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. We delineate and quantify these external benefits and costs. Their magnitudes are measured by a new metric, the "marginal corrective transfer" (MCT), that is, the grant a 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. We develop a rigorous framework for separately distinguish the benefits and costs that are internal and external to the enacting locality. The MCT enables comparisons of local policies, allowing the federal government to prioritize policies based on the external benefits and costs. Empirically, we show that K-12 education and higher education have large federal subsidies—up to $1.4 per dollar spent locally—while race-to-the-bottom type policies such as local taxes and bidding-for-firm programs should be federally taxed. A MCT greater than one, like those found for education programs, implies that the federal government gives the local government funds in excess of the costs of the program.

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. 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 grant amount that a federal government should provide 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 policy instruments 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 requirements or restrictions on localities. 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? What are the appropriate federal government interventions and what are the appropriate levels of grants necessary to correct for these externalities? Our paper addresses these questions by providing a unifying framework for quantifying these spillovers, their welfare effects, and the levels of the corrective transfers they require for optimal policymaking.

It is well known that state and local governments[1] 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 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. 2020; Brueckner 2003).

[1] To make a sweeping generalization, as noted by Wildasin (2021), many models in economics and public finance often implicitly assume that policies "are made by a unitary [central] government, that they apply to a fixed group of households and firms, and that economic interactions with the rest of the world may safely be ignored."

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 race-to-the-bottom and Tiebout-style 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.[2] 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 separately determining the benefits and costs that are specific to the locality 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—including benefit-spillovers, price effects (capitalization), mobility, congestion, profit allocations, and fiscal competition.

Local and Social MVPFs in a Federation. To define 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 locality 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, the willingness to pay and the net cost to other jurisdictions resulting from a competitor jurisdiction changing its policy.[3] Given these external effects, we then define the "social" MVPF as the MVPF of a federal planner who accounts for all spillovers.

To 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 to indirect utility from this policy. In an open

[2] 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). Each of these approaches has struggled to analyze the welfare effects of local policy. See Appendix A for further discussion.

[3] If these spillovers are global in nature (environmental protection of air pollutants), 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.

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 five novel channels by which the government cost is affected by the policy. First, mobility of firms and people alters the fiscal bases and revenues of the jurisdiction from all taxing instruments. Second, mobility then alters wages, housing rents and business profits across jurisdictions to restore spatial equilibrium, which results in changes in tax revenue.[4] Third, because local public services can be congestible, changes in the number of residents or firms and thus the number beneficiaries from public services, changes the costs of providing these services. Fourth, the mobility of firms and changes in business inputs may alter the profitability of firms, thus affecting business profits and business tax revenue. Fifth, local policies can also change federal tax revenues and costs that will not directly benefit the jurisdiction enacting the policy, if for example, an increase in education spending results in higher future wages, and therefore, increased federal income tax revenue.

For simplicity, in our baseline model we focus on "atomistic" jurisdictions whose policies do not elicit strategic responses. We show that researchers can also easily incorporate strategic reactions to the policy reforms of other jurisdictions.

Marginal Corrective Transfer. The local MVPF of a policy differs from its social MVPF because a decentralized government ignores the spillover effects on other jurisdictions. Therefore, a natural question is the extent to which the federal government can implement a corrective fiscal policy to induce the local government to internalize interjurisdictional externalities. While the distinction between the social and local MVPF is informative in measuring these externalties, the divergence in these two terms allows us to calculate the marginal corrective transfer—the grant (positive or negative) from the federal government necessary to equalize the local MVPF with the social MVPF. When the marginal grant is normalized by the local net government cost of the policy,

[4] Among local governments, we know that mobility and sorting across jurisdiction boundaries—and thus the capitalization into wages and house prices—is nontrivial, resulting in important effects on the local MVPF.

we have 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. As a result, the MCT is comparable across policies in a way that allows the federal government to rank order policies based on the external benefits and costs and 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.

