sum_{c'} r_{c'} H_{c'},$$

so that differentiating the budget constraint yields

$$\sum_{c'} \frac{\partial X_{c'}}{\partial GS_c} = \sum_{i=S,U} \sum_{c'} \left[(w_{c'}^i - \tau_{c'}^i) \frac{\partial N_{c'}^i}{\partial GS_c} \right] - \sum_{c'} r_{c'} \frac{\partial H_{c'}}{\partial GS_c}.$$

Using consumer and firm optimization and the production efficiency theorem we substitute-in prices and substituting the previous equation yields:

$$\frac{\pi^S N_c^S \phi^S + \pi^U N_c^U \phi^U}{\bar{\lambda} GS_c} - \frac{\mu}{\bar{\lambda}} \left(MRT_{G,X} - \sum_{i=S,U} \sum_{c'} \tau_{c'}^i \frac{\partial N_{c'}^i}{\partial GS_c} \right) = 0,$$

where $MRT_{G,X} = \frac{f_{GS}}{f_X}$ is the marginal rate of transformation between the consumption good and the public good. This expression is Samuelson's formula generalized to account for the marginal cost of public funds and the impact of the public good on revenue .

This expression guides our welfare analysis in Section 9. One particular application of this formula is to compare the relative effectiveness of government spending at raising welfare in areas with different fractions of skilled to unskilled workers. To conduct this exercise, first focus on the marginal benefit from providing government services (the term on the left). Holding $\frac{N_c^S}{N_c}$ constant, the ratio of this term evaluated at two values of $\frac{N_c^S}{N_c}$ gives this relative effectiveness. Taking an equal share of skilled and unskilled as a reference point, this ratio is given by:

$$\frac{\phi^S \frac{N_c^S}{N_c} + \phi^U \left(1 - \frac{N_c^S}{N_c}\right) \frac{\pi^U}{\pi^S}}{\phi^S \frac{1}{2} + \phi^U \frac{1}{2} \frac{\pi^U}{\pi^S}}.$$

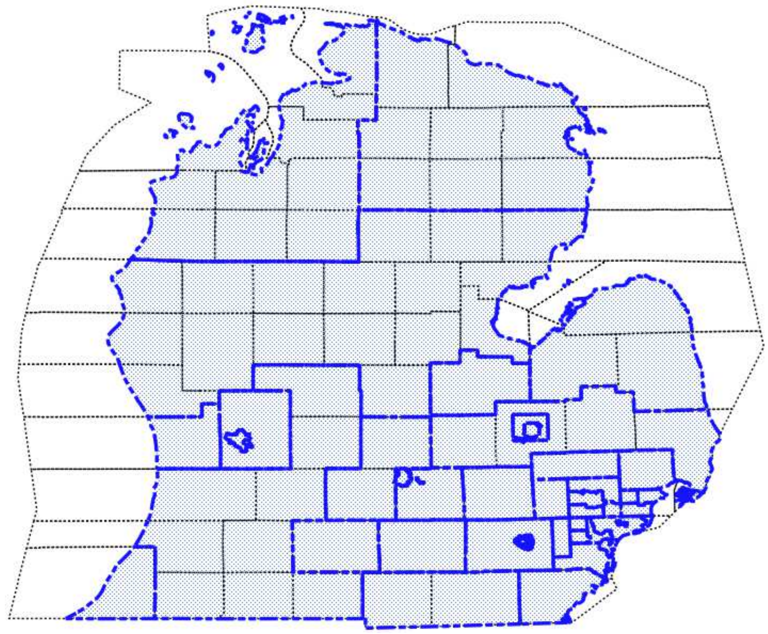
C Geography and County Groups

In order to create a balanced panel of local economies we aggregate counties into the smallest county groups that can be consistently identified in the 1980, 1990, and 200 Censuses and the 2009 American Community Survey. We use the IPUMS samples of the micro-data for these surveys (Ruggles et al. (2010)). Apart from state of residence, the original surveys do not contain a consistent geographical identifier across these surveys. IPUMS staff combined information for 1980 county groups and different versions of the public use microdata area (PUMA) identifiers for 1990 and the 2000's to create a variable for consistent PUMAs.

