A New Approach to Evaluating the Welfare Effects of Decentralized Policies

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Abstract

We establish a framework to quantify the welfare effects of decentralized policies. Local policies result in benefit-spillovers, mobility of households and firms, and interjurisdictional fiscal externalities that are not internalized by the government enacting the policy. Their magnitudes are measured by a new metric, the "marginal corrective transfer" (MCT), the share of funding the federal government should provide to induce a locality to internalize these interjurisdictional externalities. Formally, the MCT is estimated as the wedge between the marginal value of public funds (MVPF) of the locality enacting the policy and the MVPF of the entire federation. To calculate this wedge, we develop a rigorous framework for distinguishing between the benefits and costs that are internal and those that are external to the enacting locality. The MCT enables comparisons of local policies, allowing the federal government to prioritize policies based on the relative external benefits and costs. Empirically, we show that property tax cuts, K-12 education, and higher education have positive MCT's, implying federal subsidies should be employed while race-to-the-bottom type policies such as wealth tax cuts and bidding-for-firm programs with negative MCTs should be federally taxed. Depending on the taxing instruments utilized at the state level, we show if states rank policies to intervene on, they may diverge substantially from the federal government and from other states.

Keywords: marginal value of public funds, fiscal competition, fiscal externalities, welfare, spillovers, mobility, capitalization, grants, fiscal federalism.
JEL: H22, H25, L10, L50, D50

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1. Introduction

Fiscal policies are often decentralized to state and local governments, but competitive forces shape local policy determination. Unlike federal policies, local policies are characterized by inter-jurisdictional mobility, sorting of households and firms, spillover benefits from public services, capitalization, fiscal externalities on other governments, and competition among governments. These effects on other governments are not internalized by the enacting jurisdiction, resulting in socially inefficient policies. Despite empirical estimates quantifying each of these effects individually, the voluminous literature on local policy choice lacks a unifying framework that combines them to quantify the welfare implications of decentralized policymaking. To undertake this quantification, we define a new concept, "the marginal corrective transfer" (MCT)—the share of funds that a federal government should provide at the margin to induce a locality to correctly internalize all interjurisdictional benefits and costs imposed on others. The MCT is comparable across policies and allows a federal government to rank local policies based on the extent of interjurisdictional externalities on the rest of the economy.

There are many policies upper-level governments use to influence local policies, such as, the creation of government bodies that share the responsibility of providing services, intergovernmental grants to promote certain types of local spending, fiscal equalization schemes to redistribute tax revenues across localities, and state-imposed mandates on localities (Clemens and Veuger 2023). Intergovernmental transfers are 33% of U.S. local government revenue, this number being as high as 60% in Vermont (see Appendix A). Federal transfers are 32% of state revenues. Intergovernmental grants, in particular, have the potential to correct the inefficiencies stemming from decentralization (Gordon 1983; Dahlby 1996). Central governments make these interventions because of the interjurisdictional spillovers that decentralized governments generate, but which they do not consider. What are these externalities? How do we measure them? How should the federal government prioritize funding intergovernmental grants across a range of projects in order to correct for these externalities? Our paper addresses these questions by providing a unifying framework for quantifying these spillovers, their welfare effects, and the required levels of corrective transfers.

It is well known that state and local governments set policy in an open economy setting where people, firms, and factors are mobile across jurisdictions (Kleven et al., 2020; Suárez Serrato and Zidar, 2016; Fajgelbaum et al., 2019), where mobility and sorting results in capitalization (Oates, 1969), where fiscal policies of one jurisdiction have spillover effects on nonresidents (Case et al., 1993), where the costs of public services rise due to congestion (Wildasin, 1980; Scotchmer, 2002), and where jurisdictions compete and possibly interact strategically with each other (Agrawal et al. 2022; Brueckner 2003). These forces complicate whether local policies are "good" or "bad" from a welfare perspective. While the literature has made progress at quantifying each of these factors individually, it lacks a systematic framework to unify all the disparate causal effects of decentralized policymaking. But, such a framework is necessary for determining whether policies are "good" or "bad" and, the optimal amount of interventions necessary by central authorities.

To quantify these interjurisdictional externalities and spillovers, we propose calculating the marginal value of public funds (MVPF)—the ratio of the marginal benefit of a policy to the net marginal cost to the government (Slemrod and Yitzhaki 1996; Slemrod and Yitzhaki 2001; Hendren 2016; Finkelstein and Hendren 2020; Hendren and Sprung-Keyser 2020)—separately for the locality enacting the policy and then for the entire federal system.[1] However, the presence of interjurisdictional externalities means that we cannot simply use the prior MVPF framework, but instead need to disaggregate and derive various new components. This requires distinguishing between the benefits and costs that are specific to the locality changing its policy from those that go beyond the locality. We provide a rigorous framework for delineating and then aggregating the precise benefits and costs—both internal and external to the enacting locality.

Local and Social MVPFs in a Federation. To calculate the MVPF in a federal system, we first need to specify "whose MVPF?"—that of a single local government or a federal government. We first derive the "local" MVPF, which only accounts for the willingness to pay of residents and the net cost on the government budget of the jurisdiction changing the policy, whether it be a city, county, or state. Because of interjurisdictional externalities, a policy change in one jurisdiction creates "external" effects in other jurisdictions, that is, benefits (willingness to pay) and the net government costs to other jurisdictions resulting from a competitor jurisdiction changing its policy.[2] Given these external effects, we then define the "social" MVPF as the MVPF of a federal planner who accounts for all spillovers—the separate aggregation of local and external benefits and costs.

To further define these MVPF concepts, we next need to answer "what are the externalities?" The local willingness to pay for a policy is based on the change in indirect utility from this policy.

[1] The MVPF has advantages relative to marginal excess burden (Hines 1999; Auerbach and Hines 2002), cost-benefit analysis (Koopmans and Mouter 2020; Heckman et al. 2007), and the marginal costs of public funds (Poterba, 1996). See Appendix A for further discussion.

[2] If these spillovers are global in nature (environmental), then the spillover on any one other jurisdiction may be negligible. Even though the effect on any one jurisdiction may be small, the aggregate external effect summed over many small municipalities may be large. On the other hand, if these spillovers are local in nature (public roads), then these cross-jurisdiction effects may even have a large effect on a small number of external jurisdictions.

In an open economy, this includes the direct effect of the policy on utility, but also features a novel indirect effect of the policy on disposable income resulting from wage and rent changes. This effect can be interpreted as the effect of household mobility on utility. Intuitively, if a jurisdiction becomes more attractive from a policy change, mobility capitalizes the policies into wages and rents. In addition, changes in the profitability of firms and housing may change the willingness to pay depending on the ownership structure of firms and housing by residents and nonresidents.

With respect to net government cost, our model features the standard mechanical effect of the policy and the behavioral effect resulting from how the policy changes individual behavior. But, in addition, open economy concerns imply that there are additional, novel channels by which the government cost is affected by the policy. Unlike policy changes in a closed economy, changes in an open economy are likely to result in the movement of firms and residents to/from the jurisdiction. This migration will directly affect both the revenues and the public service costs of the jurisdiction. As well, mobility results in changes in wages, housing rents, and profits which, again, will affect government revenues. In addition, because a change in one jurisdiction's policy, for example a tax cut, may affect other jurisdictions' revenues or public service costs, these jurisdictions may strategically respond, an extension to the base model we consider.

Marginal Corrective Transfer. The local MVPF of a policy differs from its social MVPF because a local government ignores interjrusdictional externalities. Therefore, to what extent can the federal government can implement a policy to induce the local government to internalize interjurisdictional externalities? The divergence between social and local MVPF allows us to calculate the marginal corrective transfer—the share of expenditures on the policy (positive or negative) by the federal government necessary to equalize the local MVPF with the social MVPF. The MCT yields a clear ranking of policies: the projects with the largest MCT are those projects which have the greatest "wedge" between the local MVPF and social MVPFs. The MCT is comparable across policies in a way that allows the federal government to prioritize policies based on the external benefits and costs in order to allocate federal spending accordingly. Then the MCT allows researchers to construct a normative typology of decentralized policies. Under this typology, we show that if the social MVPF of a policy is higher than its local MVPF, the marginal corrective transfer associated to this policy is positive—a subsidy; however, if the local MVPF exceeds the social MVPF, the marginal corrective subsidy is negative—a tax. The MCT translates into the precise matching grant rate, $MCT/(1 - MCT)$, necessary to internalize all spillovers. If the MCT is greater than one, there is no finite matching grant that would achieve these aims, and the marginal dollar of the policy needs to be centralized to equate local and social MVPF. The MCT leads to a welfare interpretation distinct from ranking projects on the basis of social welfare. Policies with a higher MCT are those that have the greatest percent increase in social welfare *after* netting out the percent change in local welfare, the latter of which is removed because localities internalize these effects.

To illustrate this typology, in Figure 1 we provide the expected MCT of common state and local policies based on their intuitive external benefits and costs. Education and early life interventions are likely to have positive marginal corrective transfers, as they likely increase future federal tax revenues that benefit other jurisdictions, while certain types of tax competition or bidding-for-firms are likely to have negative transfers as they reduce tax revenues in competing jurisdictions.

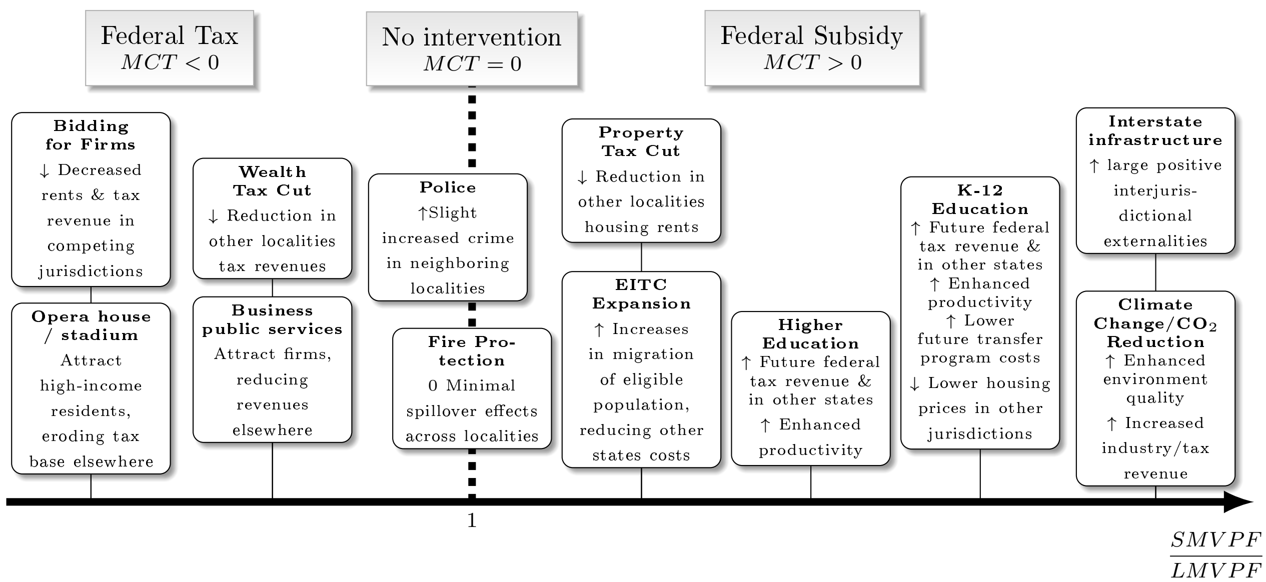


Figure 1. Ordering of common local policies by levels of marginal corrective transfer (MCT) and SMVPF/LMVPF. LMVPF: local marginal value of public funds; SMVPF: social marginal value of public funds. Each box describes the expected benefits and costs of the local policy for neighboring localities, with empirical citations in Appendix A.

In contrast to a Pigouvian tax or subsidy Pigou (1920), the MCT is based on the wedge between social and local MVPF for observed (current) policies not on the magnitude of externalities at the socially optimal output. This allows for the MCT to be more easily operationalized as the policies are actually observed. While the Pigouvian transfer will generally not equal the MCT, in fact, when calculated at the socially-optimal level of the policy, the MCT reduces to the Pigouvian transfer.

An Example. Consider constructing the MCT of an increase in education spending in Cambridge, MA, where, for this example, the social (state) MVPF is capturing both the benefits and costs of residents of Cambridge as well as those of Boston and other neighboring communities. An increase in educational spending can be expected to attract new residents to Cambridge. While this increases tax revenue, it also increases the direct cost of education, increasing house prices and potentially wages, raising tax revenues there which enter the local MVPF. However, it is not only Cambridge residents that receive benefits or bear costs from the increase in educational spending there. As people move to Cambridge, Boston and other neighboring communities see population declines, lowering house prices and tax revenues there. Additionally, if we view the economy more broadly than the surrounding communities, increases in future wages increase federal income tax revenues that are not realized by the locality. Accounting for this effect, the MCT is a large subsidy.

Empirical Applications. To illustrate these concepts and to rank various policies, we conduct six calibration exercises where we calculate the MCT. These include decentralized wealth tax cuts, subsidy competition for large firms like Amazon, K-12 education spending, property tax cuts, flood protection, and higher education spending. The bidding and K-12 education examples are particularly noteworthy. First, the structure of the bidding auction from Slattery (2020) provides information on various components necessary to calculate the MCT. Second, we derive conditions under which capitalization, under reasonable assumptions, can be used as a sufficient statistic (Chetty 2009; Kleven 2021) to estimate the components necessary to calculate the MCT.

Here, we focus on the application to K-12 spending. Many of the benefits of education spending and future tax revenues are not realized by the locality funding education-spending expansions. As a result, the local planner's MVPF is only 7.52, and although greater than one, significantly lower than that of a federal planner, infinite (-27.6), meaning that K-12 education programs pay for themselves when their effect on federal tax revenues are considered. The divergence of the local and social $MVPF$ provides an explanation for why a program that "pays for itself" appears to be underfunded: fiscal decentralization and the divergence of interests between the local and federal governments. While the program may pay for itself at the federal level, this is not true at the local level and the program expenditures are determined locally, not federally. Taken together, we calculate a marginal corrective transfer of 1.272. Because this is greater than unity, at the margin, no federal matching grant rate can internalize all spillovers; however, even in this case, the MCT can be used to by the federal government to prioritize scarce resources by a ranking of policies the social returns net of local returns. Interestingly, we state subsidies for education will be smaller. States have lower income tax rates and thus do not benefit fiscally as much from the wage gains of education. At the state level, the MCT is 0.243, implying a match rate of $0.243/(1-0.243) = 0.321$.

We explore how state tax policies affect the MCT of local programs in the state. States that are decentralized in their revenue sources, using property taxes more than state income and sales taxes, have lower MCTs and match rates. We correlate our estimated MCTs with each state's share of observed education spending, finding that states with more incentive to subsidize local spending do so. However, there still remain large benefits that remain unaccounted for suggesting that locally determined spending—even after accounting for observed state aid—does not align with social valuation. The key message is the structure of state tax systems influences the payoff of state and local policies including, for example, educational policies.

Conducting similar exercises for higher education, property tax cuts, flood protection, wealth taxation, and bidding for firms, we find MCTs of 0.287, 0.341, −0.550, −0.062, and −1.068, respectively. In words, a MCT of 0.287 says the if the local government spends \$1 on a project, the federal government matches with $MCT/(1 - MCT) = \$0.402$ and thus the share of marginal federal spending on the program will be 28.7%. In the case of $MCT = -1.068$, the matching tax rate is −0.516 per dollar. Based on these examples, we conclude that human capital policies are likely to have the marginal dollar significantly underprovided by a decentralized policymaker, while decentralized tax and firm policies are excessively provided. Our hope is that by applying the MCT to race-to-the-bottom or Tiebout-style policies, we can provide the literature with precise guidance on how to quantify the welfare effects of decentralized policymaking, which have proved elusive given the current piecemeal approach to quantifying them. Our paper provides a call to action for researchers studying decentralized policy to estimate more external effects of policies—and not just effects within the jurisdiction—necessary to calculate the MCT for more policies than we have done.