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

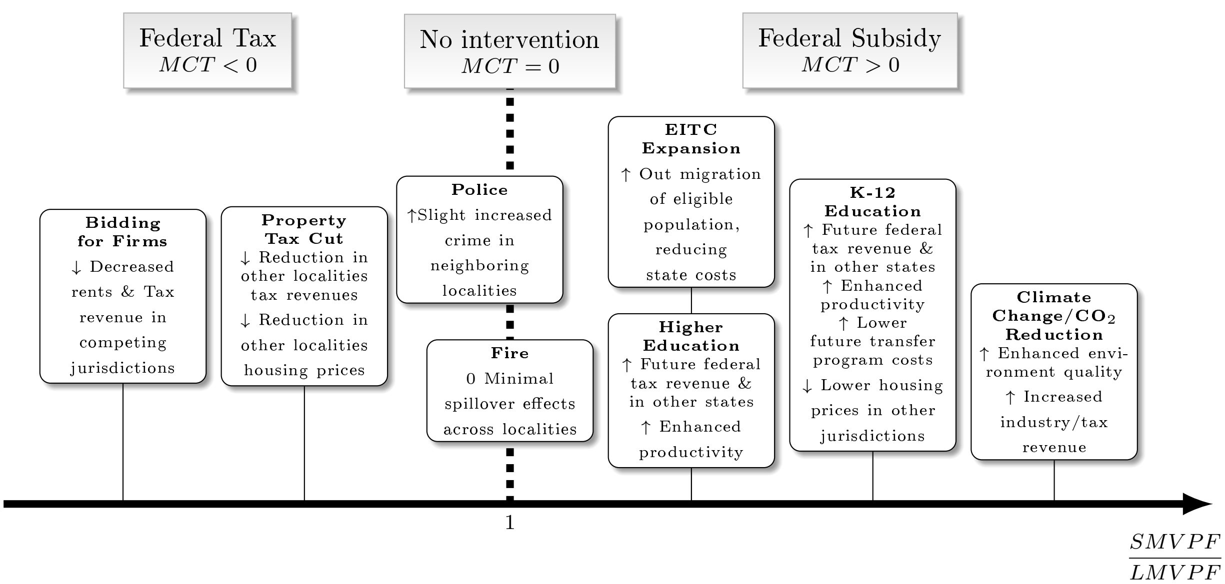

Figure 1. Likely ordering of common local policies by levels of federal marginal corrective transfer (MCT) and SMVPF/LMVPF. LMVPF: local marginal value of public funds; SMVPF: social marginal value of public funds.

An Example to Education. Consider constructing the MCT of an increase in education spending in Cambridge, MA, where, for this example, the social (federal) MVPF is capturing both the benefits and costs of residents of Cambridge as well as those of Boston and other neighboring communities, and the rest of the nation. 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. Capitalization into housing prices and wages also increases tax revenues. Mobility into Cambridge, by affecting housing prices, wages, and potentially profits there also affects the willingness to pay for more schooling. All these considerations enter the determination of the local MVPF.

However, it is not only Cambridge residents that receive benefits or bear costs from the increase in educational spending there. Migration into Cambridge means migration from Boston and other neighboring communities. Then, the resulting decreases in their tax revenues are an external cost of Cambridge's policy and decreases in their housing prices can be characterized as a negative willingness to pay. Of course, there may be positive benefits to these surrounding communities—reduced public service costs because of fewer residents along with spillover benefits that increase productivity and profits in these communities as well as Cambridge.

Should Cambridge receive a marginal corrective subsidy or a tax on its increase in educational spending? The answer depends entirely on the benefits and costs to Boston and other neighboring communities. Increased education spending in Cambridge likely reduces tax revenue in its neighboring communities. If these spillover benefits are large enough, the federal government would provide a marginal subsidy to support Cambridge policy. However, if losses in housing prices and wages from outmigration outweigh spillover benefits then the social MVPF exceeds the local MVPF. In this case, the appropriate marginal correct transfer a tax applied to Cambridge's increase in spending. If we view the economy more broadly than the surrounding communities, increases in future wages also increase federal income tax revenues. Accounting for this effect, our empirical example below will show the MCT is a large subsidy.

Empirical Applications. To illustrate these concepts and to rank various policies, we conduct four calibration exercises where we calculate the MCT. These include decentralized wealth tax cuts, subsidy competition for large firms like Amazon, K-12 education spending, and higher education. 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, the school spending literature shows that capitalization and wage incidence can, under reasonable assumptions, be used as a sufficient statistic (Chetty 2009; Kleven 2021) to estimate many of the components necessary to calculate the MCT.[5]

[5] In particular, if the mobility response to the policy is limited to the metropolitan area and the location of work is independent of residence, house price changes are sufficient to elicit the effects of the policy. If relaxing these

Here, we focus on the application to K-12 education spending. We estimate that the federal (social) MVPF of education is infinite: K-12 education programs pay for themselves. But at the local level, many of the benefits of education spending and future tax revenues are not realized by the jurisdiction funding education-spending expansions. As a result, the local planner's MVPF is only 11.85, and although greater than one, significantly lower than that of the federal planner. Taken together, we calculate a marginal corrective transfer of \$1.42. In other words, each additional dollar of education spending by a local government should be subsidized \$1.42 by the federal government. Because this is greater than unity, it means that, at the margin, the local government will receive a net amount of \$0.42 for implementing the program. In this case, the expenditure has been completely financed by the central government, and subsidized above and beyond those costs.