There are 543 consistent PUMAs in the U.S. with 540 in the contiguous United States. Consistent PUMAs can be identical to counties, contain several counties or include only a subset of a county. In contrast with MSAs, however, consistent PUMAs have the desirable characteristic that they follow county boundaries. This allows us to aggregate sub-county consistent PUMAs into county groups that we can match to county-level data on federal spending. As an example, Figure 7 presents a map of the counties and consistent PUMAs of the lower peninsula of the state of Michigan. The consistent PUMA boundary line is given by the bolder blue line while county lines are given by the thiner black dotted line. This maps shows that, while some consistent PUMAs are smaller than counties, we can aggregate consistent PUMAs into county groups since consistent PUMAs do not straddle county lines.

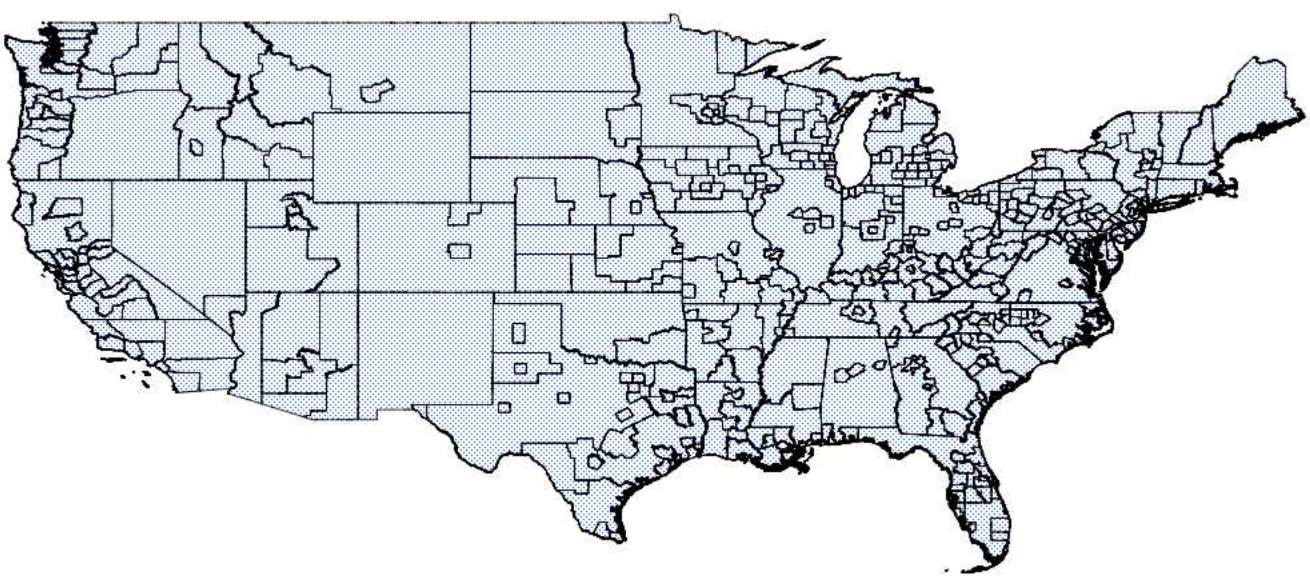
Aggregating consistent PUMAs into county groups leaves us with 497 county groups. However, the federal spending data we use aggregates 5 of these county groups corresponding to the counties of New York City (county FIPS codes 36005, 36047, 36061, 36081, and 36085) into one county group. This limits our final analysis to 493 county groups. Figure 8 presents a map of the 493 county groups we use in our analysis. This map shows that some county groups correspond to states (e.g., Wyoming) and that other states have a small number of county groups (e.g., Nevada). This fact prevents us from using state-level or state-year fixed effects in our analyses. In order to use fixed effects without losing observations we group states into groups of bordering states ensuring at least 3 county groups per state group. The number of counties and county groups per state is presented in Table 13 along with the corresponding fixed effect state group.

Figure 7: Counties and Consistent PUMAs in the Lower Peninsula of Michigan State



Notes: The consistent PUMA boundary line is given by the bolder blue line while county lines are given by the thiner black dotted line. This map shows that some consistent PUMAs are smaller than counties but that we can aggregate consistent PUMAs into county groups since consistent PUMAs do not straddle county lines.

Figure 8: County Groups in the Contiguous United States



Notes: This figure plots the county groups used throughout the paper. The map was created by editing a map of consistent PUMAs provided by Ruggles et al. (2010).