Roadmap. Section 2 introduces a spatial general equilibrium framework for deriving the MVPF and MCT. Section 3 describes the new components of our MVPF concepts. Section 4 defines the MCT and and explains how it can be used to rank policies. Section 5 proposes a recipe book to practically calculate the MCT, including using capitalization as a sufficient statistic. Section 6 provides empirical applications and we rank policies.

2. A General Framework for Welfare Analysis in a Federation

This section introduces a spatial general equilibrium model to quantify the welfare effects of decentralized policies, highlighting household and firm mobility and benefit spillovers.[3] Our welfare

[3] A large literature shows that individuals are mobile in response to taxes (Kleven et al., 2020), welfare programs (Brueckner, 2000; Agersnap et al., 2020), and education programs (Epple et al., 2014). The framework is built to capture the most features of existing public finance models in open-economy settings like Kline and Moretti

metric will be summarized by the marginal corrective transfer:

$$MCT \equiv 1 - \frac{LMVPF}{SMVPF}, \tag{1}$$

where LMVPF is the ratio of willingness to pay to net government costs for the locality enacting the policy and SMVPF is the ratio of these terms from the perspective of the social (federal) planner who accounts for all interjurisdictional effects. The MCT is the intergovernmental transfer or tax that equates local and social MVPF. To derive it, we need to explain how the local MVPF differs from the social MVPF and the components of each MVPF concept. The subsequent spatial general equilibrium model generates a clear delineation of the different causal effects a researcher needs to estimate, or have access to, in order to calculate the both MVPF concepts. Importantly, the core definitions of our welfare measures and of the marginal corrective transfer do not depend on the particular specification of the theoretical framework developed below.

2.1. Household

The national economy includes I jurisdictions (states or localities) of the same federalist tier indexed by $i = 1, \ldots, I$ with population n_i. Each jurisdiction (e.g. county) i may contain lower level jurisdictions (e.g. municipalities) and be included in a higher level jurisdiction (e.g. state and federation). There are N homogeneous households who only differ with respect to their idiosyncratic taste for jurisdiction i, denoted e_i, and are mobile across jurisdictions in the federation.The distribution of e_i does not need to be specified to derive our general MVPF formulas.Each resident of jurisdiction i is employed there, receiving wage w_i and purchases housing there at a rent p_i per unit of housing. The representative resident of jurisdiction i has the utility function $U_i(x_i, \ell_i, h_i, \mathbf{g}_i, e_i)$ where x_i is the consumption of a freely tradeable, private numéraire good, ℓ_i is the amount of labor supplied, h_i is housing consumption, and the public good vector $\mathbf{g}_i \equiv (g_1, \ldots, g_I, G_i)$ is such that residents of i may benefit from the public goods/services provided not only by their own jurisdiction g_i but also possibly by the other jurisdictions g_j, $j \neq i$ (Case et al., 1993), and by other federal tiers of government G_i.[4] As examples of horizontal expenditure spillovers, roads in one jurisdiction can be used by nonresidents, school expenditures can benefit other states because children move after

(2014), Moretti (2011), Suárez Serrato and Zidar (2016) and Fajgelbaum et al. (2019).

[4] As common in the urban and spatial economics literature, the utility function is assumed to be separable in the idiosyncratic term e_i, i.e. $U_i(\nu_i(x_i, \ell_i, h_i, \mathbf{g}_i), e_i)$ so the individual demand function are independent of e_i. Two typical cases are additive separability —often assumed if e_i is Gumbel distributed— and multiplicative separability —often assumed if e_i is Frechet distributed. The distribution of e_i does not matter for our derivations.

college, or citizens in one state might care about poverty/inequality in other states.

All jurisdictions i raise revenue from taxes: a commodity tax t_i^x, an earnings tax t_i^ℓ, a property tax t_i^h, a head tax t_i^n (alternatively, a cash transfer), and a business tax, t_i^π. For simplicity, assume that the same taxes are collected by the other levels of government; these other vertical taxes are denoted T_i^b, $b = x, \ell, h, n, \pi$ with the sum for all levels of government denoted by $\mathbb{t}_i^b \equiv t_i^b + T_i^b$. Initially, income taxes follow the residence principle and commodity taxes follow the destination principle but we will relaxes these sourcing rules later. Each individual maximizes her utility choosing her consumption and labor supply to satisfy the budget constraint $p_i h_i + (1+\mathbb{t}_i^x) x_i = y_i + (1-\mathbb{t}_i^\ell) w_i \ell_i - \mathbb{t}_i^n$, where p_i is the local cost (rent or price) of housing, w_i is the local wage rate. The profits generated in the economy accrue as individual non-labor income:

$$y_i = \eta_i + \frac{1}{n_i} \sum_j \left[(1 - \mathbb{t}_j^\pi) m_j \pi_j \theta_{ij} + \pi_j^h \theta_{ij}^h \right], \tag{2}$$

where η_i is a jurisdiction-specific individual non-labor income, π_i is the gross business profit generated in i, $\pi_j^h = (1 - \mathbb{t}_j^h) p_j H_j - c_j^h(H_j)$ the net profit of the housing production sector of i, θ_{ij} $[\theta_{ij}^h]$ is the aggregate share of profits generated in the numéraire [housing] sector in jurisdiction j owned the by all the residents of jurisdiction i. In the case of all housing being owner-occupied, the shares $\theta_{ii}^h = 1$ and $\theta_{ji}^h = 0, j \neq i$.At the local level, cross-border ownership is critical. This yields Marshallian demands and supply functions, $x_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}_i)$, $h_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}_i)$ and $\ell_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}_i)$, and the indirect utility function:

$$V_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}_i, e_i), \tag{3}$$

where $\mathbf{t}_i = \left(t_i^x, t_i^h, t_i^\ell, t_i^n, t_i^\pi\right)$ is the vector of local taxes in jurisdiction i (the federal taxes are suppressed for simplicity). In equilibrium, the individual chooses to live and work in the jurisdiction yielding the highest utility.

2.2. Businesses

In jurisdiction i, m_i firms produce the numéraire good. The production technology for the firm is denoted by the function $f_i(l_i, \mathbf{z}_i) + \epsilon_i$ where l_i is the labor employed by each firm, and $\mathbf{z}_i = (z_1, \ldots, z_I, Z_i)$ denotes the vector of local public investments (infrastructure, for example). Like households, firms benefit from local public services z_i, public services from other jurisdictions of the same level z_j and other jurisdictions of other levels Z_i. Analogous to households, the parameter ϵ_i represents a firms' idiosyncratic jurisdiction-specific added productivity. In addition to labor, production of each firm in jurisdiction i is affected by public investments in jurisdiction i, investments made by neighboring jurisdictions, and by federal jurisdictions. A firm's net profit is:

$$(1-\mathfrak{t}_i^{\pi})\pi_i + \epsilon_i = (1-\mathfrak{t}_i^{\pi})[f_i(l_i, \mathbf{z}_i) - w_i l_i] + \epsilon_i, \tag{4}$$

where $\mathfrak{t}_i^{\pi} = t_i^{\pi} + T_i^{\pi}$ is the sum of the local and federal profit taxes (or subsidies) levied by jurisdiction i. For simplicity, the jurisdiction-specific productivity is assumed not to be subject to profit taxation because it is unobserved to the jurisdiction, it represents non-taxable output or jurisdiction-specific non-deductible costs. The firm chooses its labor demand so as to maximize its profit function (4) taking the wage w_i and the levels of public services and taxes as given. This defines the firm labor demand $l_i(w_i, \mathbf{z}_i)$ and the net profit function $(1-\mathfrak{t}_i^{\pi})\pi_i(w_i, \mathbf{z}_i) + \epsilon_i$. In the locational equilibrium, each firm will choose to produce in the jurisdiction yielding the highest net profit.

2.3. Government Budgets

Government i uses tax revenue to provide public services for its residents, g_i, but can also provide services for its businesses, z_i. Large debt and deficits are a common feature of many governments meaning that policies are often not budget neutral in the short run; this is also true at the state and local level even when governments have balanced budget requirements, as these requirements are relatively weak. Thus, as in Hendren (2016), jurisdiction i's budget need not be balanced. Jurisdiction i's net government cost is:

$$NGC_i = c_i(g_i, z_i, \mathbf{n}, \mathbf{m}) - n_i\big(t_i^{\ell} w_i \ell_i + t_i^h p_i h_i + t_i^x x_i + t_i^n\big) - m_i t_i^{\pi} \pi_i, \tag{5}$$

where $c_i \equiv c_i(g_i, z_i, \mathbf{n}, \mathbf{m})$ denotes the cost function of producing public services from the private good x_i.We denote $\mathbf{n} = (n_1, \ldots, n_I)$ as the vector of populations of all jurisdictions and $\mathbf{m} = (m_1, \ldots, m_I)$ as the vector of labor force in all jurisdictions. Critically, this general cost function allows for public services to be congestible as residents and firms move in and out of the jurisdiction (Wilson, 1995). As a public service provided in i can be consumed by nonresidents, congestion can be induced by both residents and non residents. The special case of additive separability, $c_i = c_i^g(g_i, \mathbf{n}) + c_i^z(z_i, \mathbf{m})$, allows for the case of pure public goods, $c_i^g(g_i, \mathbf{n}) = c_i(g_i)$, and publicly-provided private services, $c^g(g_i, \mathbf{n}) = c_i\,(g_i) \sum_j n_j$. The analog is true for public business services. In the case of congestible public goods, while a resident moving out of the jurisdiction erodes the tax base some (all) of the lost revenue maybe be offset by public good cost reductions.

In a federal system, states and localities often cohabit the same tax base and provide overlapping services as the federal government. As a result, local policy changes may affect the federal government budget constraint and vice-versa (Keen 1998; Besley and Rosen 1998; Hoyt 2001). An example frequently discussed in the literature is the case of "shared" tax bases. Increases in taxes by either a state or federal government reduce the tax base, thereby reducing the taxes of the other level of government—a vertical fiscal externality. In our model, these fiscal externalities are captured by the vertical net government cost:

$$VNGC = C\big(G, Z, \mathbf{n}, \mathbf{m}\big) - \sum_j \Big[n_j\big(T_j^\ell w_j \ell_j + T_J^h p_j h_j + T_j^x x_j + T_j^n\big) + m_j T_j^\pi \pi_j\Big], \tag{6}$$

where G and Z are aggregations of household and business public services of all other vertical levels of government. $VNGC$ is the aggregate net cost government of the jurisdictions that are at a different levels than jurisdictions $i = 1, \ldots, I$. For example, suppose we are interested in the overall budgetary effect of a policy of a municipality i. Thus, we need to consider the effects on the budgets of the county, state and federal government to which this municipality belongs (6). In case this municipality is close to a county's or state's border, we might also need to account for the effects on this other county's or state's budget (e.g., diagonal fiscal externalities).

2.4. General Equilibrium

The labor and housing markets clearing conditions are $n_i\ell_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}_i) = m_i l_i(w_i, \mathbf{z})$ and $n_i h_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}_i) = H_i(p_i)$, where $H_i(p_i)$ is the housing supply function. Household [firm] mobility implies that the equilibrium number of residents [firms] in i depends on the level of utility [net profit] in all the other jurisdictions: $n_i = \Phi^n\big(V_j(p_j, w_j, y_j, \mathbf{t}_j, \mathbf{g}_j)\ ;\ \forall j \in [1, I]\big)$ and $m_i = \Phi^m\big((1 - \mathfrak{t}_j^\pi)\pi_j(w_j, \mathbf{z})\ ;\ \forall j \in [1, I]\big)$, where the shapes of $\Phi^n(\cdot)$ and $\Phi^m(\cdot)$ depend on the distributions of the idiosyncratic terms e_i and ϵ_i.The market clearing conditions and the location equations described above implicitly define, for each jurisdiction i, the equilibrium levels of the wage, the rent, the population and the number of firms, as functions of not only the policy instruments in i, but also those of all other jurisdictions $j \neq i$. Inserting these functions into the individual consumption, functions and profit functions defines the general equilibrium levels, in each jurisdiction i, of the wage $w_i(\mathbb{P})$, rent $p_i(\mathbb{P})$, population $n_i(\mathbb{P})$, number of firms $m_i(\mathbb{P})$, numéraire consumption $x_i(\mathbb{P})$, housing consumption $h_i(\mathbb{P})$, labor supply $\ell_i(\mathbb{P})$, numéraire profits $\pi_i(\mathbb{P})$ and housing profits $\pi_i^h(\mathbb{P})$ as a function of $\mathbb{P}$, the vector of all jurisdictions' policy instruments. Thus, inter-jurisdictional spillovers imply that any change in a given jurisdiction's policy instruments affects the equilibrium level of the variables in this jurisdiction and potentially all the other jurisdictions of the economy.

3. Local and Social MVPF

Within a federal system, it is important to account for spillover effects, mobility of firms and people, and capitalization. As both the benefits and net costs depend on policies, it is essential to account for the *distribution* of benefits and costs across jurisdictions. We need to distinguish the benefits and costs to the locality enacting the policy from the benefits and costs to other localities. To do so, we distinguish between the local MVPF for the government enacting the policy and the social MVPF that also includes effects external to that locality.

The local MVPF is the measure that government i would compute to assess the welfare impact of its policy from its own perspective. The LMVPF is useful for a local government to decide how to prioritize its policies (Hendren and Sprung-Keyser, 2020). Specifically, for two expenditure policies $\mathrm{d}\tau_i^A$ and $\mathrm{d}\tau_i^B$ such that $LMVPF_{\tau_i^A} > LMVPF_{\tau_i^B}$, then government i would increase the welfare of its residents by marginally extending policy $\mathrm{d}\tau_i^A$ and financing this expansion by shrinking policy $\mathrm{d}\tau_i^B$. In contrast, the federal planner would prioritize policies using the the social MVPFs because she cares about the aggregate welfare $\sum_j n_j V_j$. If all households have the same marginal utility of income (Hendren and Sprung-Keyser, 2020), $SMVPF_{\tau_i^A} > SMVPF_{\tau_i^B}$ means that the planner is willing to finance a marginal increase in $\mathrm{d}\tau_i^A$ by a marginal cut in $\mathrm{d}\tau_i^B$. Appendix D proves this result, extends it to a social welfare function with jurisdiction-specific weights, and relaxes the assumption of equal marginal utility of income.

3.1. Local and External Marginal Willingness to Pay

The numerator of a MVPF is the marginal willingness to pay (WTP) for the policy. In the case of a local or state policy, it is critical to know whose WTP is at stake. Denote $WTP_{\tau_i}^j$ as the aggregate WTP for jurisdiction i's policy change $\mathrm{d}\tau_i$ of the inframarginal residents of jurisdiction j. The local marginal WTP that measures the effect of jurisdiction i's policy on its own residents is defined as $LWTP_{\tau_i} \equiv WTP_{\tau_i}^i$. The external WTP that measures the effect of i's policy on all non-residents is defined as $EWTP_{\tau_i} \equiv \sum_{j \neq i} WTP_{\tau_i}^j$. Appendix B shows that the WTP for policy $\mathrm{d}\tau_i$ of the residents of jurisdiction j (i included) can be decomposed as:

$$WTP_{\tau_i}^j = \mathrm{DE}_{\tau_i}^j + \mathrm{IE}_{\tau_i}^j + \mathrm{OE}_{\tau_i}^j, \tag{7}$$

which indicates that the effect of a change in local policy $\mathrm{d}\tau_i$ on welfare of residents includes three sub-effects, the direct effect $\mathrm{DE}^j_{\tau_i}$, the disposable income effect $\mathrm{IE}^j_{\tau_i}$, and the ownership effect $\mathrm{OE}^j_{\tau_i}$, described in the subsections that follow.