Conducting similar exercises, for higher education, wealth taxation, and bidding for firms, we find marginal corrective transfers of \$0.81, −\$0.06, and −\$5.50, respectively. 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.

Roadmap. The remainder of the paper is organized as follows. Section 2 introduces a spatial general equilibrium framework, similar to those in Kline and Moretti (2014), Moretti (2011) and Suárez Serrato and Zidar (2016), for deriving the MVPF and MCT. Section 3 describes the new components of our MVPF concepts. Section 4 contrasts the different concepts of MVPFs in a federation and links them to social welfare. Section 5 derives precise conditions when the MCT is a subsidy or tax. Section 6 provides empirical applications and we rank policies based on the MCT.

2. A General Framework for MVPF in a Federation

This section develops a spatial general equilibrium model to derive the MVPF in an open economy setting, highlighting household and firm mobility, which has been argued to be critical at the state and local level.[6] The framework is in line with regional models like Kline and Moretti (2014),

assumptions, then wages and house prices are both necessary. Critically, these market prices quantify the effect of decentralized policy in the context of the open economy forces motivating this paper.

[6] 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).

Suárez Serrato and Zidar (2016) and Fajgelbaum et al. (2019) in which individuals work in their place of residence, but differs from urban models in line with Ahlfeldt et al. (2015) in which individuals commute outside of the place of residence.[7] Contrary to these contributions, our model does not assume specific functional forms because the MVPF is independent of the specification of the model.

2.1. Household

The national economy consists of I jurisdictions (states or localities) indexed by $i = 1, \ldots, I$ with population n_i. Homogeneous individuals are mobile across jurisdictions in the federation that includes N households who only differ with respect to their idiosyncratic taste for jurisdiction i, denoted e_i.[8] 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 following separable utility function $U_i(x_i, \ell_i, h_i, \mathbf{g}) + e_i$ where x_i is the consumption of a freely tradeable, private numeraire good, ℓ_i is the amount of labor supplied, h_i is housing consumption, and the public good vector $\mathbf{g} \equiv (g_1, \ldots, g_I)$ imply that residents of i benefit from the public goods/services provided not only by their own jurisdiction g_i but also by the other jurisdictions g_j, $j \neq i$ (Case et al., 1993).[9] As examples of these expenditure spillovers, roads in one jurisdiction can be used by nonresidents, school expenditures can benefit other states because children move after college or because workers compete though the product market, or citizens in one state might care about poverty/inequality in other states and derive utility from those states' social assistance programs.

All jurisdictions i raise revenue from the same taxes: a commodity tax t_i^x, an income tax t_i^ℓ, a property tax t_i^h, a head tax t_i^n (alternatively, a cash transfer), and a business tax introduced in the next subsection. The commodity, income, and head taxes are considered in Hendren (2016); given our interest in local government policies, we also include a property tax which is a major source of local revenues. Initially, income taxes follow the residence principle and commodity taxes follow the destination principle but Appendix C relaxes these sourcing rules.

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7 The baseline "regional" version of our model ignores cross-jurisdiction commuting but the absence of commuting does not always fit with the context of sub-metropolitan jurisdictions like municipalities (Ly, 2018). Appendix C.3 shows that the MVPF formulas derived in the paper easily extends to the presence of commuting. It also analyses the case of non-resident labor taxes paid by commuters.

8 These idiosyncratic preferences allow households' inter-jurisdictional mobility to be imperfect, so that in the equilibrium the utility levels are not the same in all jurisdictions. This implies a divergence between a jurisdiction's welfare and the social welfare, which is key to understand how the local MVPF differs from the social MVPF. The distribution of e_i does not need to be specified to derive our general MVPF formulas but the special case of section 5 a Gumbel distribution will be used for illustration purposes.

9 Of course, one might have $\partial U_i / \partial g_j = 0$ for some jurisdiction j which are spatially far away from i.

Each individual maximizes her utility choosing her consumptions and labor supply so as to satisfy the budget constraint $(1+t_i^h)p_ih_i + (1+t_i^x)x_i = y_i + (1-t_i^\ell)w_i\ell_i - t_i^n$, where p_i is the local cost (rent or price) of housing, w_i is the local wage rate and y_i is the non-labor income that will be defined hereafter. This yields Marshallian demands and supply functions, $x_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g})$, $h_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g})$ and $\ell_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g})$, and the indirect utility function:

$$V_i + e_i = V_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}) + e_i \tag{1}$$

where $\mathbf{t}_i = \left(t_i^x,\, t_i^h, t_i^\ell,\, t_i^n\right)$, the vector of household taxes in jurisdiction i and $\mathbf{g} = (g_i, \mathbf{g}_{-i})$ is the vector of public goods provided in the economy. In the locational equilibrium, the individual will choose to live and work in the jurisdiction yielding the highest utility.