Table 13: County Groups and Fixed Effect Groups by State

State	Number of Counties	Number of County Groups	Fixed Effect State Group
Alabama	67	5	AL
Arizona	15	7	AZ, NM
Arkansas	75	9	AR
California	58	32	CA
Colorado	63	3	CO, WY
Connecticut	8	4	CT
Delaware	3	2	DE
District of Columbia	1	1	VA, DC
Florida	67	20	FL
Geogia	159	10	GA
Idaho	44	6	ID
Illinois	102	8	IL
Indiana	92	14	IN
Iowa	99	16	IA
Kansas	105	9	KS
Kentucky	120	18	KY
Louisiana	64	12	LA
Maine	16	1	VT, ME, NH
Maryland	24	12	MD
Massachusetts	14	7	MA
Michigan	83	24	MI
Minnesota	87	8	MN
Mississippi	82	4	MS
Missouri	115	12	MO
Montana	56	4	MT, ND
Nebraska	93	5	NE, SD
Nevada	17	2	NV
New Hampshire	10	1	VT, ME, NH
New Jersey	21	17	NJ
New Mexico	33	1	AZ, NM
New York	62	23	NY
North Carolina	100	19	NC
North Dakota	53	1	MT, ND
Ohio	88	18	OH
Oklahoma	77	2	OK
Oregon	36	9	OR
Pennsylvania	67	31	PA
Rhode Island	5	2	RI
South Carolina	46	12	SC
South Dakota	66	2	NE, SD
Tennessee	95	7	TN
Texas	254	30	TX
Utah	29	5	UT
Vermont	14	1	VT, ME, NH
Virginia	135	13	VA, DC
Washington	39	14	WA
West Virginia	55	9	WV
Wisconsin	72	20	WI
Wyoming	23	1	CO, WY
Totals: 49	3109	493	42

Note: This table presents the number of counties and county groups in the contiguous United States. The last column presents the state group used in creating fixed effects.

D Data

This appendix describes in detail the construction of the skill-specific, county group outcomes using micro-data from the IPUMS samples of the 1980, 1990, and 2000 Censuses and the 2009 American Community Survey (Ruggles et al. (2010)). Our sample is restricted to adults between the ages of 18 and 64 that are not institutionalized and that are not in the farm sector. We define an individual as skilled if they have a college degree.[47]

A number of observations in the data have imputed values. We remove these values from the following variables: employment status, weeks worked, hours worked, earnings, income, employment status, rent, home value, number of rooms, number of bedrooms, and building age. Top-coded values for earnings, total income, rents, and home values are multiplied by 1.5. Since the 2009 ACS does not include a variable with continuous weeks worked, we recode the binned variable for 2009 with the middle of each bin's range.

Our measure of individual wages is computed by dividing earnings income by the estimate of total hours worked in a year given by multiplying of average hours worked and average weeks worked. Aggregate levels of income, earnings, employment, and population at the county group level are computed using person survey weights. Average values of log-wages are also computed using person survey weights while log-rents and log-housing values are computed using housing unit survey weights and restricting to the head of the household to avoid double-counting.

We create composition-adjusted values of mean wages, rents, and housing values in order to adjust for changes in the characteristics of the population of a given county group. First, we de-mean the outcomes and the personal and household characteristics relative to the whole sample to create a constant reference group across states and years. We then estimate the coefficients of the following linear regression model

$$\tilde{y}_{ctsi} = \tilde{X}_{ctsi}\Gamma^{s,\tau} + \nu_c + \mu_{c,\tau} + \varepsilon_{ctsi},$$

where $\tilde{y}_{ctsi}$ is observations i's de-meaned log-price in county group c, year t and state group s. $\tilde{X}_{ctsi}$ is observations i's de-meaned characteristics, ν_c is a county group fixed effect, and $\mu_{c,\tau}$ is a county group-year fixed effect. Allowing $\Gamma^{s,\tau}$ to vary by state and year allows for heterogeneous impacts of individual characteristics on outcomes.

We run this regression for every state group described in Appendix C and for years $\tau = 1990, 2000$, and 2010.[48] For each regression we include observations for years $t = \tau, \tau - 10$ so that the county group-year fixed effect corresponds to the average change in the price of interest for the reference population. Our analysis of adjusted prices uses the set of fixed effects $\{\mu_{c,t}\}$ as outcome variables.