3.1.1. Direct Effect

The *direct effect* effect in the marginal WTP (7) depends on the policy instrument τ_i considered and whether the effect is in jurisdiction $j = i$ or $j \neq i$. For a tax cut in i:

$$\begin{cases} \mathrm{DE}^i_{t^b_i} = -\mathrm{B}^b_i \times \mathrm{d}t^b_i, \\ \mathrm{DE}^k_{t^b_i} = 0, \quad k \neq i, \end{cases} \quad \text{(8a)} \qquad \mathrm{DE}^j_{\tau_i} = -\theta^h_{ji} p_i H_i \times \mathrm{d}t^h_i, \quad \text{(8b)} \qquad \mathrm{DE}^j_{t^\pi_i} = -\theta_{ji} m_i \pi_i \times \mathrm{d}t^\pi_i, \quad \text{(8c)}$$

where $b = \ell, x, n$ indexes each type of household tax base. And for an increase in the provision of household public goods g_i or public business services z_i:

$$\mathrm{DE}^j_{g_i} = \frac{n_j}{\lambda_j} \frac{\partial U_j}{\partial g_i} \times \mathrm{d}g_i, \quad \text{(8d)} \qquad \mathrm{DE}^j_{z_i} = \sum_k \theta_{jk} (1 - \mathbb{t}^\pi_k) m_k \frac{\partial f_k}{\partial z_i} \times \mathrm{d}z_i, \quad \text{(8e)}$$

where $\lambda_j \equiv \partial V_j / \partial y_j$ is the marginal utility of income of the residents of j. All the direct effects are, as expected, non-negative because tax cuts ($\mathrm{d}t^b_i < 0$) and public good/service provision are desirable policies. Household commodity, labor and head taxes do not induce an external direct effect on other jurisdictions as we assume that consumption taxes are destination-based and income taxes are residence-based.[5] Unlike these three taxes, all the other policies may generate external direct effect on the WTPs if inter-jurisdictional spillovers of various nature exist in the open economy. Expression (8b) [(8c)] indicates that a unit cut in jurisdiction i's property [profit] tax has a direct positive effect on the WTP residents of any jurisdiction j (including i itself) who own positive shares θ^h_{ji} [θ_{ji}] in the housing properties [the firms] in i: their income increases by $\theta^h_{ji} p_i H_i$ [$\theta_{ji} m_i \pi_i$]. If "foreign" ownership is negligible, the external direct effect approaches zero.

Expression (8d) indicates that the local direct effect of public good provision $\mathrm{DE}^i_{g_i}$ is the well-know marginal rate of substitution between the public good and the numéraire good of i's residents. This directly extends to nonresidents as jurisdiction i's public good provision has a positive effect on the WTP of $j \neq i$'s residents if they directly enjoy i's public goods. Finally, (8e) indicates that the residents of jurisdiction j directly benefit from jurisdiction i's provision of public business

[5] Appendix C shows that origin-based consumption taxes paid by cross-border shoppers and source-based income taxes paid by commuters induces interjurisdictional direct effects.

services due to the increase in the production of all the jurisdictions k in which j's residents own business shares. Here, direct external effects across jurisdictions might occur via two channels: cross-ownership of profits or direct spillover of public business service.

3.1.2. Disposable Income Effect

The second term in WTP is the *disposable income effect*. It has the same form, whatever the policy, for all jurisdictions j (including i), but the sign and magnitude can differ across jurisdictions:

$$\mathrm{IE}^{j}_{\tau_i} \equiv \left[(1-\mathbb{t}^{\ell}_{j})L_j \frac{\partial w_j}{\partial \tau_i} - H_j \frac{\partial p_j}{\partial \tau_i}\right] \times \mathrm{d}\tau_i. \tag{9}$$

This effect results from the effect of price (wage and housing rent) changes on the individual disposable income $(1-\mathbb{t}^{\ell}_{i})w_i\ell_i - p_i h_i$. This price capitalization may result from behavioral or mobility responses to policies. To the extent that the individual housing demand and labor supply are relatively inelastic, the disposable income effect can essentially be interpreted as a consequence of mobility, which explains why it is not present in closed-economy models.[6] And as discussed below, price capitalization is essential for allocating the WTP across jurisdictions.

An example of a policy that would generate housing price changes is K-12 educational spending. An increase in spending (and, presumably, quality) leads to households moving into the enacting jurisdiction, increasing the demand for housing and increasing labor supply, resulting in increases in housing prices and reductions in wages—a reduction in disposable income. The in-migration means an outflow of households from other jurisdictions, reducing housing prices and increasing wages—an increase in disposable income there.

3.1.3. Ownership Effect

Nonresident ownership of firms/land are important for localities (Braid, 2005). The last effect on the WTP is the (profit) *ownership effect* resulting from the change in profits received by the residents of j due to price capitalization of jurisdiction i's policy. For policy $\mathrm{d}\tau_i$, the ownership effect is:

$$\mathrm{OE}^{j}_{\tau_i} \equiv \sum_k \left[-\theta_{jk}(1-\mathbb{t}^{\pi}_{k})L_k \frac{\partial w_k}{\partial \tau_i} + \theta^{h}_{jk}(1-\mathbb{t}^{h}_{k})H_k \frac{\partial p_k}{\partial \tau_i}\right] \times \mathrm{d}\tau_i. \tag{10}$$

[6] For example, Hendren and Sprung-Keyser (2020) assume inelastic individual labor supply in the calculation of their MVPFs, eliminating general equilibrium effects. However, the empirical literature on capitalization via mobility indicates it is an important channel.

To understand the importance of both the disposable income and ownership effects, suppose that ownership is entirely local ($\theta_{jj} = \theta^h_{jj} = 1, \theta_{jk} = \theta^h_{jk} = 0$, $j \neq k$), the case in a closed economy, and that there are no taxes on housing or profits ($\mathfrak{t}^\pi_j = \mathfrak{t}^h_j = 0$). In this case, as can be seen from (9) and (10), the disposable income and ownership effects sum to zero—the gains (losses) to renters of homes from changes in housing prices are fully offset by losses (gains) to homeowners and, analogously, the gains (losses) to workers are fully offset by losses (gains) to firm owners (profits). However, when not all housing or firms are locally-owned, these changes in prices will not be offset—owners of i's housing and firms in residing in other jurisdiction are affected as well.

3.2. Local and External Marginal Net Government Cost

The denominator of the MVPF is the marginal net government cost (NGC). Again, in the case of decentralized policies, it is critical to distinguish among the different governments whose NGC is affected. Denote $NGC^j_{\tau_i}$ the marginal effect of jurisdiction i's policy $\mathrm{d}\tau_i$ on the NGC of any jurisdiction j (i included) of the same level of the fiscal federalism hierarchy as i. The policy may also generate a vertical fiscal externality, denoted VE_{τ_i}, which is the marginal effect of policy $\mathrm{d}\tau_i$ on the aggregate NGC of all the jurisdictions of the federation at a different level than that of i. Local policies, such as education, might influence federal tax revenues as a result of higher future wages. The local NGC which measures the effect of jurisdiction i's policy on its own NGC is defined as $LNGC_{\tau_i} \equiv NGC^i_{\tau_i}$. The external marginal NGC which measures the effect of jurisdiction i's policy on all the non-residents is defined as $ENGC_{\tau_i} \equiv \sum_{j \neq i} NGC^j_{\tau_i} + \text{VE}_{\tau_i}$. The external effects might differ for a federal versus a state social planner, as the former accounts for externalities on both the federal and state budgets, while the latter does not account for federal budgetary issues.

Appendix B shows the marginal effect of policy $\mathrm{d}\tau_i$ on NGC of jurisdiction j is decomposed as:

$$NGC^j_{\tau_i} = \text{ME}^j_{\tau_i} + \text{BE}^j_{\tau_i} + \text{PE}^j_{\tau_i} + \pi\text{E}^j_{\tau_i} + \text{LE}^j_{\tau_i} \tag{11}$$

The effect on the budget of policy $\mathrm{d}\tau_i$ can be decomposed in five types of effects: the mechanical effect $\text{ME}^j_{\tau_i}$, the behavior effect $\text{BE}^j_{\tau_i}$, the price and profit effects $\text{PE}^j_{\tau_i}$ and $\pi\text{E}^j_{\tau_i}$, and the locational effect $\text{LE}^j_{\tau_i}$. In addition to these horizontal effects, the external marginal NGC also includes the vertical effect, VE_{τ_i}, which can also be decomposed into similar effects. Because of this similarity, the exposition of the explicit expressions of these vertical effects are relegated to Appendix B.

3.2 Local and External Marginal Net Government Cost

3.2.1. *Mechanical Effect*

The first term in the NGC (7) is the *mechanical effect*. Like the direct effect on the WTP, the specific form of the mechanical effect depends on the policy instrument considered and whether the own-jurisdiction or an external jurisdiction is being considered. For a tax cut or change in public good provision in i, the mechanical effects on $NGC^j_{\tau_i}$ are:

$$\text{ME}^i_{t^b_i} = -\text{B}^b_i \times \mathrm{d}t^b_i, \qquad (12a) \qquad \text{ME}^i_{s_i} = \frac{\partial c_i}{\partial s_i} \times \mathrm{d}s_i, \qquad (12b) \qquad \text{ME}^j_{\tau_i} = 0, \qquad j \neq i. \qquad (12c)$$

where $s_i = g_i, z_i$ represents public services, and $b = \ell, h, x, n, \pi$ indexes the household tax bases, the tax bases B^b_i are as defined in (8) for the household taxes and $\text{B}^\pi_i = m_i \pi_i$ for the profit tax. The mechanical effect is the budgetary counterpart of the direct effect on WTP (section 3.1.1). The local mechanical effects, $\text{ME}^i_{\tau_i}$, are also all positive because tax cuts and additional public service/good provision are costly. However, even in an open economy, none of the policy instruments of jurisdiction i entail a mechanical budgetary effect on jurisdiction j, as (12c) makes clear. This reflects the obvious fact that as jurisdiction i changes its taxes or its public services provision, in the absence of fiscal reactions, jurisdiction j does not incur mechanical changes in its tax revenues or budgetary costs.But, as a result of economic responses in j, then i's policy will affect j's budget.

3.2.2. *Behavioral effect*

The second term in the NGC of a local policy is the *behavioral effect*, that is, the effect of households' changes in their consumption bundle and labor supply on the government budget. For any policy change, $\mathrm{d}\tau_i$, implemented by jurisdiction i, the behavioral effect of jurisdiction j's deficit is:[7]

$$\text{BE}^j_{\tau_i} = -n_j \left(t^x_j \frac{\partial x_j}{\partial \tau_i} + t^h_j p_j \frac{\partial h_j}{\partial \tau_i} + t^\ell_i w_j \frac{\partial \ell_j}{\partial \tau_i} \right) \times \mathrm{d}\tau_i \qquad (13)$$

Unlike the external behavioral effect $\text{BE}^j_{\tau_i}$, $j \neq i$, the local behavioral effect $\text{BE}^i_{\tau_i}$ is present in closed-economy MVPF formulas (Hendren, 2016) and is also referred to as the "fiscal externality". No mobility is required for, say, a tax to affect the consumption or labor supply choices of a taxpayer, and thus change tax revenue. However, the effects of mobility, and the changes in housing prices and wages it induces, result in local behavioral effects that would be particularly difficult to interpret

[7] The head tax is independent of consumption and labor levels, and thus does not appear here.

in closed-economy models. Consider the behavioral effect of a change in housing consumption as a jurisdiction increases its public good provision. Increases in public good provision are likely to attract new residents resulting in increases in housing prices (Ahlfeldt et al., 2015). And, as this is a general equilibrium concept, while housing consumption may not be directly affected by public goods, it will be influenced by changes in housing prices. Then as the increase in public goods can will increase housing prices we can expect that housing consumption and, therefore, property tax revenue fall, $t_i^h \partial h_i / \partial g_i$. The effect of policies on other private consumption is similar.

3.2.3. Price Effect

The third policy effect in the NGC changes in tax revenues from general equilibrium price changes. The *price effects* on government j's NGC are:

$$\mathrm{PE}^j_{\tau_i} = -\left(t_j^\ell L_j \frac{\partial w_j}{\partial \tau_i} + t_j^h H_j \frac{\partial p_j}{\partial \tau_i} \right) \times \mathrm{d}\tau_i, \tag{14}$$

which are the public budget counterparts of the disposable income effect on households' WTP. They result from the ad valorem nature of the taxes that implies that changes in the wage [housing rent] affect the labor [property] tax base.

3.2.4. Profit Effect

The fourth effect in the NGC are general equilibrium profit changes on tax revenues. The *profit effect* on government j's NGC is:

$$\pi\mathrm{E}^j_{\tau_i} = -m_j t_j^\pi \frac{\partial \pi_j}{\partial \tau_i} \times \mathrm{d}\tau_i = \left(t_j^\pi L_j \frac{\partial w_j}{\partial \tau_i} - t_j^\pi m_j \frac{\partial f_j}{\partial \tau_i} \right) \times \mathrm{d}\tau_i. \tag{15}$$

where $\partial f_j / \partial z_i > 0$ and $\partial f_j / \partial \tau_i = 0$ if $\tau_i \neq z_i$ that is, only public business services directly increase the profit through a rise in the productivity of the firms. It is the public budget counterpart of the ownership effect on WTP (section 3.1.3). In general, a policy that increases wages reduces the profit tax revenues. An exception is the case of business public services. If their direct effect on profit $\partial f_j / \partial z_i$ is sufficiently large compared to wage changes, an increase in the provision in i is likely to increase the firm's profit in j and thus reduce its NGC.

3.2.5. Locational Effect

The last effect on NGC is the *locational effect* which include household and a firm mobility effects:

$$\mathrm{LE}^{j}_{\tau_i} \equiv \left(\sum_k \frac{\partial c_j}{\partial n_k}\frac{\partial n_k}{\partial \tau_i} - r_j \frac{\partial n_j}{\partial \tau_i}\right) \times \mathrm{d}\tau_i + \left(\sum_k \frac{\partial c_j}{\partial m_k}\frac{\partial m_k}{\partial \tau_i} - t^{\pi}_j \pi_j \frac{\partial m_j}{\partial \tau_i}\right) \times \mathrm{d}\tau_i, \tag{16}$$

where $r_j \equiv t^{\ell}_j w_j \ell_j + t^h_j p_j h_j + t^x_j x_j + t^n_j$ is the overall household tax paid by a resident of j. The household locational effect (first term) simply states that attracting a new household to a jurisdiction might either increase or decrease the NGC, depending on whether the congestion cost entailed by a new resident consuming the local public services outweighs the tax revenues this new resident pays. The interpretation of the firm locational effect (second term) is similar to that of the household locational effect, except that congestion costs and tax revenues are generated firms' mobility. Because public services generate congestion costs on public services, this model is richer than standard tax competition models where losses of residents/businesses simply harm tax revenues. In this model, depending on the cost function, losing residents/businesses may increase/decrease or—consistent with many services with constant marginal congestion costs—hold net government costs constant.

3.3. The MVPF as a Welfare Measure in a Federal System

We now distinguish between the MVPF of the government enacting the policy from that of a social (federal/state) planner that accounts for spillovers.