2.2. Businesses

In jurisdiction i, m_i identical firms produce the numéraire good. The production technology for the firm is denoted by the function $f_i\left(l_i, \mathbf{z}\right) + \epsilon_i$ where l_i is the labor employed by each firm, and $\mathbf{z} = (z_1, \ldots, z_I)$ denotes the vector of public investments (infrastructure, for example). The parameter ϵ_i represents a firms' idiosyncratic jurisdiction-specific added productivity.[10] The production technology for each firm exhibits positive but decreasing marginal returns with respect to labor, i.e. $\partial f_i/\partial l_i > 0$ and $\partial^2 f_i/\partial l_i^2 < 0$. Production of each firm in jurisdiction i is positively affected by public investments in both jurisdiction i, i.e. $\partial f_i/\partial z_i > 0$, and as a result of possible spillovers resulting from investment made by neighboring jurisdictions, i.e. $\partial f_i/\partial z_j \geq 0,\ j \neq i$. The net profit of a firm is:

$$(1-t_i^\pi)\pi_i + \epsilon_i = (1-t_i^\pi)[f_i(l_i, \mathbf{z}) - w_il_i] + \epsilon_i, \tag{2}$$

where t_i^π is the profit tax (or subsidy) 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 (2) taking the wage w_i and the levels of public services and taxes as given. This defines the firm labor demand $l_i(w_i, \mathbf{z})$ and the net profit function $(1-t_i^\pi)\pi_i(w_i, \mathbf{z}) + \epsilon_i$. In the locational equilibrium, the firm will choose to produce in the jurisdiction yielding the highest net profit. Unlike Hendren (2016) and Hendren and Sprung-Keyser

[10] Again, the distribution of ϵ_i does not matter to derive our general MVPF formulas, as discussed in footnote 8.

(2020) whose MVPF analysis focuses on household policies, our framework includes public business services and profit taxation because of the importance of bidding for inter-jurisdictionally mobile firms and subsidy competition for state and local governments (Black and Hoyt, 1989; Mast, 2019; Slattery, 2020; Slattery and Zidar, 2020).

2.3. Government Budgets

The government 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:

$$NGC_i = c_i(g_i, z_i, \mathbf{n}, \mathbf{m}) - n_i\big(t_i^\ell w_i \ell_i + t_i^h p_i h_i + t_i^x x_i + t_i^n\big) - m_i t_i^\pi \pi_i \tag{3}$$

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.[11] 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 jurisdiction. Critically, this general cost function allows for public services to be congestible as residents and firms move in and out of the jurisdiction. 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.

2.4. General Equilibrium

The labor and housing markets clearing conditions, in each jurisdiction i, are $n_i \ell_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}) = m_i l_i(w_i, \mathbf{z})$ and $n_i h_i(p_i, w_i, y_i, \mathbf{t}_i, \mathbf{g}) = H_i(p_i)$, 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

[11] Our general formulation gathers specifications of the public cost function in many models: those with congestible public goods and mobile residents in which $c_i = c_i^g(g_i, n_i)$ (e.g. Wilson, 1995), models with congestible public business services with mobile firms in which $c_i = c_i^z(z_i, m_i)$ (e.g. Matsumoto, 2000), and models with both which usually assume the additive form $c_i = c_i^g(g_i, n_i) + c_i^z(z_i, m_i)$. Our specification also includes the case of public goods generating spillovers as modeled in Wellisch (1996) which considers a two-jurisdiction model in which the cost function $c_i = c_i^g(g_i, n_i, n_{-i})$.

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 $m_i = \Phi^m\big((1-t_j^\pi)\pi_j(w_j, \mathbf{z})\ ;\ \forall j \in [1, I]\big)$, where the shapes of $\Phi^n(\cdot)$ and $\Phi^m(\cdot)$ depend on the distributions of the idiosyncratic terms e_i and ϵ_i.[12] The profits generated in the economy accrue to the resident as individual non-labor income:

$$y_i = \eta_i + \sum_j \left[(1-t_j^\pi)m_j\pi_j\frac{\theta_{ij}}{n_j} + \pi_i^h\frac{\theta_{ij}^h}{n_j}\right] \tag{4}$$