The regressions on wage outcomes use individual survey weights while the regressions on housing outcomes use housing survey weights and restrict to the head of the household. The wage regressions

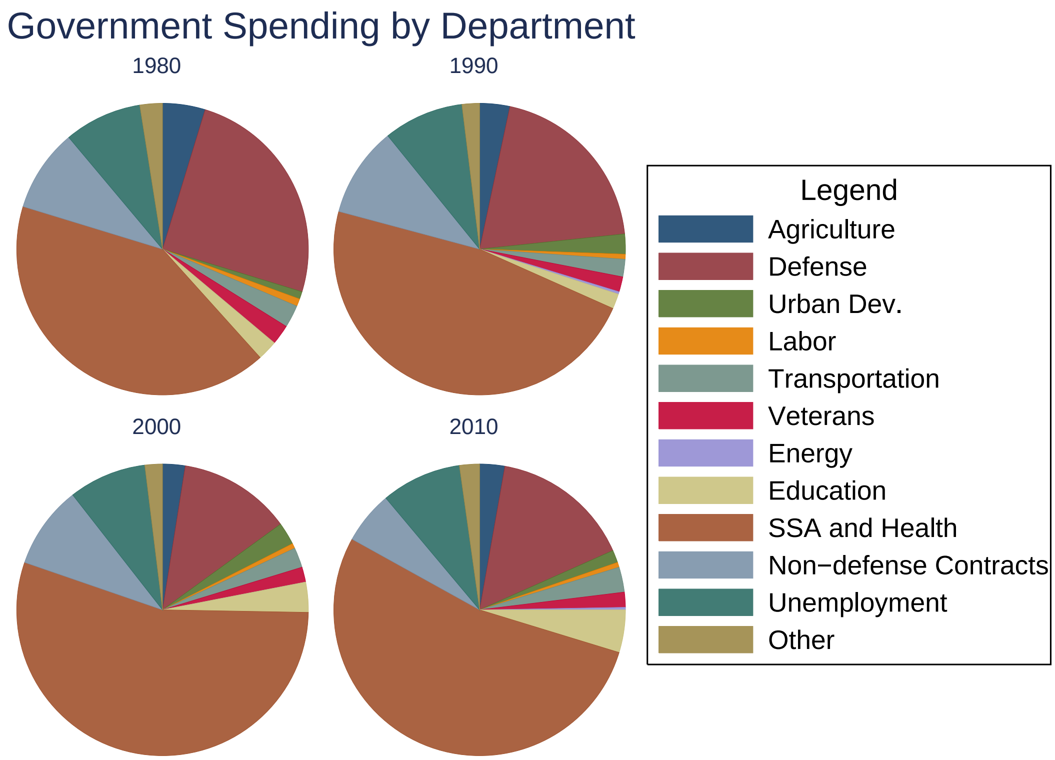
[47] For the 1980 Census there is no college degree code. We code those with less than 4 years of college education as not having a college degree. This corresponds to detailed education codes less than 100.

[48] As a technical note, before every regression was computed, an algorithm checked that no variables would be automatically excluded by the software program in order to avoid problems with cross-equation comparisons.

include the following covariates: a quartic in age and dummies for hispanic, black, other race, female, married, veteran, currently in school, some college, college graduate, and graduate degree status. The housing regressions included the following covariates: a quadratic in number of rooms, a quadratic in the number of bedrooms, an interaction between number of rooms and number of bedroom, a dummy for building age (every 10 years), interactions of the number of room with building age dummies, and interactions of the number of bedroom with building age dummies.

E Supplementary Graphs and Tables

Figure E.1: Government Spending By Department



Notes: This graph plots the allocations of federal funds by deparment. Data on federal spending come from the CFFR (Census Bureau, 2010c).

Table E.1: Federal Spending in Top 20 Formula Programs

Rank	Program	% of top 20 Programs	Amount (billions)
1	Medical Assistance Program (Medicaid)	59.50%	$183.20
2	Highway Planning and Construction	10.40%	$31.90
3	Temporary Assistance for Needy Families	5.60%	$17.20
4	Special Education Grants to States	3.30%	$10.10
5	Title I Grants to Local Education Agencies	2.70%	$8.30
6	National School Lunch Program	2.40%	$7.40
7	Head Start	2.10%	$6.60
8	Food Program for Women, Infants, and Children	1.60%	$5.00
9	State Children's Health Insurance Program	1.60%	$4.90
10	Foster Care Title IV E	1.50%	$4.70
11	Federal Transit Formula Grants	1.20%	$3.70
12	Airport Improvement Program	1.10%	$3.40
13	Community Development Block Grants	1.00%	$3.00
14	Child Support Enforcement	0.90%	$2.90
15	Improving Teacher Quality	0.90%	$2.90
16	Child Care and Development Fund	0.90%	$2.70
17	Rehabilitation Services-Vocational Rehabilitation	0.80%	$2.60
18	State Administrative Food Stamp Program	0.80%	$2.50
19	Public Housing Capital Funds	0.80%	$2.50
20	Unemployment Insurance	0.80%	$2.40
Top 20 programs			$307.90
Total 1,172 programs programs			$460.20

Notes: Top 20 formula programs in 2004 as reported by GAO (2006).