3.3.1. Local MVPF

Using our prior derivations, the local MVPF of a policy enacted in jurisdiction i is the ratio of the marginal willingness to pay (WTP) for the policy of i's residents, denoted $LWTP_{\tau_i}$, to the marginal net government cost (NGC) incurred by jurisdiction i, denoted $LNGC_{\tau_i}$:

$$LMVPF_{\tau_i} = \frac{LWTP_{\tau_i}}{LNGC_{\tau_i}} = \frac{\mathrm{DE}^i_{\tau_i} + \mathrm{IE}^i_{\tau_i} + \mathrm{OE}^i_{\tau_i}}{\mathrm{ME}^i_{\tau_i} + \mathrm{BE}^i_{\tau_i} + \mathrm{PE}^i_{\tau_i} + \pi\mathrm{E}^i_{\tau_i} + \mathrm{LE}^i_{\tau_i}}. \tag{17}$$

Before discussing the details of our LMVPF, it is useful to compare it to the standard MVPF formula in the literature (Hendren, 2016; Hendren and Sprung-Keyser, 2020):

$$MVPF_{\tau_i} = \frac{WTP^i_{\tau_i}}{NGC^i_{\tau_i}} = \frac{\mathrm{DE}^i_{\tau_i}}{\mathrm{ME}^i_{\tau_i} + \mathrm{BE}^i_{\tau_i}}, \tag{18}$$

which includes direct, mechanical and behavioral effects. As the prior literature usually assume that there is no spillover effect across jurisdictions and because prices are assumed to be exogenous, this MVPF concept can best be characterized as applicable to a closed economy without mobility.

In contrast, the LWTP includes two additional effects when compared to (18): the disposable income and the ownership effects. These two effects are due to capitalization of the policy into housing prices and wages. With mobility, these effects are become important for the distribution of benefits. For example, if a local school district increases its spending on teachers and, by doing so, attracts households and increases the housing price in the district, the disposable income of renters is reduced while landlords' (possibly located elsewhere) income is increased.

The LNGC also includes additional effects. Again, interjurisdictional mobility makes it difficult to ignore these effects. Using the example of K-12 education, this policy will likely attract residents to the jurisdiction, increasing property tax revenues there, changing the marginal cost of services, and potentially influencing future firm profitability and commercial property values.

3.3.2. Social MVPF

A local government can be expected to focus its policies on the well-being of its residents and the impacts to its budget, not on spillover or mobility effects on other jurisdictions. But, these spillover effects have been shown to be empirically important (Etzel et al., 2021). While these spillovers might be irrelevant to local policymaking, they are critical for a federal planner seeking to internalize them via corrective transfers. Formally, the social MVPF of a policy $d\tau_i$ conducted in jurisdiction i, denoted $SWTP_{\tau_i}$, is the ratio of the aggregate marginal WTP for the policy of all the residents of all jurisdictions in the federation to the aggregate marginal NGC incurred by all the jurisdictions in and all tiers (local, state, national) of the federation, denoted $SNGC_{\tau_i}$:

$$SMVPF_{\tau_i} = \frac{SWTP_{\tau_i}}{SNGC_{\tau_i}} = \frac{LWTP_{\tau_i} + EWTP_{\tau_i}}{LNGC_{\tau_i} + ENGC_{\tau_i}} = \frac{LWTP_{\tau_i} + \sum_{j \neq i}(\mathrm{DE}^j_{\tau_i} + \mathrm{IE}^j_{\tau_i} + \mathrm{OE}^j_{\tau_i})}{LNGC_{\tau_i} + \sum_{j \neq i}(\mathrm{BE}^j_{\tau_i} + \mathrm{PE}^j_{\tau_i} + \pi\mathrm{E}^j_{\tau_i} + \mathrm{LE}^j_{\tau_i}) + \mathrm{VE}_{\tau_i}}, \tag{19}$$

where $EWTP_{\tau_i}$ is the external WTP, that is, the aggregate WTP of the households living in jurisdictions other than i; and $ENGC_{\tau_i}$ is the aggregate net government cost of all other governments (of all levels).If the external effects are zero, SMVPF reduces to LMVPF.

The formula for SMVPF highlights that in the presence of mobility or spillover effects, local and social MVPFs do not coincide, making federal intervention necessary to internalize these external effects. While these interjurisdictional externalities include expenditure spillovers on nonresidents or potentially tax cuts affecting nonresident commuters or cross-border shoppers, they also impose fiscal externalities on other jurisdictions due to mobility and price changes.

It is important to note that in (19) that we have implicitly assumed equal welfare weights across all jurisdictions, with the WTP of each jurisdiction, regardless of its residents' characteristics, entering $SMVPF$ equally. In Appendix D we relax this assumption and consider the calculation of $SMVPF$ with different welfare weights attached to the jurisdictions' WTP.

Our derivation of the $SMVPF$ focuses only the effects of change in policy of single jurisdiction (i) on welfare and net government costs throughout the federation assuming that no other jurisdictions react to $i's$ change in policy. That there are no policy responses in other jurisdictions follows from the assumption that any fiscal competition is of the atomistic form—tax/spending competition is at work, but jurisdictions are sufficiently small such that no one jurisdiction induces a strategic response by other jurisdictions. More generally, when jurisdictions are not atomistic, public policies are chosen in an interdependent manner (Agrawal et al., 2022). Appendix E extends our characterization of the MVPF of a policy by one jurisdiction to include the effects of *strategic* policy reactions to it from other jurisdictions. For the purposes of calculating the $MVPF$ we can be agnostic with the respect to the reason for the policy reactions. To construct these MVPFs, we always define the policy as the *initial* $\mathrm{d}\tau_i$ unit increase in the policy of jurisdiction i. Consistent with the prior literature, any response by jurisdiction j occurs using the same policy instrument.

As previously, each expression in our MVPF is a general equilibrium response. This means, for example, any estimated change in labor supply is the response inclusive of any indirect effects via changes in wages and, by extension, the same logic applies to policy reactions. Thus, for the jurisdiction initially enacting the policy, if the appropriate general equilibrium effects are estimated, there are no additional terms to estimate. The interpretation of these terms is more nuanced: each estimated parameter is the response, *inclusive* of any endogenous adjustment of policies elsewhere.

For jurisdiction $j \neq i$, all terms previously derived apply and are general equilibrium responses; thus, they should be estimated without controlling for i's policy. However, the WTP and NGC have additional effects. In particular, the $WTP^j_{\tau_i}$ now contains a competitive (strategic) direct effect, $\mathrm{CDE}^j_{\tau_i} = \mathrm{DE}^j_{\tau_j} \times \partial\tau_j/\partial\tau_i$, while the $NCG^j_{\tau_i}$ now contains a competitive (strategic) mechanical effect, $\mathrm{CME}^j_{\tau_i} = \mathrm{ME}^j_{\tau_j} \times \partial \mathrm{d}\tau_j/\partial\tau_i$.Intuitively, policy reactions impose direct and mechanical effects on their own jurisdictions existing residents and tax bases. These effects are proportional to the slope of the best response function, $\partial\tau_j/\partial\tau_i$, and may be positive or negative. The literature estimating these policy reaction function slopes is voluminous (Agrawal et al., 2022). And with careful empirical measurement, the MVPF framework can thus evaluate the effects of fiscal competition.

4. Marginal Corrective Transfer

As local and social MVPFs of a local policy might significantly differ due to the interjurisdictional spillovers, local governments might have incentives that differ dramatically from those of the society. For example, a local government could see a business tax cut as having a higher local MVPF than construction of a road, because it ignores its neighbors' tax revenue losses resulting losses of businesses as well as ignoring the benefits their neighbors' receive from a well-connected road network. Thus, the local government might favor tax competition policies at the expense of infrastructure investment. In contrast, the federal planner would likely prioritize the road network over tax cuts. Given the decentralization of these policies, the federal government may wish to correct the valuation of the local government to reflect those of the higher-level planner. The marginal corrective transfer or MCT is an instrument that does so. Intuitively, the MCT fills the "gap" between the local MVPF and the social MVPF of a policy, caused by the existence of spillover effects.

In line with Pigou (1920), there is a federal intervention that can increase social welfare by correcting for unaccounted effects on the welfare of others. However, the MCT markedly differs from a Pigouvian tax or subsidy in one important aspect—a Pigouvian tax or subsidy is based on the magnitude of externalities at the socially optimal output. In contrast, the MCT focuses on the wedge between social and local MVPF for observed (current) policies in order to correct them at the margin—not the socially-desired level of the policy. Such a concept is more easily operationalized than a Pigouvian transfer because estimated causal effects of policies are, in fact, for observed—not socially optimal—policies. Like the MVPF, the MCT is focused on the value of marginal changes of policies, and thus able to determine the ranking of marginal changes in alternative policies.

4.1. The MCT to Correct Local Policy Incentives

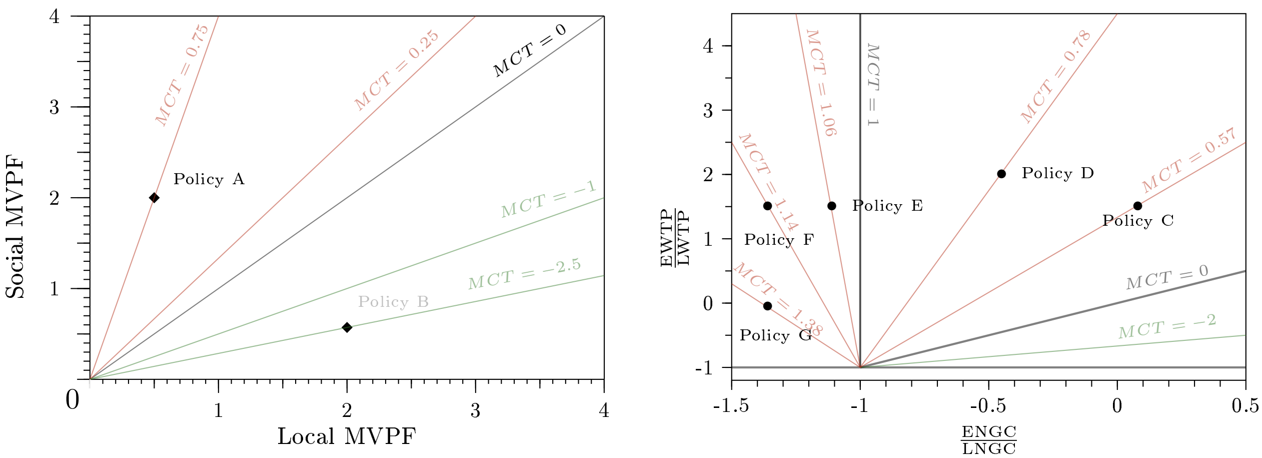
The MCT is the fraction of federal spending on a local program that is need for the marginal dollar that the locality spends on a policy to internalize the interjurisdictional externalities of its policy. In other words, the MCT is the marginal transfer that adjusts the local MVPF of a policy so that it equals the social MVPF. If the federal government provides the appropriate MCT for each policy conducted by lower-level governments of the country, it will guarantee that all decentralized incentives to marginally change local and state policies are socially welfare improving.

Computing the MCT is remarkably simple given the local and social MVPFs of a policy. Consider a policy conducted by local government i consisting of a small change $d\tau_i$ in the level of the policy instrument τ_i. Suppose that the central government provides funding—possibly negative—of $S_i(\tau_i)$ to government i that depends on the level of τ_i.Thus, jurisdiction i's net government cost after the transfer is $NGC_i - S_i(\tau_i)$. Then, the marginal corrective transfer is derived such that jurisdiction i's adjusted local MVPF including the grant is set to equal the $SMVPF$ of the policy, $LWTP_{\tau_i}/(LNGC_{\tau_i} - S_{\tau_i}) = SMVPF_{\tau_i}$, where $S_{\tau_i} \equiv \partial S_i/\partial \tau_i$ is the marginal amount of federal funding. Formally, S_{τ_i} is chosen such that:

$$MCT_{\tau_i} \equiv \frac{S_{\tau_i}}{LNGC_{\tau_i}} = 1 - \frac{LMVPF_{\tau_i}}{SMVPF_{\tau_i}} = \frac{\dfrac{EWTP_{\tau_i}}{LWTP_{\tau_i}} - \dfrac{ENGC_{\tau_i}}{LNGC_{\tau_i}}}{1 + \dfrac{EWTP_{\tau_i}}{LWTP_{\tau_i}}}. \tag{20}$$

The MCT can be positive or negative. If the social MVPF is greater than the local MVPF, the MCT is positive: a subsidy supporting the local policy. However, if the social MVPF is less than the local MVPF, the local government is ignoring negative spillovers so that the optimal correction is a tax aiming to limit the policy. How do we interpret the MCT? The MCT is the fraction of marginal spending by the federal government such that the local MVPF is set equal to the SMVPF. For example, in Figure 2, Policy A has $LMVPF_{\tau_i} = 0.5$, and $SMVPF_{\tau_i} = 2$, yielding a $MCT_{\tau_i} = 0.75$, which means that the federal government pays for 75% of the marginal dollar of spending on the policy. To see this, note that $S_{\tau_i} = MCT_{\tau_i} LNGC_{\tau_i}$, so that for every dollar of local cost, the MCT gives the share financed by the federal government.

An alternative interpretation of the MCT arises from the final expression of (20). In this expression, we can see that whether MCT is positive or negative depends on the difference in the ratios of external to local benefits and external to local government costs. If the relative benefits of the program accrue more to other jurisdictions than the relative costs, the program should be subsidized (MCT>0). When both external and local benefits and costs are all positive, the MCT provides a clear ranking of which policies the federal government should prioritize. However, when the ratios of $ENGC/LNGC$ and $EWTP/LWTP$ becomes sufficiently negative prioritizing policies requires additional assumptions. We discussion these assumptions in the following subsection.



(a) MCT: first representation.

(b) MCT: second representation.

Figure 2. Ranking policies using the MCT. The graph represents of the local MVPF, the social MVPF and the MCT from equation (20).

A lengthy literature in economics highlights the role of matching grants as a means to internalizing externalities. We can use the MCT to determine the grant necessary for the local government implementing the policy to internalize the external willingness-to-pay and net costs to governments. While the MCT provides a cardinal ranking of projects, it also determines the matching grant rate that will equate LMVPF to SMVPF. With a matching grant, federal expenditures will be $S_{\tau_i} = (1 + M_{\tau_i})L_{\tau_i}$ where M_{τ_i} is the match rate and L_{τ_i} are marginal local expenditures (alternatively, revenues for taxes). Then because the MCT is the share of marginal expenditures by the federal government, it follows that: $MCT_{\tau_i} = M_{\tau_i}L_{\tau_i}/[(1 + M_{\tau_i})L_{\tau_i}]$. Solving this equation for M_{τ_i} then allows us to derive the policy relevant (marginal) match rate that will allow the local government to internalize the interjurisdictional externalities, that is, equate their LMVPF with the matching funds to the SMVPF:

$$M_{\tau_i} \equiv \frac{MCT_{\tau_i}}{1 - MCT_{\tau_i}} = \frac{SMVPF_{\tau_i}}{LMVPF_{\tau_i}} - 1, \tag{21}$$

for all $MCT_{\tau_i} \in (-\infty, 1)$. The interpretation of the match rate differs from that of the MCT. In the above example where $MCT_{\tau_i} = 0.75$, condition (21) implies that the match rate is $MCT_{\tau_i} = 3$, which means that the federal government should contribute \$3 additional dollars for each dollar spent by the local government. These \$3 represent 75% of the marginal local net government cost.

The relation between the MCT and the match rate is represented in Figure A.2 in Appendix D. The figure makes it clear that the match rate is only defined on the interval $MCT_{\tau_i} \in (-\infty, 1)$, where the match rate ranges from $[-1, \infty)$. As can be seen in (21), as the ratio between SMVPF and LMVPF approaches zero, the federal government will tax the project at a rate of 100%, ensuring no additional funding of the project. At the opposite extreme as the ratio of SMVPF to LMVPF approach infinity (if, for example, SNGC approaches zero), the federal government seeks will subsidize the project at extremely high rates as the local project has virtually no social net government costs. Obviously, if the match rate approaches infinity, or equivalently $MCT \geq 1$, there exists no feasible match rate at which the local government effective LMVPF can be equated to the SMVPF. While the matching rate is only defined on this range, as shown in Hendren and Sprung-Keyser (2020), there are many projects where the SMVPF is negative (infinite), making the MCT greater than one. Thus for $MCT_{\tau_i} \geq 1$, because no finite match rate exists to internalize spillovers, centralization would be necessary at the margin to completely internalize these external effects.