where η_i is a jurisdiction specific individual non-labor income, $\pi_i^h(p_i)$ the untaxed profit of the housing production sector, θ_{jk} $[\theta_{jk}^h]$ is the aggregate share of profits generated in the numeraire [housing] sector in jurisdiction k owned the by all the residents of jurisdiction j. In the case of all housing being owner occupied, the shares $\theta_{kk}^h = 1$ and $\theta_{jk}^h = 0, j \neq k$.[13] 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 and labor supply functions and the profit functions defines the general equilibrium that is the levels, in each jurisdiction i, of the wage $w_i(\mathbf{P})$, the rent $p_i(\mathbf{P})$, the population $n_i(\mathbf{P})$, the number of firms $m_i(\mathbf{P})$, the numeraire consumption $x_i(\mathbf{P})$, the housing consumption $h_i(\mathbf{P})$, the labor supply $\ell_i(\mathbf{P})$, the numeraire profit $\pi_i(\mathbf{P})$ and the housing profit $\pi_i^h(\mathbf{P})$ as a function of $\mathbf{P} \equiv (P_1, \ldots, P_I)$ which the aggregation of all jurisdictions i's policy instruments $P_i \equiv \left\{t_i^x, t_i^\ell, t_i^h, t_i^n, t_i^\pi, g_i, z_i\right\}$. Thus, inter-jurisdictional spillovers resulting from agents' mobility imply that any change in a given jurisdiction's policy instruments affects the equilibrium level of the variables and determines an MVPF not only in this jurisdiction but also (possibly) in all the other jurisdictions of the economy.

3. The Components of the MVPF

This section describes the fundamental structure of the MVPF in an open jurisdiction, highlighting the key role of mobility and the resulting capitalization. to make clear that assessing the normative impact of a policy on an open locality requires an "open-MVPF" measure, we systematically contrast

[12] The illustration of appendix D.1.2 assumes that e_i and ϵ_i are Gumbel distributed so that $\Phi^n(\cdot)$ and $\Phi^m(\cdot)$ will take form of exponential weights.

[13] Allowing for exogenous heterogeneous local profit shares, θ_{ij} and θ_{ij}^h owned by inter-jurisdictionally mobile individuals that are identical requires to implicitly assume that the firms are owned by the governments (possibly in other localities) which transfer the profits to their residents.

our formulas with those derived in a closed-economy (Hendren, 2016; Hendren and Sprung-Keyser, 2020).[14]

Specifically, consider a policy $\mathrm{d}\tau_i > 0$ consisting in a small change in the level of a policy instrument $\tau_i \in P_i$ of jurisdiction i. Following the MVPF literature, we primarily describe policies that entail direct costs to government: household tax cuts and public goods/service provision, i.e. $\mathrm{d}\tau_i \in \Delta P_i \equiv \left\{-\mathrm{d}t_i^x, -\mathrm{d}t_i^\ell, -\mathrm{d}t_i^h, -\mathrm{d}t_i^n, -\mathrm{d}t_i^\pi, \mathrm{d}g_i, \mathrm{d}z_i\right\}$.[15, 16] The MVPF of this policy conducted in i measured in any open jurisdiction j of the economy (including i itself) is:

$$MVPF^j_{\mathrm{d}\tau_i} = \frac{WTP^j_{\mathrm{d}\tau_i}}{NGC^j_{\mathrm{d}\tau_i}} \tag{5}$$

that is, the ratio of the marginal willingness to pay for the policy of jurisdiction j's residents, denoted $WTP^j_{\mathrm{d}\tau_i}$ to the marginal net government cost incurred by jurisdiction j as result of the policy, denoted $NGC^j_{\mathrm{d}\tau_i}$. The MVPF (5) measures in dollars the welfare provided to the residents of j per dollar of government spending on the policy conducted in i. As the policy is enacted in i, $MVPF^i_{\mathrm{d}\tau_i}$, $WTP^i_{\mathrm{d}\tau_i}$, and $NGC^i_{\mathrm{d}\tau_i}$, are named "*local*" MVPF, "*local*" marginal willingness to pay and "*local*" marginal net cost, respectively. The same quantities measured in another jurisdiction $j \neq i$ are qualified as "*external*" and are denoted $MVPF^{j\neq i}_{\mathrm{d}\tau_i}$, $WTP^{j\neq i}_{\mathrm{d}\tau_i}$ and $NGC^{j\neq i}_{\mathrm{d}\tau_i}$. The rest of this section describe the components of the marginal willingness to pay (section 3.1) and those of the marginal net government cost (section 3.2) in an open economy.