Table E.2: Summary Statistics in Levels

Variable	Obs	Mean	SD	Quantile 5	25	50	75	95
Census and ACS Data								
Population (100,000's)	1972	2.98	4.25	0.64	0.89	1.46	3.09	10.62
Skilled	1972	0.65	1.09	0.07	0.13	0.27	0.65	2.61
Unskilled	1972	2.33	3.27	0.53	0.73	1.17	2.41	8.11
College Share of Population	1972	0.19	0.09	0.09	0.13	0.17	0.24	0.37
Employment (100,000's)	1972	2.02	2.90	0.40	0.59	0.98	2.11	7.15
Skilled	1972	0.53	0.88	0.06	0.11	0.22	0.53	2.13
Unskilled	1972	1.49	2.09	0.33	0.46	0.75	1.56	5.21
Income per Adult (1000's)	1972	28.23	7.32	19.36	23.35	26.73	31.40	42.88
Skilled	1972	50.55	9.69	37.52	43.88	49.05	55.56	68.23
Unskilled	1972	22.35	4.18	16.11	19.36	21.97	24.87	30.09
Earnings per Adult (1000's)	1972	24.01	6.66	15.98	19.45	22.66	27.02	37.10
Skilled	1972	43.01	9.00	31.05	36.55	41.54	47.89	59.93
Unskilled	1972	18.96	3.99	13.17	16.08	18.64	21.41	26.52
Welfare Inc per U Adult (REIS)	1972	0.91	1.56	0.24	0.43	0.62	0.99	2.06
Wage	1972	15.79	2.71	12.35	13.88	15.28	17.06	21.33
Skilled	1972	23.08	3.42	18.52	20.60	22.57	24.84	29.92
Unskilled	1972	14.00	1.95	11.22	12.57	13.72	15.22	17.63
Rent	1972	495.40	220.95	185.71	349.74	468.00	606.15	928.11
Skilled	1972	592.71	267.14	201.92	416.52	562.42	729.94	1094.82
Unskilled	1972	472.55	201.49	182.46	337.18	450.90	573.39	855.92
Home Value (1000's)	1972	144.72	85.66	64.29	91.19	121.18	166.26	314.86
Skilled	1972	199.45	92.18	107.92	144.98	177.09	220.75	377.74
Unskilled	1972	125.57	70.15	57.00	80.98	106.24	146.60	269.45
Migration Flows (IRS)								
Outmigration (1000's)	1972	29.29	42.05	4.77	8.56	15.01	32.61	105.04
Inmigration (1000's)	1972	30.07	41.94	4.50	9.05	16.51	32.27	105.00
Flowmigration (1000's)	1972	0.78	12.27	-8.40	-0.98	0.27	2.32	13.11
Net Migration (1000's)	1972	59.35	83.09	9.53	17.65	31.73	65.09	211.24
Local Government (COG)								
Taxes (100,000's)	1972	2.62	7.20	0.00	0.27	0.66	2.08	10.60
Prop. Taxes (100,000's)	1972	1.24	2.54	0.00	0.20	0.48	1.24	4.73
Spending (100,000's)	1972	4.85	10.36	0.00	0.78	1.81	4.70	19.05
Op Budget (100,000's)	1972	3.62	7.55	0.00	0.62	1.41	3.56	14.01
Federal Government (CFFR)								
Federal Spending (billion)	1972	3.75	6.18	0.43	0.88	1.74	3.83	13.49

Source: All rows present statistics of county group aggregates for years 1980,1990, and 2000. Census data include the 1980,1990, and 2000 Census and 2009 ACS IPUMS sample (Ruggles et al., 2010). REIS data at the county group level are used for welfare income (BEA, 2011). Migrations flows come from IRS county-to-county migration files (IRS, 2011). Local government data come form the Census of Governments (Census Bureau, 2011). Federal spending data comes from the CFFR (Census Bureau, 2010c). Appendix D and the text provide further detail.