4.2. Properties of the MCT

When both $LMVPF$ and $SMVPF$ are positive, the MCT allows the federal government to fully prioritize local policies based their interjurisdictional spillovers. In the upper right quadrant of Panel b of Figure 2, as intuition suggests, the MCT increases in $EWTP/LWTP$ and decreases in $ENGC/LNGC$. However, in the upper left quadrant, while the MCT decreases in $ENGC/LNGC$ it does not have the desirable property of increasing in $EWTP/LWTP$. Intuitively, this ordering violation is similar to the fact that a policy with negative $MVPF$ is preferred to any policy that a positive $MVPF$ despite the numerical value being smaller. However, the MCT will still allow us to rank these policies when $EWTP/LWTP$ is similar across policies. But, by transitivity of the MCT, because we rank all policies in the upper right quadrant, the necessity of similar benefit ratios can be relaxed substantially. Then, in Panel b of Figure 2, it follows that the MCT of policy F exceeds those of both policies E and C and, as well, policy D. However, we cannot use MCT to rank policies F and G because while F has a smaller MCT it has greater external spillovers.

When a federal government has limited resources, a marginal dollar should always be allocated to policies where $SMVPF < 0$. Further, the MCT can be used to prioritize the marginal dollar among policies that pay for themselves under assumptions about relative benefits.

Why use MCT to rank policies rather than simply use the $SMVPF$? Solely using the SMVPF would rank projects on their combined local and external benefits and costs. In terms of allocating federal dollars, this could be problematic because the SMVPF could be very high, but may be entirely a result of a high LMVPF (no external effects). In this case, we would expect the local government to finance the project to the extent that reflects all of the benefits and costs to the locality. In contrast, the MCT focuses on the benefits and costs beyond those for the enacting jurisdiction, that is, the distinction between LMVPF and SMVPF. Our empirical analysis below, will highlight the fact that projects with big $SMVPFs$ do not necessarily have big $MCTs$.

How does this new ranking method compare to existing methods (benefit/cost ratios, MCPF, DLW) and why is it more desirable? Because the MCT builds on the $MVPF$ framework, many of the advantages that apply to $MVPF$ apply to the MCT. For example, consistent with the concept of $MVPF$, the MCT is not derived holding utility constant, as is the case with marginal excess burden or compensating variation. In addition, the MCT allows us to prioritize spending and tax policies absent constraints on the budget, in contrast to the marginal cost of public funds.

4.3. Welfare Interpretation

As shown in Appendix D, given SMVPF can be used to prioritize projects on the basis of social marginal welfare SMW and LMVPF prioritizes projects on the basis of local marginal welfare LMW, the MCT has a straightforward welfare interpretation. If comparing two projects with the same local MVPF, then the MCT rank ranks the project on the basis of social marginal welfare. But, this is a special case, as the MCT can be used to rank projects with different local MVPFs. In particular, totally differentiating the MCT and substituting for marginal welfare yields:

$$dMCT_{d\tau_i} = \frac{LMW_{d\tau_i}}{SMW_{d\tau_i}} \left[\frac{dSMW_{d\tau_i}}{SMW_{d\tau_i}} - \frac{dLMW_{d\tau_i}}{LMW_{d\tau_i}} \right]. \tag{22}$$

From this we learn comparing MCT of policies is *not* simply a comparison of SMW but of rather the difference between the percent change of SMW and the percent change LMW of the two policies. This term represents the percentage change in social welfare after removing any change in local welfare, as the local government should optimize its own welfare. From this, we conclude that if $MCT_{A_i} > MCT_{B_i}$ then subsidize policy A_i relative to B_i yields a larger percentage increase in social welfare net of the percentage increase in local welfare.

Although welfare is increasing at the margin, it might be asked whether the MCT moves the policy toward the socially-optimal policy of a unilateral government.[8] Consistent with Auerbach

[8] There is also the question as to whether the MCT moves the policy toward the socially-optimal coordinated policy. Consider the example of levees discussed subsequently, such as the decision of New Orleans to unilaterally build a levee. The social optimum may be that New Orleans builds fewer levees than it does to avoid flooding nearby regions. Movement toward the unilateral optimum does not imply that the social planner would want to reduce levees in all jurisdictions. If all governments coordinated then $LMVPF$ converges to $SMVPF$ and the

(1985), this is certainly true if the policy is sufficiently close to the optimum. A related matter is whether piecemeal policy reform (Boadway and Harris 1977; Hatta 1977), that is, the reform of a single policy rather than the entirety of policies, increases social welfare. In this literature, restrictions on the policy interdependencies between the policy to be reformed and other existing policies are required to make welfare claims of the reform. An advantage of the MCT is that it incorporates fiscal externalities among policies.

We can also contrast the marginal correct transfer with a commonly-discussed alternative to internalizing externalities, a Pigouvian transfer. The MCT, like the $MVPF$, is based on observed and thus practicably identified policy effects while the Pigouvian transfer is based on optimal and thus unobserved policy. Thus, generally, the Pigouvian solution will not equal the marginal correct transfer MCT. However, in D.8, we show that at the socially-optimal policy, the MCT will, in fact, reduce to the Pigouvian transfer. This is a powerful link between a theoretical transfer and practically-implemented policy as the MCT is both a prescription for observed policy but is also tied to the more theoretical Pigouvian transfer.

5. Recipe Book and Sufficient Statistics for Welfare Analysis

While one approach to calculating the MCT is to estimate each of the individual components of LMVPF and SMVPF separately, there exist appealing simplification relying on standard equilibrium conditions. In this section, we outline how and when researchers can infer some of the components of WTP and NGC based based on simple assumption about the policy equilibrium. The formal model used to get the inution provided in this section can be found in Appendix F. A sufficient statistics approach is developped in Appendix H.

5.1. Step 1: Estimate WTP in i

In order to calculate the direct effect of a policy, one approach would be to estimate the causal benefits accruing to residents of the jurisdiction enacting the policy. As in Hendren (2016), due to the envelope theorem, we do not need to worry about behavioral responses in the policies. In addition, in our setting with mobility, because individuals have optimized their location choice initially, we do not need to be concerned with migration or mobility for WTP.

However, an alternative approach, as implemented in the K-12 education example, is to use

MCT goes to zero; as our estimated MCT this provides evidence that levee policy is implemented unilaterally.

estimated local price changes to infer the WTP. We consider this approach as being similar to a *sufficient statistic* approach because house price changes in the jurisdiction enacting the policy can be used to infer WTP, in the enacting jurisdiction and other jurisdictions, and many of the components of NGC. In this case, which price reveals the direct effect in WTP (DE)—house price capitalization or wage capitalization? If the local policy is residence-based and only affects housing demand or supply via prices, the policy has no direct spillovers on non-residents, and does not affect employment decisions of current residents (in the case of K-12 education, this would be the decisions of the parents, not the children), then housing prices should capture all of the benefits. If jurisdictions are atomisitic, this is simply the price change in the jurisdiction enacting the policy. If not atomistic, the price change in a jurisdiction does not fully reflect the DE because of price changes in the rest of the MSA. To adjust for this market power, the DE is the house price changes divided by the jurisdiction's share of the metropolitan population. If all housing is locally owned, then DE represents the WTP of the jurisdiction. If not all housing is owned locally, then the share that is externally owned needs to be considered and accounted for.

In contrast, if the policy is employment-based such as business public services, the policy has no direct spillovers on firms outside the jurisdiction, all ownership of firms is local, and the decision of where to live and work are independent, then wage capitalization is sufficient to infer the DE of a policy. As with house prices, similar adjustments are necessary if firms are not mobile across MSAs and if ownership of firms is not local.

If the policy is not purely residence-based or employment-based and if residence is not independent of employment, then both wage and house price capitalization are necessary.

While our discussion here has focused on wages and housing prices as a revelation of direct effect, other pricing mechanisms such as the bidding auction, can provide information on WTP.

5.2. Step 2: Estimate WTP in j

With the above assumptions, if there is no spillover benefit and all housing/firms are locally owned, then researchers need not know the price changes in j. However, if not all housing are locally owned, these price changes are necessary to determine WTP^j even if policies have no direct spillover effects. Then, when can the price change in i be used to infer the aggregate external price changes?

Under the assumption of no direct spillover benefits, regardless of whether there is inter-MSA or intra-MSA mobility, the aggregate effects of price changes externally must be equal in magnitude and opposite in sign to the the population-weighted local effects, $n_{-i}\partial p_{-i}/\partial\tau_i = -n_i\partial p_i/\partial\tau_i$ where

n_{-i} is the sum of the population of all external jurisdictions. Thus, only estimates of the price change in the enacting jurisdiction—as commonly estimated in the literature–are needed. However, if a policy adopted in i has a direct spillover benefit on residents of j, then researchers must estimate price changes in both jurisdictions. However, note that if jurisdictions are a non-negligible share of population, the estimated price changes compound the direct effect with the feedback effect from price changes elsewhere in the MSA.

5.3. Estimate NGC

As many of the components of NGC include price changes, many of the above comments apply to estimating LNGC. For other more standard components, such as quantity behavioral responses, it is important researchers estimate general equilibrium rather tan partial equilibrium effects.

Our emphasis in this section is on estimating population/firm mobility on the cost function for public services. With respect to interjurisdictional mobility, if there is restrictive zoning or full development, the change in population or number of firms can be assumed to be zero for purposes of additional property or local tax revenue purposes. Intuitively, capitalization in this case arises as households that value the policy more simply replace households that value it less. However, even with restrictive zoning, the resorting of households by preferences for public services changes the cost of providing those services. These cost changes might be directly estimated using revenue data without estimates of resorting, or alternatively, might be obtained by estimating the change in beneficiaries and scaling it by the marginal cost. Population changes need not be directly estimated. Instead, estimated changes in house prices, combined with estimates of the housing supply elasticity can be used to obtain estimates of population changes.

6. Empirical Applications

We next conduct calibration exercises similar to Hendren and Sprung-Keyser (2020) by taking estimates of various elasticities and causal effects from the literature to estimate the local MVPF, the social MVPF and the MCT of various policies.[9] We consider household benefit programs—higher education spending, K-12 spending, environmental flood protection programs, and property

[9] As we do not have access to estimates for the social weights of policies, η_{τ_i}, following Hendren and Sprung-Keyser (2020), we assume that they are equal to one. In the context of our spatial economy, this requires to assume that all households have the same individual marginal utility of income (Hendren and Sprung-Keyser, 2020) but also that the federal planner is utilitarian.

tax cuts—and race-to-the-bottom policies—wealth tax cuts and bidding for firms. Following on the recipe book presented previously, we first consider an example where we calibrate each of the individual components of the MCT. However, as few studies estimate effects on housing prices in jurisdictions other than the one enacting the policy, we then turn to using the sufficient statistic approach where capitalization in i can be used to infer price changes in j. Further examples, such as bidding for firms, relies on the auction format to reveal many of the components necessary for welfare analysis. Then, we summarize our findings and propose a normative typology of these local policies. The range of empirical examples we show will illustrate the wide array of methods one could use to estimate the MCT, including estimating all reduced form effects separately, relying on structural models, employing a sufficient statistics approach relying on hedonic models, to exploiting theoretical models.

6.1. Higher Education Scholarship Programs

6.1.1. Institutional Context

We consider higher education spending reforms consisting of a cut in tuition fees for community college students in Texas. Students who live in the taxing district of the college are eligible for a discounted tuition rate. Over time, towns are annexed into the taxing district, allowing researchers to estimate the causal effect of reduced tuition on enrollment. Using estimates from Denning (2017), Hendren and Sprung-Keyser (2020) estimate an MVPF of this program large, but finite.

We focus on the Austin Community College which had numerous annexations over the last several decades. Rather than study one of these, we focus on what Simon (2021) defines as the "optimal" community college size. Specifically, the (hypothetical) reform we study consists in the necessary annexation of sixteen new towns to the community college district in 2015 to achieve this size. We define the annexed areas as our "local" region, so that the local MVPF reflects the returns to these municipalities from deciding to cut their tuition fees by joining the district assuming the costs of the program are born by them. The external effects then include the existing areas in the Community College district and other areas of Texas and other states not annexed into the district.

Reducing the costs of higher education changes household location decisions, which imposes externalities on the housing markets and budgets of neighboring jurisdictions in the MSA. While a literature estimating capitalization traditionally studies effects of a policy only on the jurisdiction enacting it, Simon (2021) uses a structural model to also obtain price effects on external jurisdictions. In addition to price externalities, after attending college, graduates do not necessarily stay in the local area, meaning that the benefits of higher wages may accrue to where they move. We adjust the MVPF for these moves using estimates from Conzelmann et al. (2021). In this section, we show how Simon's structural model combined with causal effects can be used to estimate each component of the MVPFs separately.[10] Our calculations and assumptions are detailed in Appendix I.1.

6.1.2. *Local MVPF*

First, we present the local MVPF of the annexed areas. For convenience, all values are scaled so that a representative household of the annexed areas benefit from a one-dollar cut in tuition fee.

LWTP. The marginal WTP includes the direct benefit of the program which is the \$1 cut in tuition for inframarginal individual, \$1 plus the direct benefits from the earning gains due to higher human capital net of the student contribution to tuition for marginal individuals \$2.72, totaling $\text{DE}^i_{\tau_i} = \$3.72$. As we have already measured the direct benefit of the program, the willingness to pay of treated jurisdictions need only be lowered by the increase in *rental* prices for renters due to the stronger pressure on the housing market ($\text{IE}^i_{\tau_i} = -\$1.371$). But individuals in the annexed areas also own rental properties throughout the MSA, further lowering the WTP, as prices of homes they own in other parts of the MSA fall ($\text{OE}^i_{\tau_i} = -\$1.466$) and the local marginal WTP is $LWTP_{\tau_i} = \$0.882$.

LNGC. The net government cost includes first the mechanical cost to inframarginal individuals, that is, the cut in tuition fees (\$1), plus the costs due to increased education attainment including the cost of the program induced to go to college (\$1.339). This means a mechanical effect on the NGC of $\text{ME}^i_{\tau_i} = \$2.339$. The local NGC is reduced by the fiscal externality: the increase in sales tax revenue from higher earnings (adjusted to account for the share of college graduates that stay in Austin), $\text{BE}^i_{\tau_i} = -\$0.002$ plus increases in property tax revenue for owner-occupied and rental property values due to price appreciation, $\text{PE}^i_{\tau_i} = -\$1.715$. Thus, the local marginal NGC is $LNGC^i_{\tau_i} = \$0.622$.

LMVPF. The local MVPF is 1.418, as represented in Figure A.4. The local MVPF is smaller than those in Hendren and Sprung-Keyser (2020) because the WTP is offset due to higher rental prices in the area and because the tuition savings program imposes relatively large costs on local governments. Local governments do not account for federal income tax revenues nor do changes in property tax revenues from capitalization raise enough revenue to recoup the direct costs.

[10] Because many of the estimates we use come from the structural model, we cannot include standard errors like we do in our other applications.

6.1.3. *Social MVPF and MCT*

Now, we turn to the social MVPF and the MCT assessed by a social planner accounting for the effects of the local \$1 cut in tuition fees beyond the annexed areas. We consider two different social concepts: one for the state of Texas and one for the federal government.