3.1. Local and External Marginal Willingness to Pay

The marginal willingness to pay, $WTP^j_{\mathrm{d}\tau_i}$, is a welfare measure equal to the aggregate amount of money that the n_j current residents of jurisdiction j are willing to pay for jurisdiction i to change τ_i by one unit (e.g. one dollar spent in schooling). Formally, it is defined as $WTP^j_{\mathrm{d}\tau_i} \equiv$

[14] Appendix A introduces the basic MVPF concept (Hendren and Sprung-Keyser, 2020) and discusses related welfare measures developed in previous literature.

[15] We focus on a limited set of policy instruments P_i but the MVPF formulas we derive can be easily adapted to many other local policies (e.g. custom duties and zoning policies). Moreover, many policy changes are large but the focus on marginal changes allows to apply the envelope theorem, simplify the MVPF and highlight the key additional parameters necessary when estimating the welfare effects of policies in an open economy. Hendren and Sprung-Keyser (2020) and Kleven (2021) describes the modification necessary to adapt marginal welfare measures, in particular the MVPF, to discrete policy changes.

[16] Focusing on expenditure policies is innocuous because the MVPF of a small policy change $\mathrm{d}\tau_i$ is simply the opposite of that of the opposite policy change $-\mathrm{d}\tau_i$, and interpretations are straightforward to adapt.

$(n_j/\lambda_j)\partial V_j/\partial \tau_i$, where $\lambda_j \equiv \partial V_j/\partial y_j$ is the marginal utility of income of the residents of j.[17] To derive an intuitive and empirically operational expression of $WTP^j_{\mathrm{d}\tau_i}$, notice that using the individual budget constraint, the equilibrium level of the deterministic indirect utility (1) can be written as:

$$V_j^\star = U\left(\frac{1}{1+t_j^x}\left[y_j^\star + (1-t_j^\ell)w_j^\star \ell_j^\star - (1+t_j^h)p_j^\star h_j^\star - t_j^n\right], h_j^\star, \ell_j^\star, \mathbf{g}\right) \tag{6}$$

where the "star" superscript indicates that the variable is a function of the policy vector $\mathbf{P}$ including τ_i, as defined in section 2.4. Differentiating (6) with respect to τ_i and applying the envelope theorem, we obtain the expression of the *marginal willingness to pay* of the residents of each j for $\mathrm{d}\tau_i$:

$$WTP^j_{\mathrm{d}\tau_i} = \mathrm{DE}^j_{\mathrm{d}\tau_i} + \underbrace{(1-t_j^\ell)L_j\frac{\partial w_j}{\partial \tau_i} - (1+t_j^h)H_j\frac{\partial p_j}{\partial \tau_i}}_{\mathrm{IE}^j_{\mathrm{d}\tau_i}} + \mathrm{OE}^j_{\mathrm{d}\tau_i} \qquad \tau_i \in P_i \tag{7}$$

where $L_j = n_i\ell_j$ and $H_j = n_j h_j$ denote the labor supply and the housing consumption in the jurisdiction j, respectively. Condition (7) indicates that the effect of a marginal increase in the local instrument τ_i on welfare of residents includes three sub-effects described in the subsections below: the direct effect $\mathrm{DE}^j_{\mathrm{d}\tau_i}$, the disposable income effect $\mathrm{IE}^j_{\mathrm{d}\tau_i}$ and the profit ownership effect $\mathrm{OE}^j_{\mathrm{d}\tau_i}$. The marginal willingness to pay (7) generalizes in two important respects the closed-economy MVPF formulas (Hendren, 2016). First, only the direct effect is present in closed-economy MVPFs formulas. The disposable income and ownership effects are mostly resulting from household and firm mobility. Second, and importantly, expression (7) includes inter-jurisdictional spillovers effects so that the external marginal willingness to pay $WTP^{j\neq i}_{\mathrm{d}\tau_i}$ is usually not zero, unlike in prior literature which describes a single jurisdiction economy.

3.1.1. Direct Effect

The first effect that determines the marginal WTP (7) is the *direct effect.* Its specific form 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 jurisdiction i:

[17] Expression (6) makes it clear that $\lambda_j = \frac{\partial V_j}{\partial y} = \frac{1}{1+t_j^x}\frac{\partial U_j}{\partial x_j}$, that is, one additional income unit given to the resident of jurisdiction j allows her to consume $1/(1+t_j^x)$ units of the numeraire good and thus increases her utility by $1/(1+t_j^x) \times \partial U_j/\partial x_j$ units.