Table E.3: Summary Statistics in Percentage Changes

				Quantile				
Variable	Obs	Mean	SD	5	25	50	75	95
Census and ACS Data								
Population (100,000)	1479	0.12	0.11	-0.04	0.04	0.10	0.17	0.33
Skilled	1479	0.28	0.17	0.04	0.17	0.27	0.37	0.57
Unskilled	1479	0.07	0.11	-0.08	0.00	0.06	0.14	0.28
Employment	1479	0.13	0.13	-0.06	0.04	0.11	0.19	0.37
Skilled	1479	0.28	0.17	0.02	0.16	0.26	0.37	0.58
Unskilled	1479	0.08	0.14	-0.12	-0.01	0.06	0.15	0.33
Total Income	1479	0.18	0.18	-0.12	0.06	0.18	0.28	0.49
Skilled	1479	0.36	0.20	0.05	0.23	0.34	0.47	0.71
Unskilled	1479	0.09	0.19	-0.20	-0.04	0.08	0.20	0.41
Total Earnings	1479	0.19	0.17	-0.09	0.09	0.19	0.28	0.47
Skilled	1479	0.36	0.20	0.04	0.23	0.34	0.47	0.71
Unskilled	1479	0.10	0.17	-0.18	-0.01	0.10	0.20	0.40
Welfare Inc per U Adult (REIS)	1479	0.28	0.36	-0.27	0.01	0.25	0.59	0.82
Wage	1479	0.00	0.09	-0.14	-0.07	-0.01	0.07	0.13
Skilled	1479	0.01	0.07	-0.11	-0.03	0.02	0.06	0.12
Unskilled	1479	-0.03	0.09	-0.18	-0.10	-0.03	0.04	0.11
Adjusted Wage	1479	-0.03	0.08	-0.17	-0.09	-0.03	0.03	0.09
Skilled	1479	0.01	0.07	-0.11	-0.03	0.01	0.06	0.12
Unskilled	1479	-0.05	0.09	-0.20	-0.11	-0.04	0.02	0.08
Rent	1479	0.15	0.27	-0.23	-0.01	0.11	0.26	0.67
Skilled	1479	0.19	0.34	-0.25	0.00	0.13	0.31	0.83
Unskilled	1479	0.14	0.27	-0.24	-0.01	0.10	0.25	0.67
Adjusted Rent	1479	0.19	0.34	-0.30	0.00	0.14	0.32	0.83
Skilled	1479	0.24	0.40	-0.25	0.02	0.17	0.38	1.03
Unskilled	1479	0.17	0.34	-0.34	-0.01	0.13	0.31	0.82
Home Value (1000)	1479	0.05	0.28	-0.46	-0.16	0.10	0.26	0.44
Skilled	1479	0.04	0.24	-0.37	-0.13	0.07	0.21	0.41
Unskilled	1479	0.03	0.29	-0.50	-0.19	0.08	0.24	0.44
Adjusted Home Value (1000)	1479	0.05	0.25	-0.39	-0.14	0.08	0.22	0.43
Skilled	1479	0.05	0.23	-0.33	-0.12	0.07	0.20	0.41
Unskilled	1479	0.03	0.26	-0.42	-0.15	0.05	0.21	0.43

Source: All rows present statistics of county group aggregates for years 1980,1990, and 2000. Census data include the 1980,1990, and 2000 Census and 2009 ACS IPUMS sample (Ruggles et al., 2010). REIS data at the county group level are used for welfare income (BEA, 2011). Appendix D and the text provide further detail.

Table E.4: Summary Statistics in Percentage Changes (Cont.)

				Quantile				
Variable	Obs	Mean	SD	5	25	50	75	95
Migration Flows (IRS)								
Outmigration	1479	0.92	0.68	0.45	0.64	0.78	0.99	1.63
Inmigration	1479	0.93	0.62	0.42	0.63	0.81	1.06	1.65
Flowmigration	1479	1.84	1.29	0.86	1.26	1.59	2.05	3.19
Net Migration	1479	0.01	0.20	-0.21	-0.06	0.01	0.09	0.28
Local Government (COG)								
Taxes	1479	0.39	0.75	-0.10	0.09	0.24	0.45	1.66
Prop. Taxes	1479	0.18	0.52	-0.21	0.04	0.17	0.30	0.56
Spending	1479	0.18	0.59	-0.11	0.04	0.15	0.27	0.53
Op Budget	1479	0.18	0.56	-0.10	0.06	0.17	0.26	0.47
Federal Government (CFFR)								
Federal Spending	1479	0.18	0.12	-0.01	0.12	0.18	0.24	0.36
Census Shock (Census Bureau)								
Census Shock	1479	0.00	0.03	-0.05	-0.02	0.00	0.02	0.05