SWTP. A federal and state planners accounts for the marginal WTP of three types of households. First, the residents of the annexed areas of the MSA have a marginal WTP equal to the LWTP computed above, $LWTP_{\tau_i} = \$0.882$. Second, the renters of the other areas of the MSA benefit from lower rental prices in these less attractive areas, that is, a positive disposable income effect of $\sum_{j \neq i} \text{IE}^j_{\tau_i} = \$1.132$. Third, other residents who own some the housing of the MSA benefit from the additional ownership income generated by the policy: the ownership effect amounts to $\sum_{j \neq i} \text{OE}^j_{\tau_i} = \$1.07$.[11] It follows that the external margial WTP is $EWTP_{\tau_i} = \sum_{j \neq i}(\text{IE}^j_{\tau_i} + \text{OE}^j_{\tau_i}) = \$2.202$ and the social marginal WTP is $SWTP_{\tau_i} = \$3.084$ per household. No one outside of Texas is affected.

SNGC. The external marginal NGC includes three effects. First, in the areas of the MSA not annexed, property tax revenues decrease as a result of the fall in house prices, imposing a net cost to the government. This entails a price effect of $\sum_{j \neq i} \text{PE}^j_{\tau_i} = \$1.121$. Second, as a share of graduates move from their home communities after graduation, other parts of Texas or even other states benefit from additional tax revenues as a result of the cut in tuition fees in the annexed areas. We use mobility estimates from Conzelmann et al. (2021) to prorate by the share of graduates induced to take-up college who stay in the MSA, stay in Texas but not Austin, or leave Texas all together. With respect to the state, given Texas does not have an income tax, revenue costs arise from state and local sales tax revenue $\text{VE}^{\text{TX}}_{\tau_i} = -\$0.06$. Unlike Texas, other state have income taxes, but relatively few graduates leave the state, so the effect on other state budgets is $-\$0.015$. Third, there is also a vertical effect on the federal NGC. Federal income tax revenues increase due to both the added earnings from attending community college and landlords rental income changes due to capitalization. This amounts to a vertical effect of $\text{VE}^F_{\tau_i} = -\$0.704$. In sum, the external marginal NGC of Texas is $ENGC^{\text{TX}}_{\tau_i} = \$1.061$, thus yielding $SNGC^{\text{TX}}_{\tau_i} = \$1.683$. At the federal level, higher income taxes, mean $ENGC^F_{\tau_i} = 0.356$, yielding $SNGC^F_{\tau_i} = 0.978$.

SMVPF and MCT. The social MVPF of the state of Texas and federal government are equal to 1.833 and 3.152, respectively. Figure A.4 summarizes all the above results. At the Texas state level,

[11] This effect accounts for the rent increase in the annexed areas, for the rent cut in the other areas of the MSA, and for the federal taxes on rental property income that the landlords have to pay.

the MCT is a subsidy of 0.226 implying a match rate of 0.292. However, the federal government is much more willing to subsidize higher education because of the additional federal income tax revenues: its MCT is 0.55 (i.e. a match rate of 1.223. The federal and state governments are both willing to subsidize governments to make local cuts in tuition fees, in part because it lowers the cost of rent elsewhere in the MSA. The divergence of the MCTs for a state and federal planner show the role of state intuitions: because the state of Texas does not have an income tax, there are minimal effects on the state budget. Were Texas to have a income tax, then it would realize substantial revenue from the higher graduate wages, and would be more willing to subsidize community colleges. Critically, state subsidies for higher education may not be as large as federal subsidies, and the magnitude of these subsidies may differ across states simply because of the existing tax rates in each state.

6.2. K-12 Education Spending

There is a large literature on the sorting effects, house price effects, and long-run effects on children (e.g., Jackson et al. 2016) of K-12 education spending. Combined with recent evidence on sorting and capitalization (Bayer et al., 2020), our paper is a nice way to think about summarizing the results of that large literature to highlight the resulting divergence to quantify the MCT.

We investigate the effects of a marginal increase in K-12 education spending by a school district in a typical MSA. Unlike the prior example we take a sufficient statistics approach developed Appendix H. Beyond the insights on the marginal corrective transfer required, the analysis adopts an original approach. It shows that under reasonable assumptions (mobility in response to the policy is limited to a metropolitan area; location of work is independent of residence; property tax is main source of local revenue), researchers can calculate both the social and local MVPF by relying extensively on the estimate of house price capitalization in the jurisdiction which conducts the policy. Capitalization effects are a sufficient statistic to estimate WTP and NGC in *both* sets of jurisdictions. Further results can be found in Appendix I.2.

6.2.1. Local MVPF

The experiment we consider is an additional dollar spent on K-12 education by a typical locality, i, in a MSA. For the purpose of exposition, we assume the the single relatively small jurisdiction increasing its spending has house prices that are at the median of the MSA, and thus, similar to the housing prices in the rest of the MSA. The appendix shows results when the enacting jurisdiction has higher and lower prices than other jurisdictions in the MSA.

LWTP. The local WTP is the revealed valuation of how \$1 in education spending translates into house prices changes. We do not estimate the benefit directly and instead rely on capitalization from standard hedonic estimation as a sufficient statistic. Under the assumptions outlined in section XXX, we use the fact that $s_i(p_i) + s_{-i}(p_{-i}) = 1$, where s_i denotes the share of the population in the jurisdiction enacting the policy and s_{-i} denotes the share in the rest of the MSA. Then, differentiating with respect to the policy τ_i yields

$$\frac{\partial p_{-i}}{\partial \tau_1} = -\frac{s_i}{1-s_i}\frac{\partial p_i}{\partial \tau_i}. \tag{23}$$

Free mobility within the MSA then implies that housing prices adjust in all jurisdictions to restore equal utility. Then, we can obtain the DE implied by (23) as:

$$DE^i_{d\tau_i} - \frac{\partial p_i}{\partial \tau_i} = -\frac{\partial p_{-i}}{\partial \tau_i} \Rightarrow DE^i_{d\tau_i} = \frac{\partial p_i}{\partial \tau_i}\frac{1}{1-s_i} \tag{24}$$

where we have assumed the jurisdiction enacting the policy is at the median house value in the MSA.[12] Then, using (24) and estimates from Bayer et al. (2020), we obtain a direct effect of $\text{DE}^i_{g_i} = \$6.274$ for each additional dollar spent on K-12 education. Parents care significantly about the future of their children. However, the educational spending makes city i more attractive and thus raises the housing rent there. For renters, higher rents represent a loss of available income. Using data on the share of renters, this rent represents a cost of $\text{IE}^i_{g_i} = -\$0.912$ for renters of city i. However, as the residents of city i also own some of the housing stock there, they also benefit from $\text{OE}^i_{g_i} = \$0.025$ of additional ownership income.[13] Thus, the local marginal WTP is $6.274 - 0.912 + 0.025 = \$5.387$.

LNGC. The net cost to the local government first include the mechanical educational spending of $\text{ME}^i_{g_i} = \$1$. This spending attracts new families in city i, so keeping constant their level of public public service per capita, these new households induce budgetary costs of educating their additional children which are not compensated by the additional sales tax and property tax they pay. We can use estimates of the housing supply elasticity, ϵ^S_i, to obtain the population change where $dn_i/d\tau_i = n_i\epsilon^S_i \partial p_i/\partial\tau_i$. Using this implies that additional households attracted to i generate a locational net cost of $\text{LE}^i_{g_i} = \$0.159$. These costs are reduced by the additional property taxes

[12] See appendix XXX for how to relax the assumption and calibrate the price changes.

[13] This amount accounts for the fact that the residents of i also own properties in the rest of the MSA where the house prices decrease.

that the city can collect from higher housing prices, $\text{PE}^{i}_{g_i} = -\$0.417$. Moreover, the children who benefit from the schooling expenditures will earn higher wages and pay sales taxes on the additional consumption, which reduces the net cost by $\text{BE}^{i}_{g_i} = -\$0.026$. Thus, the local marginal NGC is $1 + 0.159 - 0.417 - 0.026 = \$0.716$.

LMVPF. This yields a local MVPF of 7.523, as represented in Figure A.5.

6.2.2. Social MVPF and MCT

We also consider the social MVPF of the state and that of the federation in which city i is located. In addition to the local effects, the social MVPFs account for the WTP effects and budgetary effects on other localities of the metro area. They also account for the state and federal tax revenues.

SWTP. Because education policy is residence-based and cannot be consumed by nonresidents, there is no *direct* willingness to pay elsewhere. However, we assume the jurisdiction enacting the policy has a large enough share of the metropolitan population to affect prices elsewhere. In addition to the local WTP, the social willingness to pay includes the benefit to renters elsewhere of lower housing rents in other localities ($\text{IE}^{j}_{g_i} = \$0.912$) and the cost for the landlords there who own a majority of the declining housing stock there ($\text{OE}^{j}_{g_i} = -\$0.025$). These effects are obtained using (23), which means only price changes in the enacting jurisdiction need to be estimated. Notice that these external disposable-income and ownership effects are exactly the opposite value of their local counterparts in i described above. This results from the fact that house prices are assumed to be initially equal, so price increases in one jurisdiction are offset by price cuts elsewhere.In sum, the external marginal WTP is $EWTP_{g_i} = \$0.887$ and the social marginal WTP reduces to the direct local benefit so that $SWTP_{g_i} = \$6.274$.

SNGC. The external net government cost first includes the property tax loss by the other localities of the MSA where the house prices decreased ($\text{PE}^{j}_{g_i} = \$0.417$ which is the opposite of the local price effect, as already discussed). The house price cut elsewhere reduces the landlords' income and consumption which slightly reduces sales tax revenues ($\text{BE}^{j}_{g_i} = \$0.002$). However, because households leave these jurisdiction to settle in i, net cost of public service provision in those localities is reduced $\text{LE}^{j}_{g_i} = -\$0.159$.[14]

The state and federal governments also accounts for the vertical fiscal externalities of the policies. Both will be able to collect income tax revenues from the increased earnings of better educated grown

[14] This external locational effect is the same magnitude as the local effect, as we assume that in the initial equilibrium, taxes, prices and public services in i are at the same level as in other localities.

children. Using the causal effects of education on wages Jackson et al. (2016), income taxes increase \$0.138 for the state[15] and an even more significant gain of \$0.858 for the federal government. As these grown children will also consume more, the state will be able to collect an extra \$0.207 in sales taxes from higher earnings. This implies a vertical fiscal externality of $\text{VE}^{\text{S}}_{g_i} = -\$0.345$ for the state and $\text{VE}^{\text{F}}_{g_i} = -\$0.858$ for the federal government.

Thus, the external marginal NGC is $ENGC^{\text{S}}_{g_i} = 0.26 - 0.345 = -0.085$ for the state and $ENGC^{\text{F}}_{g_i} = -0.085 - 0.858 = -0.943$ for the federal government. As the state government accounts for effects in all localities in addition to its own budget, $SNGC^{\text{S}}_{g_i} = \$0.716 - \$0.085 = \$0.631$, which is positive. However, the high income tax revenues that the federal government will be able to collect from higher earnings implies a negative social NGC of $SNGC^{\text{F}}_{g_i} = -\$0.227$, so that the policy pays for itself from a social planners perspective.

SMVPF and MCT. It follows that the social MVPF of the state is 9.939, which is significantly higher than the local MVPF. This yields a MCT of 0.243 so that the state provides a subsidy to the local government for each dollar it spends. In terms of a match rate, this means that for each local dollar spent on education, the state is ready to add an extra \$0.321 on the project, implying state spending is 24.3% of the marginal spending. At the federal level, as the policy pays for itself, the social MVPF is infinite (literally, it is negative), so the MCT is above one, $MCT^{\text{F}}_{g_i} = 1.272$. Thus, there is no finite match rate that internalizes all spillovers. Thus, if internalizing all spillover were the goal, only centralization could do so. The results in this section are summarized in Figure A.5. Like the prior example, because states have different taxing instruments, the MCT of the state differs across states and from the federal.

Local education programs must be subsidized because the locality conducting the policy ignores three main benefits to the society. First, education spending reduce the rent and thus the cost of living in other localities. Second, it reduces the cost of providing public services their. Third, education induce higher earnings which will raise state and federal income and sales tax revenues.

6.3. Property Tax Cut and Tax Competition

Property taxes are the primary source of local tax revenues in the United states. Policies reducing property taxes are often discussed and implemented. For example, in France, the French property tax reform of 2020 consisted in suppressing this tax for 80% of taxpayers.

15 We do not know the probability that increasing K-12 education will result in interstate mobility.

We investigate the effects of a cut in property tax of a single municipality. To do so, we use the same general quantitative framework framework for analyzing local policies that we already used to investigate the example of K-12 spending. Further quantitative results are given in Appendix I.3.

Several aspects distinguish the analysis of property tax cuts from that of education spending. First, unlike education spending, a property tax cut does not directly affect the future earnings of the students. Therefore, if the metropolitan wage is determined by productivity levels, price effects in the MVPFs only come from house price capitalization. Thus, one can use the the local housing price elatisticity as a (purely) sufficient statistic. Second, the direct effect of a tax cut is directly observable from the data. Thus, we do not need the preference revelation approach used in the K-12 application to quantify this benefit.Third, the property tax cut may generate strategic tax reactions in the non-treated jurisdictions which provides a good illustration of how welfare is affected by strategic tax competition (appendix E.3).

6.3.1. Local MVPF

To paralell our K-12 application, we consider a \$1 cut in property tax revenue in jurisdiction i of a typical U.S. metro area. The following description focuses, again, on the case of a jurisdiction i whose house price is similar to that in other areas of the MSA, which cancels out aggregate price effects. The appendix extends the analysis to asymmetric housing prices.

LWTP. The direct effect of cutting the property tax rate are the tax savings. As some of the housing stock is owned by nonresidents, this direct benefit is smaller than the \$ change, $\text{DE}^i_{t^h_i} =$ \$0.931. However, the tax cut makes the municipality more attractive and thus increases the local housing rent, generating a negative disposable income effect of $\text{IE}^i_{t^h_i} = -\$0.360$. This negative effect is only partly offset by a positive housing ownership effect resulting from the fact that households are also owners of properties: $\text{OE}^i_{t^h_i} = \$0.010$. In sum, the local WTP generated by the dollar cut in property tax is \$0.580.

LNGC. Cutting its tax entails a mechanical cost of $\text{ME}^i_{t^h_i} = \$1$ for city i, as all revenue accrues to jurisdiction i. In addition, the attraction of new families increases the cost of public service provision to maintain the per capita level of services. This cost is only partly compensated by the additional tax revenues paid by these new households. This entail a net locational cost of $\text{LE}^i_{t^h_i} = \$0.063$. But this cost is more than compensated by the higher local property tax revenues collected from the more expensive housing: $\text{PE}^i_{t^h_i} = -0.165$. Additionally, as they earn more income, landlords consume a very small amount more and pay a negligible amount more ($\text{BE}^i_{t^h_i} = -\$0.001$) of sales taxes. In sum, the local marginal NGC is \$0.897.

LMVPF. This yields a local MVPF of 0.647. It is significantly lower than the local MVPF of K-12 spending because property tax cuts do not entail earning gains from human capital accumulation.

6.3.2. Social MVPF and MCT

At the MSA level, when the enacting jurisdiction has the median house price, any housing price increase in municipality i is offset by overall housing price cuts of the same magnitude in the rest of the MSA.Thus, as all the indirect effects described above result exclusively from housing price changes, in the absence of policy reaction from other localities of the MSA, the social MVPF is one. However, due to tax competition, the tax cut in i spur other localities to cut their tax as well. This behavior affects the level of the social MVPF and thus the incentive for a central government to support or limit tax cuts.

As house price increase in i are exactly offset by decreases in j and as the metropolitan wage is fixed, the policy does not alter the the state and federal government's budgets. AS there is no vertical fiscal externality, and the state and federal social MVPFs are identical.