$$\begin{cases} \text{DE}^{i}_{-\text{d}t^b_i} = \text{B}^b_i, \\ \text{DE}^{j \neq i}_{-\text{d}t^b_i} = 0, \end{cases} \quad (8a) \qquad \text{DE}^{j}_{-\text{d}t^\pi_i} = \theta_{ji} m_i \pi_i, \quad (8b)$$

where $b = \ell, h, x, n$ indexes each type of household tax base, and $\text{B}^\ell_i = w_i L_i$, $\text{B}^h_i = p_i H_i$, $\text{B}^x_i = n_i x_i$ and $\text{B}^n_i = n_i$ are the tax bases. And for an increase in the provision of household public goods g_i or public business services z_i:

$$\text{DE}^{j}_{\text{d}g_i} = \frac{n_j}{\lambda_j} \frac{\partial U_j}{\partial g_i}, \quad (8c) \qquad \text{DE}^{j}_{\text{d}z_i} = \sum_k \theta_{jk}(1 - t^\pi_k) m_k \frac{\partial f_k}{\partial z_i}, \quad (8d)$$

All the direct effects are, as expected, non-negative because tax cuts and public good/service provision are desirable policies. Expression (8a) indicates that the local direct effects of household tax cuts in the tax district, $\text{DE}^{i}_{-\text{d}t^b_i}$, are positive because a unit cut in any household tax increases the income of the taxpayer by the amount of her individual tax base. Noticeably, (8a) also indicates that household taxes do not induce an external direct effect on jurisdictions; this is a result of the assumption that consumption taxes are destination-based and income taxes are residence-based, so that only the residents pay the taxes.[18]

Unlike household 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) indicates that a unit cut in jurisdiction i's profit tax has a direct positive effect on the WTP residents of any jurisdiction j (including i itself) who own shares $\theta_{ji} > 0$ in the m_i firms in i: their income increases by $\theta_{ji} m_i \pi_i$. If "foreign" ownership is negligible, the external direct effect approaches zero.

Expression (8c) indicates that the local direct effect of public good provision $\text{DE}^{i}_{\text{d}g_i}$ is positive as expected. Its expression is the well-know marginal rate of substitution between the public good and the numéraire good of i's residents. This directly extends to non-residents as jurisdiction i's public good provision has a positive effect on the WTP of $j \neq i$'s residents if they directly enjoy (more or less intensely) i's public goods, i.e. $\partial U_j / \partial g_i > 0$.

Finally, (8d) indicates that the residents of jurisdiction j directly benefit from the jurisdiction i's provision of public business 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

[18] 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.

occur via two channels: cross-ownership of profits or direct spillover of public business service.[19]

3.1.2. Disposable Income Effect

The second effect on the WTP is the *disposable income effect.* It has the same form, whatever the policy $\mathrm{d}\tau_i \in \Delta P_i$, for all jurisdiction j (including i itself), but the sign and magnitude can differ across jurisdictions:

$$\mathrm{IE}^j_{\mathrm{d}\tau_i} \equiv (1 - t^\ell_j) L_j \frac{\partial w_j}{\partial \tau_i} - (1 + t^h_j) H_j \frac{\partial p_j}{\partial \tau_i}. \tag{9}$$

This effect results from the effect of price (wage and housing rent) changes on the individual disposable income $(1 - t^\ell_i) w_i \ell_i - (1 + t^h_i) p_i h_i$. 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 an indirect consequence of mobility, which explains why it is not present in closed-economy models.[20]

As expression (9) suggests, the disposable income effect is ambiguously signed. Section 5 will describe in details the different economic forces which might increase or decrease the disposable income effect. However, one can already get much intuition by considering the example of an increase in household public good provision ($\mathrm{d}\tau_i = \mathrm{d}g_i$) or a household tax cut ($\mathrm{d}\tau_i = -\mathrm{d}t^b_i$).

Consider first the effect of this policy on jurisdiction i itself. Under reasonable assumptions, the policy attracts new households to i. This exerts an upward pressure on the local housing rent which reduces the disposable income of i's residents and thus their WTP for the policy.[21] In addition, the new residents in i also work there. Suppose that this increases the local wage w_i due to the resulting from agglomeration of businesses (section 5). This positive effect on the individual disposable income offsets the negative housing rent effect. Which of these two effects dominates is an empirical question.

Under similar assumptions, the disposable income effect of i's policy on the marginal WTP of another jurisdiction $j \neq i$ is qualitatively the opposite sign: as residents migrate from j to i, the rent

[19] For example, if all profits are owned locally but public business services exert spillover effects, jurisdiction $j \neq i$ benefits from the increase in its local production generated by business public services provided in i. Alternatively, in the absence of spillover but if j owns profits in i, then, j's residents directly benefit from the output increase in i.

[20] 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.