Source: All rows present statistics of county group aggregates for years 1980,1990, and 2000. Migrations flows come from IRS county-to-county migration files (IRS, 2011). Local government data come form the Census of Governments (Census Bureau, 2011). Federal spending data comes from the CFFR (Census Bureau, 2010c). Appendix D and the text provide further detail.

Table E.5: Migration Outcomes

(a) OLS Results

	(1) Population	(2) Out Migration	(3) In Migration	(4) Flows	(5) Net
All Workers					
Federal Spending	0.262***	0.091	0.486***	0.577*	0.395***
	(0.037)	(0.151)	(0.159)	(0.305)	(0.054)
Skilled Workers					
Federal Spending	0.296***				
	(0.047)				
Unskilled Workers					
Federal Spending	0.248***				
	(0.034)				
Observations	1,479	1,479	1,479	1,479	1,479

(b) IV Results

	(1) Population	(2) Out Migration	(3) In Migration	(4) Flows	(5) Net
All Workers					
Federal Spending	1.463***	1.906**	3.127***	5.033***	1.221***
	(0.314)	(0.969)	(0.977)	(1.899)	(0.426)
Skilled Workers					
Federal Spending	1.335***				
	(0.397)				
Unskilled Workers					
Federal Spending	1.265***				
	(0.294)				
Observations	1,479	1,479	1,479	1,479	1,479

Notes: Panel (a) presents OLS results and Panel (b) presents IV results. Each column present the results of three regressions corresponding to aggregate values and values specific to skilled and unskilled workers. Each of these coefficients corresponds to β from Equation 8. Both outcomes and federal spending are in log-differences so coefficients can be interpreted as elasticities. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. Data come from IPUMS 1980, 1990, and 2000 census extracts and the 2009 ACS (Ruggles et al., 2010). Migration data come from IRS migration files (IRS, 2011). Spending data come from the CFFR (Census Bureau, 2010c). Final sample is a balanced panel of 493 county groups. See Section 4 and Appendices D and C for more detail.
* $p < .1$, ** $p < .05$, *** $p < .01$.

Table E.6: Reduced Forms Effects of Census Shock Interacted with Amenity Share

	(1) Adj. Wage	(2) Adj. Home Val.	(3) Real Wages	(4) Population
All Workers				
Census Shock	0.205***	0.003	0.204***	0.871***
	(0.065)	(0.151)	(0.059)	(0.250)
CSXShare	-0.619**	0.902	-0.759**	-1.097
	(0.289)	(0.947)	(0.295)	(0.854)
Amenity Share	-0.007	-0.092*	0.007	-0.025
	(0.020)	(0.051)	(0.018)	(0.045)
Skilled Workers				
Census Shock	0.168**	-0.057	0.179**	0.784**
	(0.073)	(0.152)	(0.071)	(0.314)
CSXShare	-0.080	0.877	-0.239	-0.916
	(0.353)	(0.954)	(0.352)	(1.293)
Amenity Share	-0.016	-0.087*	0.000	-0.026
	(0.027)	(0.049)	(0.025)	(0.064)
Unskilled Workers				
Census Shock	0.205***	0.055	0.229***	0.790***
	(0.063)	(0.152)	(0.061)	(0.235)
CSXShare	-0.969***	0.238	-1.099***	-1.242
	(0.331)	(0.956)	(0.353)	(0.828)
Amenity Share	-0.000	-0.116**	0.014	-0.021
	(0.022)	(0.052)	(0.021)	(0.044)
Observations	1,479	1,479	1,479	1,479