SWTP. Residents of j own some of the properties in i, so that they directly benefit from the property tax cut in i ($\text{DE}^j = \$0.046$). Moreover, the reduction in the housing rent in non-treated municipalities increases the disposable income by $\text{IE}^j_{t^h_i} = -\text{IE}^i_{t^h_i} = \$0.360$ there. This is partly compensated by lower income from j's housing ownership in i, $\text{OE}^j_{t^h_i} = -\text{OE}^i_{t^h_i} = -\$0.010$. Rent capitalization increases the earnings of landlords who leave outside the MSA [state] but in the state [federation] by \$0.006 [0.018]. Thus, in the absence of a policy reaction, the external marginal WTP is \$0.402 for the state and \$0.420 for the federal government. The social marginal WTP is \$0.982 for the state and \$1 for the federal government which is the direct effect of the property tax cut on the economy. Tax competition increases this social willingness to pay because other as the other localities of the MSA also cut their property tax rate, their residents benefit by $\text{CDE}^j_{t^h_i} = \$1.381$. This raises the social marginal WTP from \$2.363 for the state and \$2.381 for the federal government.

SNGC. As households move to town i, this reduces the net cost of public service provision in other places by $\text{LE}^j_{t^h_i} = -\text{LE}^i_{t^h_i} = -\$0.063$. But this is more than compensated by the loss in property tax revenues resulting from the lower housing prices, $\text{PE}^j_{t^h_i} = -\text{PE}^i_{t^h_i} = \$0.165$. In addition, the reduction of the landlords' income slightly reduces their consumption and thus the sales tax revenues by a negligible amount, $\text{BE}^j_{t^h_i} = -\text{BE}^i_{t^h_i} = -\$0.001$. In the absence of policy reactions, this yields an external marginal NGC of \$0.103 and a social marginal NGC of \$1 for both the state and federal governments.

However, as non-treated localities cut their property tax rate in response to i's tax cut, they incur an additional cost of $\text{CME}^{j}_{t^h_i} = \$1.426$, so the social marginal NGC rises to \$2.426. Importantly, tax competition raises more the external budgetary costs than it increases the willingness to pay of non-residents. This comes from the fact that part of the housing in the non-treated areas is owned by residents of i. This implies that when they cut their tax rates, these governments incur a cost which only partly benefit their residents. This explains why strategic tax competition reduces the incentive for a central government to support property tax cuts as we will see just below.

SMVPF and MCT. In the absence of tax competition, the state's [federal government's] social MVPF is 0.982 [1] and the MCT is 0.341 [0.353] (and the corresponding match rate is 0.518 [0.546]). Thus, the central government subsidizes local tax cuts just as it does for education spending, but to a smaller extent. Two external benefits ignored by city i when cutting its tax explain this central government's subsidy. First, property tax cuts directly benefit non-resident landlords. Second, by making non-treated localities less attractive, the residents who stay there benefit from lower rents.

Allowing for policy responses, the state's [federal government's] social MVPF falls to 0.974 [0.982] which induces a lower MCT of 0.336 [0.341] (and a match rate of 0.506 [0.518]).[16] As explained above, in general, property tax competition reduces the incentive for a central government to support property tax cuts. As other jurisdictions are forced to cut their tax rates, they incur budgetary costs which only partly benefit their residents if properties are not fully owned locally.

6.4. Decentralized Wealth Tax Competition

Historically, Spain operated a progressive centralized taxation on wealth. However, starting in 2011, the wealth tax was decentralized to the regions. In the absence of regional autonomy, a "default" schedule set by the centralized government prevailed. However, regions were able to deviate from the schedule. Only the region of Madrid dramatically lowered the wealth tax schedule, with Madrid zeroing out all tax liability for its residents. Thus, the salient tax differential in Madrid is well characterized as the difference between Madrid and all other regions. Wealth taxes as well as other income taxes follow the residence principle, so taxes can be avoided by moving to—or falsely declaring—Madrid. Agrawal et al. (2021) estimate various causal effects of Madrid's zero tax rate.

[16] This small effect of property tax competition on the the MCT is a result of assuming the enacting jurisdiction has the median house price. When house prices are asymmetric in the MSA, the match rate can decrease by up to 10% due to tax competition (Appendix I.3).

We consider treatment as Madrid's deviation to zero from the centralized default schedule. We assume that each region obtains revenue from labor income taxes, capital income taxes, and wealth taxes. We do not have data on other regional taxes, but these three taxes represent over 90% of regional revenue, as property taxes mainly accrue to localities. We consider the same five year horizon studied in Agrawal et al. (2021). Acknowledging our model does not have a wealth tax, its MVPF would be similar to other household taxes. More details about the calculation and assumptions made are given in Appendix I.4.

6.4.1. Local MVPF

Let us construct the local MVPF for the region of Madrid as it cuts its wealth tax by €1 per taxpayer.All subeffects are in Euros per initial wealth taxpayer of Madrid.

LWTP. The willingness to pay for the wealth tax cut reduces to the $\text{DE}^{i}_{\tau_i} = €1$ tax saved by a taxpayer in Madrid. The absence of disposable and ownership effects is due to the fact that most residential relocations from other regions to Madrid were fraudulent, as explained in Agrawal et al. (2021). To benefit from the wealth tax cut in Madrid, wealthy taxpayers who already owned housing in Madrid established changed their primary residences there without actually moving. Thus, the local marginal WTP is equal to 1 euro per resident.

LNGC. The mechanical effect on Madrid's net government cost is also $\text{ME}^{i}_{\tau_i} = €1$ which represents its direct expenditure. The lower wealth tax rate results in behavioral responses stimulating wealth accumulation which translate into additional capital income tax revenues.Using the estimate of the elasticity of taxable wealth from Jakobsen et al. (2020), this behavioral effect amounts to $\text{BE}^{i}_{\tau_i} = -€0.024$ per resident. Finally, by cutting its wealth tax (down to zero), Madrid attracts new households who pay labor and capital income taxes, but who do not consume public services. This yields a locational effect of $\text{LE}^{i}_{\tau_i} = -€0.034$ per initial resident. In sum, the local marginal NGC is $1 - 0.024 - 0.034 = 0.94$ Euros per resident.

LMVPF. This yields a local MVPF of 1.062 which That is, for each euro spent by Madrid's government cutting its wealth tax, Madrid's residents are willing to pay €1.062. This MVPF is only slightly greater than unity because responses to the tax cut have been relatively small.

6.4.2. Social MVPF and MCT

SWTP. The social marginal WTP reduces to the local marginal WTP which is the direct benefit of the tax cut, $\text{DE}^{i}_{\tau_i} = €1$.

SNGC. In addition to the local marginal NGC (€0.94), the social marginal NGC also include the effects on other regions of Spain from the relocation of households from these regions to Madrid. This relocations entails a loss of €0.024 in wealth tax revenue and a loss of €0.034 in personal income tax from labor and capital income. In sum, the external household locational effect $\sum_{j \neq i} \mathrm{LE}_{\tau_i}^{j} = 0.024 + 0.034 = 0.058$ euros per resident and the social marginal NGC is $0.942 + 0.058 = 1$. This means that the locational effects cancel out at the national scale. Specifically, income taxes are mainly a transfer between the rest of Spain and Madrid, and, by coincidence, the loss in wealth tax revenue to the rest of Spain is similar to the behavioral effect gain in Madrid.

SMVPF and MCT. This entails a social MVPF of 1.000 and a MCT of -0.062 that is, for each euro spent by Madrid in cutting by its wealth tax, the national government is willing to impose a matching rate tax of €0.058 to the government of Madrid per Euro of tax cuts. Figure A.10 summarizes the results of this section.

The social MVPF is lower than the local MVPF because Madrid does not value the fact that cutting its tax rate entails tax revenue losses for other regions. Although Madrid's resident marginally value the tax cut more than its government costs, the society sees this tax cut as a simple transfer of revenues from the public sector to the households. This explains why the MCT is a corrective tax that aim to make Madrid internalize the negative externality it entails on other regions. This scenario is useful because the lack of capitalization due to fraud rather than real moves, means the entire difference in MVPFs is a result of interjursdictional fiscal externalities studied in the tax competition literature.

6.5. Bidding for Firms

States and local governments often "bid for firms," that is, provide subsidies, tax concessions, worker training, and public services to attract large employers. State and local governments devote significant effort to increase employment and earnings in their own locality, but do not account for the benefits other localities had they attracted the new plant.Much of the literature on bidding for firms has focused on the competition between the the state in which the firm decides to locate and the runner-up state (Slattery, 2020; Slattery and Zidar, 2020; Greenstone et al., 2010).

Here, we focus on states and their policies. We consider a bid—in the form of firm-specific subsidies—by the state of Tennessee for the new 2008 Volkswagen plant, conditional on the bids of other states. Taking as given that regardless of what it does, other states will bid, should Tennessee enter the bidding competition? If Tennessee makes a bid, consistent with the observed outcome, it wins the plant; if it does not, then the bid will go to the observed runner-up, Alabama. By conditioning on the other bids, this is the MVPF of Tennessee's unilateral decision to bid and is not the MVPF of all bidding or of eliminating bidding. The Volkswagen subsidy competition is a prominent example of bidding for firms, was a very large subsidy deal, and has been highlighted in the prior literature (Slattery and Zidar, 2020). Unlike the K-12 example, where house prices are used to reveal WTP, modeling subsidy competition using an auction framework allows us use empirical IO tools to recover estimates of WTP.

6.5.1. Local MVPF

Firs, we consider the local MVPF of Tennessee as it makes a bid b_i and attracts Volkswagen.

LWTP. Slattery (2020) discusses how the English auction format of subsidy deals helps reveal information about firm valuations. Just as capitalization acts as a sufficient statistic, the English auction reveals information in both the local and social MVPF. Following this structure in Appendix I.5 we estimate the valuation of the plant in TN and the auction reveals the precise valuation in AL. In MVPF terms, this valuation is the willingness to pay of the state for attracting Volkswagen. For Tennessee, we estimate valuation using observable characteristics of the state and firm—combined with an idiosyncratic component—to obtain a local WTP of \$897 million. As VW is primarily owned by nonresident shareholders, we ignore any effects on the profitability of VW.

LNGC. The net government cost of Tennessee to attract Volkswagen is its realized bid minus Volkswagen's promised contribution to education in Tennessee, $\text{ME}^i = \$558 - 5.3 = 552.7$ million, minus the additional fiscal revenue collected due to the new plant. To compute these revenues, we use ex post information from causal estimates of winning the plant on economic outcomes (Slattery and Zidar, 2020). These authors show that $3,854$ jobs were created by Volkswagen, but they essentially crowded out existing jobs. But because these new jobs paid higher wages than in other sectors, workers can consume more, so that the Tennessee's NGC benefit from additional retail sales tax revenue. This amounts to a behavioral effect of $\text{BE}^i = -\$28$ million. Thus, local NGC is $552 - 28 = 524$ million dollars.

LMVPF. Then, the local MVPF is 1.71.

6.5.2. Social MVPF and MCT

To obtain the social MVPF of Tennessee entering the bidding competition for Volkswagen, we need to determine the external benefit/cost for the U.S.. Given that if Tennessee does not bid, then

Volkswagen would locate in the runner-up state, Alabama, the federal planner sees any benefit [cost] of Alabama attracting the Volkswagen as an opportunity cost [benefit].

SWTP. In terms of WTP, in the English auction, the valuation of the runner-up is equal to the bid. Alabama incurs an opportunity cost equal to its valuation, which is perfectly revealed by its bid of \$386 million. Differences in profits to VW should also factor in the SWTP. As Slattery (2020) shows, the properties of the bidding auction reduce the profit difference to the difference in bids: $\text{OE} = \pi_{\text{AL}} - \pi_{\text{TN}} = b_{\text{AL}} - b_{\text{TN}} = -\$172$ millions.[17] Thus, the external WTP is $-\$558$ million and the social WTP is of $897 - 558 = \$339$ million.

SNGC. The mechanical effect in Alabama reduces to the beneifts of its saved bid, $\text{ME}_{\text{AL}} = -\$386M$. The forgone sales tax revenues in Alabama represent a cost of $\text{BE}_{\text{AL}} = \$63M$. Unlike Tennessee, Alabama taxes labor income which implies a social cost of $\text{PE}_{\text{AL}} = \$53M$. The federal government also taxes income. Given that the wage gain is higher in Alabama than in Tennessee, this represents an extra cost of $\text{VE} = \$155M$. In sum, the external net government cost is $ENGC = -\$115M$, that is a tax revenue gain of $\$115M$. Adding the local and external net government costs, we obtain a social NGC of $SNGC = \$409M$.

SMVPF and MCT The social MVPF of Tennessee entering the bidding competition for Volkswagen is 0.827 and the marginal corrective transfer is -1.068 and the match rate is $-\$0.516$. Figure A.12 summarizes the above results.

Like in the wealth tax example (section 6.4), the federal government is willing to marginally tax Tennessee to limit its local valuation of entering bidding competition. This tax aims at making Tennessee internalize the negative spillover effects (in particular the negative fiscal externality) entailed by its competing behavior. Although the social MVPF is small, it is not trivially small suggesting there are some benefits of subsidy competition such as matching firms to high valuation states that would not occur in the absence of the subsidies (Black and Hoyt, 1989). But, the MCT is still negative due to the parasitic effects on other studies not accounted for when bidding. The intuition is simple: the local planner believes the fiscal externality accrues to Tennessee with no cost elsewhere, but the federal planner sees the revenue gain of Tennessee as simply a transfer of revenue that would have accrued to the runner up.

[17] Define ν_i as the valuation of the firm by the residents of state i. Then the SWTP of Tennessee bidding is the difference between both states valuation and profits $\nu_{\text{TN}} + \pi_{\text{TN}} - (\nu_{\text{AL}} + \pi_{\text{AL}})$. In the English auction the winning bid will satisfy $b_{\text{TN}} = \nu_{\text{AL}} + \pi_{\text{AL}} - \pi_{\text{TN}}$. This being the case, SWTP simplifies to $\nu_{TN} - b_{\text{TN}}$, allowing the English auction to reveal many of the components of WTP.

6.6. Flood Protection

A common response to rising waters is the building of levee systems. While levees protect homes behind the levees, they can also divert waters imposing adverse flood risks to nearby homes. Brandt and Aldy (2023) estimate the willingness to pay of residents for levees and the spillover effects of federally built levees on nearby properties by estimating capitalization effects. The authors also translate the home price changes into property tax revenues. In their paper, levees are built by the federal government. To think about the MCT, we consider the following question. If levies were built by local governments, what federal transfers/taxes would be necessary to equate the local MVPF to that of the federal government.

Brandt and Aldy (2023) obtain the total costs of levees for a subset of their data, estimate WTP as house price capitalization (both in neighborhoods benefiting from the levee and on neighborhoods that the levee harms by increasing flood risk), and calculates changes in property tax revenues from any capitalization. We assume there are no changes in profits or wages, as would be the case in a metropolitan model. Further, we assume the levees are built by the county/municipality such that all negative spillover effects are on nonresidents.

6.6.1. Local MVPF

Brandt and Aldy (2023) estimate the local WTP of levee protection as \$5.3 (million) while the external WTP from the levees increasing flood risk in other jurisdictions is -\$1.6.

The total construction cost of a locality building a levee is \$9.4. But, higher house prices in the jurisdiction with the levee add an additional \$2.2 in property tax revenues.[18] Thus, the local MVPF is 0.74. As is clear, locally building a levee has benefits less than the costs.

6.6.2. Social MVPF and MCT

As house prices fall in neighboring jurisdictions, so too does property tax revenue by \$0.6. Summing local and external willingness to pay yields a SWTP of \$3.7 and dividing by net government costs of both, \$7.8, yields a social MVPF of 0.47. Because the federal planner accounts for the negative spillovers on nearby communities the MVPF is lower.

Putting this together, the MCT is -0.55, which implies a match rate of -0.36. Local construction

[18] They calculate property tax changes as an infinite stream using a 3.5% discount rate. For simplicity, we do not change these calculations.

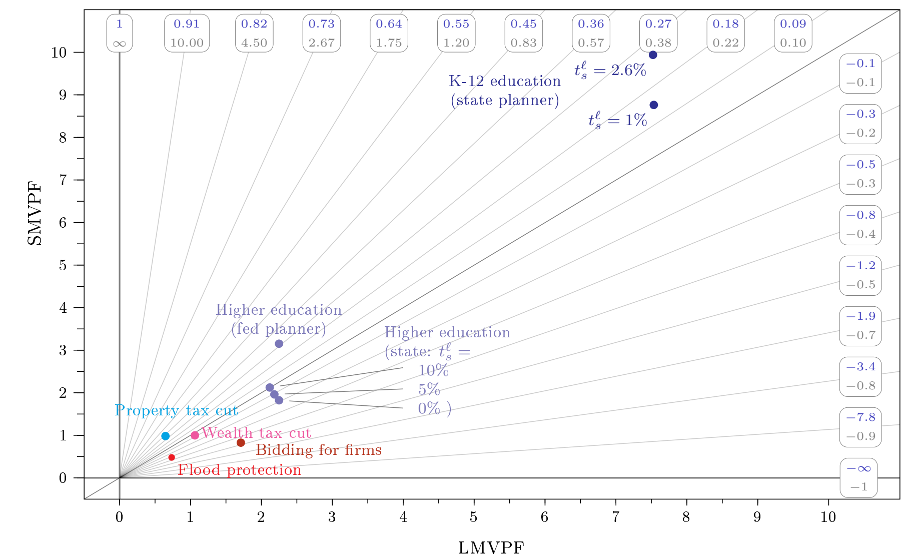
of levees should be taxed because building them is very costly relative to the gains, but also because these authors are the first to estimate the negative spillover effects on nearby neighborhoods.

6.7. A Normative Typology of Decentralized Policies

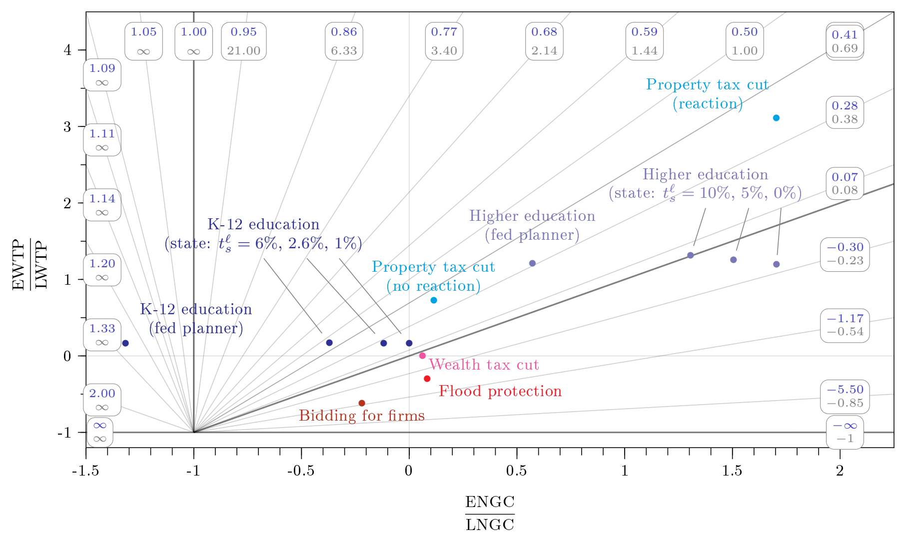
Figure 3 summarizes the levels of the local MVPF, the social MVPF and the MCT of our empirical applications. We observe that two types of policies can be distinguished.

First, the household spending policies like education expenditure, which exert significantly higher social MVPFs and which, at the federal level, require encouraging subsidies. Indeed, education increases the income and housing prices in other jurisdictions and thus brings extra tax revenues there. In line with Hendren and Sprung-Keyser (2020), our results indicate that the federal government should subsidize more K12 education (the federal government needs an infinite match rate) than higher education (each dollar of marginal spending should be matched by $2.39 in federal funds) because the former generates more beneficial interjurisdictional spillovers. But these rates exceed unity, and so any matching grant must have an infinite match rate, implying that at the margin both policies should be centralized to equate LMVPF to SMVPF. But in the absence of entirely centralizing, the higher MCT for K12 spending says that any marginal grant allocated to it, will have a bigger effect than for college education.

Second, the business or capital tax/subsidy competition policies (the bidding and wealth tax examples) that systematically require to be limited through a federal corrective contribution requested from local authorities. The basic reason is that as it cuts it tax or provides a subsidy, a local government does not account for the negative externality exerted on other localities by depriving them from their tax base.



(a) MCT with respect to the local and social MVPFs.



(b) MCT with respect to the external-to-local benefits and costs.

Figure 3. Local MVPF, social MVPF and MCT. The level curves represents the values of the MCT and the match rate (M). The property tax cut represents the case without policy reaction. Panel 3a represents the marginal corrective transfer with respect to local and social MVPFs, according to equation (20). Panel 3b represents the marginal corrective transfer with respect to the external-to-local marginal willingness to pay (net government cost) ratio. The K-12 and higher education spendings are represented for different levels of state income taxes.

6.8. The Role of State Tax Systems

The divergence of the federal and state MCT suggests that places with higher income taxes will have higher MCTs. Just as investors differ in the type of assets they hold, states and localities also differ in the extent to which they rely on income, sales, and property taxes (Seegert, 2018). In this section, we study the role of state tax institutions on the incentives to subsidize local policies, focusing on the example of K-12 education. We first focus on the state income tax rate, allowing it to change across states but holding constant sales (state and local) and property taxes. We then repeat this exercise with only the local property tax rate varying among the states. Finally, we allow all four of these taxes to vary based on each state's 2010 tax rates portfolio.[19] Income taxes are those that apply for the median high school graduate, local sales taxes are population weighted averages within the state, and property tax rates are value weighted effective tax rates within states. Wages and house prices are held constant across the states in order to focus on the role of institutions.[20]

With respect to income taxes, higher income taxes imply more state tax revenues from the earnings of individuals benefiting from more local education, raising the social MVPF. The local MVPF remains approximately constant. As a result, Appendix J shows the state MCT is monotonically increasing in the state tax rate applied over the life-cycle of high school graduates, ranging from 0.074 in states like Florida and Texas without income taxes to 0.476 in Oregon which has a tax rate of 6.25%. Matters are more complex with the property tax, as higher property taxes influence both the willingness to pay and net government costs for the locality enacting the policy and those external to it. Both the local and social MVPFs are increasing in the property tax rate. However, the MCT is negatively related to the property tax rate because the LMVPF rises faster in the rate than the SMVPF. In particular, the MCT ranges from 0.497 in Hawaii with an effective tax rate of 0.30% to -0.677 in New Jersey with an effective tax rate of 1.98%. Interestingly, if the property tax rate is sufficiently high, the MCT can become negative because house price appreciation in the locality enacting the policy spurs a larger amount of new tax revenues, raising the LMVPF above the social. Even in cases where LMVPF is less than SMVPF (states with low property tax rates), LMVPF is still larger than unity, consistent with the story in Bayer et al. (2020) indicating that education spending is inefficient.

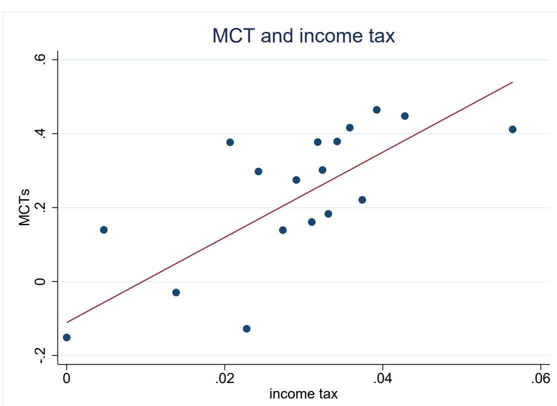
Next, we study how the entirety of the state and local tax system influences the marginal corrective transfers. To do this, we allow the state income tax rate, state sales tax rate, local sales tax rate, and local property tax rate to vary across states according to their observed patterns. Among the fifty states, Appendix J shows West Virginia has the highest MCT (0.531), while New Hampshire has the lowest (-1.031). West Virginia's low property tax rate lowers its LMVPF but its SMVPF is also higher as a greater share of revenue come from state sources, raising its MCT.

[19] State income tax rates are simulated in TAXSIM (Feenberg and Coutts, 1993), state and local sales tax rates are sources from Agrawal (2014), and local property tax rates are calculated from the Census and adjusted based on empirical estimates resulting from households over-reporting values (Twait and Haveman, 2015).

[20] Of course, property tax rates are negatively correlated with property values. As a result, given property tax rates are often chosen jointly with the tax base, we also consider specifications where house prices vary by state.

On the other hand, New Hampshire's lack of a sales tax or income tax lowers its SMVPF, but its heavy reliance on the local property tax raises its LMVPF. These two offsetting forces result in the LMVPF rising above the SMVPF. As a result, correcting the externalities in some states relies on strong subsidies ($MCT > 0$), but may involve taxes in other states ($MCT < 0$). States that are more decentralized will have higher local MVPFs, but lower state MVPFs. In other words, local policy has smaller external effects in states that are more decentralized. In Appendix J we also rank order states based on the MCT as perceived by the federal government. As the ratio of EWTP/LWTP is (approximately) constant across states, even though this federal MCT is greater than unity for most states, the ranking of states allows the federal government to prioritize which states to subsidize in the presence of scarce resources.

To demonstrate the role of state tax rates, in Figure 4 we correlate the state MCT estimated from our causal effects with the tax rates in each state. Income taxes have a clear positive effect on the MCT, while local property taxes have a negative relationship. State sales taxes have similar positive effects, while local sales taxes have no relationship due to their small component of municipal budgets. Intuitively, as education spending increases future wages, higher state sales and income taxes increases the vertical fiscal benefits to the state government. Higher local property tax rates reduce local net government costs in the jurisdiction enacting the policy. However, as property value increase in the jurisdiction enacting the policy are offset by decreases in values nearby, at the state level total property tax revenue is unaffected. Thus, the MCT rises.



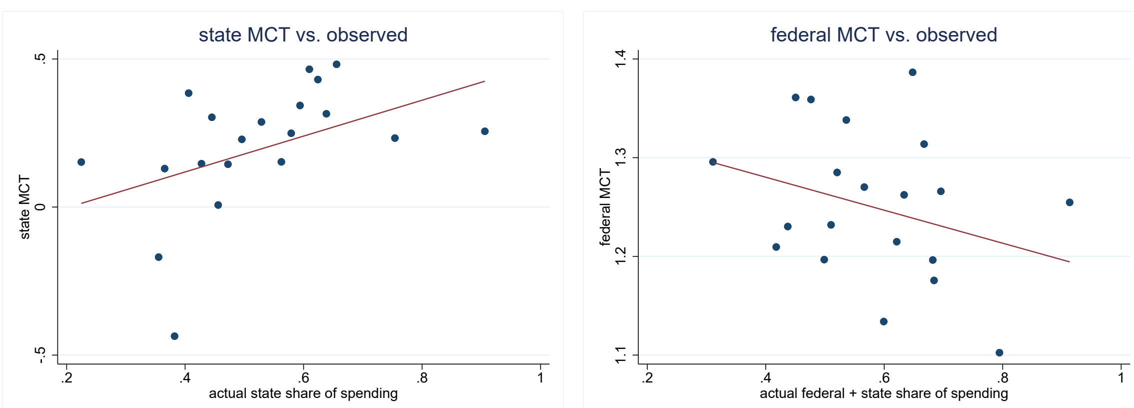
(a) State MCT and Income Taxes

(b) State MCT and Property Taxes

Figure 4. MCTs and State/Local Tax Policies
Notes: The first panel shows the correlation between the state MCT and observed state income tax rates. The second panel shows the correlation with the local property tax rate.

Finally, in Figure 5 we relate our optimal state level subsidies/taxes to the observed state share of education spending in each state. To do this, we calculate state spending as a share of state plus local spending on education using the F-33 Annual Survey of School System Finances. We then correlate this with the state level MCT. We then repeat this procedure to correlate the federal MCT, which also depends on state and local tax policies, with observed federal and state spending as a share of total spending. Our state MCTs are positively correlated with observed spending, but federal MCTs are not, in part because of the minimal role the federal government plays. This suggests that state spending on education at least partially internalizes interjurisdictional externalities, while federal spending likely serves an alternative purpose, such as achieving equity goals. The latter result is consistent with the subnational nature of education spending in the U.S.

Taken together, these results imply that local spending has a high return to the locality enacting the policy (LMVPF>1). But, unlike the prior literature, the gains to both the locality and state vary dramatically depending on the structure of the tax system and the extent of policy decentralization in the state. Although state spending appears to internalize some of these external benefits, there still remain large benefits—especially accruing outside of the state—that suggest locally determined spending does not aligned with its social valuation.



(a) State MCT vs. Actual Share

(b) Fed MCT vs. Actual Share

Figure 5. MCTs and Observed Higher Level Government Subsidies

Notes: The first panel shows the correlation between the state MCT and state spending as a share of total state plus local spending by state. The second panel shows the correlation between the federal MCT and federal plus state spending as a share of total spending, assuming the state plus federal spending are coordinated.

7. Conclusions

We quantify the interjurisdictional externalities resulting from decentralized policy determination and policy-specific federal government interventions necessary to internalize these externalities. To estimate the marginal corrective transfer, researchers need to simply calculate the transfer that equalizes marginal value of public funds for the locality enacting the policy with that of the entire federal system. This requires distinguishing the benefits and costs that are specific to the locality from those that extend beyond the locality. We develop a rigorous framework for delineating benefits and costs both internal and external to the enacting locality, including benefit-spillovers, capitalization effects, mobility, congestion, profit allocations, and fiscal competition.

Although the definition of the MCT is elegant, that is not to say that estimating all the components necessary to calculate it is easy. In particular, even in a closed economy setting, estimating the willingness to pay of a policy change can be challenging, especially for in-kind policies and policies that have effects on individuals not directly benefiting from the policy. The same is true for the local and social MVPFs we propose. For example, just like studying the effects on non-beneficiaries of policies is difficult, studying the effects on other jurisdictions is also challenging. Although not all parameters necessary to construct the MCT may be currently estimated (or convincingly estimated) in the literature, our derivations provide a way forward by making it clear to researchers what parameters are necessary or what assumptions are needed to ignore certain terms as negligible. But like the literature in environmental and urban economics, we show that market prices (housing and wages) act as sufficient statistics for the components of the MCT in a federal system. We hope that our derivations will spur a new wave of policy research that focuses on interjursidictional externalities, measurement of the spillover benefits of public services, and the price effects of policies. We provide some guidance for estimating these effects, but readily acknowledge many others—especially structural modeling—may be useful to studying cross-jurisdictional issues.

Researchers have been drawn to the use of "natural expirements" to identify causal effects. This often includes exploiting the staggered implementation of taxes or spending across states or localities (e.g., Fuest et al. 2018). Exploiting the staggered adoption of policies across states in empirical identification strategies is something that is generally only possible in federalist countries where states act as "laboratories" for policy innovation, but where administrative records are maintained centrally. Given this literature exploits subnational policy changes, which inevitably have mobility, capitalization, and spillover effects, a next step is to convert the plethora of causal effects estimated using staggered policy adoptions to determine the welfare effects of these programs both locally and nationally. Doing so will yield necessary empirical quantification of whether decentralization is "good" or "bad" at the margin. Our paper provides a comprehensive framework for this.

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