Notes: This tables presents reduced form regressions that test an additional prediction of the model that exploits cross-sectional variation in the types of government spending to analyze whether government services are valued by workers as amenities. Intuitively, if a locality receives more spending in the form of government services, the impacts on wages would be smaller and the impacts of rents would be larger. There is no prediction for the relative size of the impact on population since the share of spending on amenities measures the composition of spending and not the total amount spent. That is, if a higher amenity share is related to higher spending in amenities, it will also be related to less spending on infrastructure or public hiring. In contrast, if we could compare two counties with the same amounts of non-amenity spending but with different amounts of amenity spending, we would expect to see a higher population response. For every county group we compute the share of federal spending for each government department. We then aggregate the shares of spending by departments that would be likely to produce services that would be valued by workers and that would not have direct effects on labor demand. These include spending by the Department of Housing and Urban Development, the Environmental Protection Agency, and the National Endowment for the Humanities. Consistent with these predictions, we find negative and statistically significant interactions for wages and real wages that are larger for unskilled workers. We also find positive, though statistically insignificant effects on housing values. Each column present the results of three regressions corresponding to aggregate values and values specific to skilled and unskilled workers. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. Data come from IPUMS 1980, 1990, and 2000 census extracts and the 2009 ACS (Ruggles et al., 2010). Spending data come from the CFFR (Census Bureau, 2010c). Final sample is a balanced panel of 493 county groups. See Section 4 and Appendices D and C for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table E.7: Reduced Forms Effects of Census Shock Interacted with Lagged Population Growth

	(1) House Value	(2) House Value	(3) House Value	(4) Gross Rent	(5) Gross Rent	(6) Gross Rent
Census Shock	0.610***		0.455**	0.214*		0.184
	(0.216)		(0.219)	(0.118)		(0.121)
CS X LPG	-2.547***		-2.192***	-1.218**		-1.390***
	(0.754)		(0.730)	(0.611)		(0.497)
Bartik		0.543***	0.445***		0.141*	0.088
		(0.104)	(0.112)		(0.078)	(0.080)
Bartik X LPG		-0.866	-0.346		0.662	1.003**
		(0.553)	(0.620)		(0.440)	(0.481)
Lagged Pop Growth (LPG)	0.031	0.067	0.055	0.033	-0.033	-0.034
	(0.033)	(0.052)	(0.054)	(0.021)	(0.040)	(0.041)
Observations	986	986	986	986	986	986

Notes: This tables presents reduced form regressions of each of the outcomes on the two instrumental variables. We interact each shock with lagged population growth in the prior decade to control for underlying differences in the areas being identified by each shock. The table shows that controlling for the interaction with lagged population growth, the effects on housing values and rents are of a similar magnitude. The estimates of both shocks in column (3) can be interpreted as the effects in a steady state where there are no population dynamics. The results provide further evidence that the two shocks trace the housing supply function along different regions of its domain. State group-year fixed effects included. Standard errors clustered at the county group level in parentheses. Data come from IPUMS 1990, and 2000 census extracts and the 2009 ACS (Ruggles et al., 2010). Final sample is a balanced panel of 493 county groups. This table only includes two panels as one is lost when including lagged population growth. See Section 4 and Appendices D and C for more detail. * $p < .1$, ** $p < .05$, *** $p < .01$.

Table E.8: Supply and Demand Components of Government Spending

(a) Skilled Workers

	Employment			Wages		
α^S	Demand	Supply	Supply/Total Ratio	Demand	Supply	Supply/Total Ratio
$\hat{\alpha}^S = 0.67$	1.22	0.29	0.19	0.41	-0.10	-0.32
0.10	1.35	0.16	0.10	0.46	-0.14	-0.46
0.33	1.32	0.19	0.13	0.45	-0.13	-0.42
0.50	1.28	0.23	0.15	0.43	-0.12	-0.38
0.66	1.23	0.28	0.19	0.41	-0.10	-0.33
0.90	1.07	0.44	0.29	0.36	-0.05	-0.15

(b) Unskilled Workers

	Employment			Wages		
α^U	Demand	Supply	Supply/Total Ratio	Demand	Supply	Supply/Total Ratio
$\hat{\alpha}^U = 0.90$	0.65	0.73	0.53	0.24	-0.08	-0.46
0.10	1.12	0.27	0.19	0.41	-0.24	-1.49
0.33	1.06	0.33	0.23	0.39	-0.22	-1.37
0.50	1.00	0.39	0.28	0.36	-0.20	-1.23
0.66	0.91	0.47	0.34	0.33	-0.17	-1.04
0.90	0.66	0.72	0.52	0.24	-0.08	-0.48

Notes: This table presents decompositions of the supply and demand components of a government spending shock for a range of values of the output elasticity for each skill group. The first row presents the decomposition for the values estimated in Section 8. All rows use the estimated elasticity of labor supply for each group from Table 10 and the estimated long-run effects from Section 6.