[21] In $\mathrm{IE}^j_{\mathrm{d}\tau_i}$ increases in housing prices result in a decrease in utility. While this might seem counterintuitive for a homeowner, it is the increase in their imputed rent. The effect of an increase on owners of housing is separated and included in the ownership effect, $\mathrm{OE}^j_{\mathrm{d}\tau_i}$ – this is the increase in rents.

decreases and the wage increases in j. Because many jurisdictions might see out-flows of migrants, the magnitudes of these effects on any one external jurisdiction may be small.

3.1.3. Ownership Effect

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 $\mathrm{d}\tau_i \in \Delta P_i$, the ownership effect is:[22]

$$\mathrm{OE}^j_{\mathrm{d}\tau_i} \equiv \sum_k \left[-\theta_{jk}(1-t^\pi_k) L_k \frac{\partial w_k}{\partial \tau_i} + \theta^h_{jk} H_k \frac{\partial p_k}{\partial \tau_i} \right]. \tag{10}$$

To get intuition of how policies can affect the WTP through changes in the return to assets (profits) of residents, consider again the example of an increase in household public good provision ($\mathrm{d}\tau_i = \mathrm{d}g_i$) or a household tax cut ($\mathrm{d}\tau_i = -\mathrm{d}t^b_i$), in two specific ownership configurations. First, suppose that ownership is entirely absentee ($\forall j, k,\ \theta_{jk} = \theta^h_{jk} = 0$), that is, completely outside of the federal economy. The ownership effect is zero, because no household is benefit from profit changes in the economy. Second, suppose that all profits from the numéraire and housing sectors are locally (θ_{jk} equals 1 if $k = j$ and 0 otherwise). Then, (10) reduces to $\mathrm{OE}^j_{\mathrm{d}\tau_i} = -(1-t^\pi_j) L_k \partial w_j / \partial \tau_i + H_j \partial p_j / \partial \tau_i$. Remarkably, in the absence of taxes (i.e. $t^h_i = t^\ell_i = t^\pi_i = 0$), this effect is the exact opposite of the disposable income effect (9). Indeed, the increase in p_j due to the policy is incurred as a cost by the residents of e j as housing consumers, but it is also perceived as increase in their rental income as housing owners. Similarly, an increase in the wage is both a benefit as a worker and cost of the same magnitude as a business owner. This perfect offsetting does not occur in the presence of taxes because, as well known, they introduce an edge consumer and supplier prices.

Again, the sign of the ownership effect is an empirical question. In general, it is ambiguously signed not only because wage and rent capitalization might offset each other in a given jurisdiction (section 3.1.2), but also because cross-ownership imply that the ownership income of the residents of a jurisdiction might be affected by capitalization effects of various signs in many other jurisdictions. Finally, note that the ownership effect is also not in closed-economy models (Hendren, 2016) because they ignore capitalization effects of policies.

[22] See Appendix B.2 for a detailed derivation of the expression of the ownership effect.

3.2. Local and External Marginal Net Government Cost

The denominator of the MVPF in jurisdiction j gives the effect of a policy change $\mathrm{d}\tau_i$ on the marginal net government cost, $NGC^j_{\mathrm{d}\tau_i} \equiv \partial NGC_j / \partial \tau_i$. The equilibrium level of the net cost (3) of jurisdiction j can be written in vector form:[23]

$$NGC^\star_j = c\big(g_j, z_j, \mathbf{n}^\star, \mathbf{m}^\star\big) - n^\star_j \mathbf{t}_j \mathbf{q}^\star_j \mathbf{x}^\star_j - m^\star_j \, t^\pi_j \, \pi^\star_j. \tag{11}$$

where $\mathbf{t}'_j = (t^\ell_j \;\; t^h_j \;\; t^x_j \;\; t^n_j)$ is the household tax vector, $\mathbf{q}'_j = (w_j \;\; p_j \;\; 1 \;\; 1)$ is the price vector and $\mathbf{x}'_j = (\ell_j \;\; h_j \;\; x_j \;\; 1)$ is the consumption vector, as summarized in the notation Table A.1.[24] Differentiating (11), we obtain the local/external *marginal net government cost* in jurisdiction j resulting from a small change in the policy $\mathrm{d}\tau_i \in \Delta P_i$ of jurisdiction i:

$$NGC^j_{\mathrm{d}\tau_i} = \mathrm{ME}^j_{\mathrm{d}\tau_i} \underbrace{- n_j \mathbf{t}_j \mathbf{q}_j \frac{\partial \mathbf{x}_j}{\partial \tau_i}}_{\mathrm{BE}^j_{\mathrm{d}\tau_i}} \underbrace{- n_j \mathbf{t}_j \mathbf{x}_j \frac{\partial \mathbf{q}_j}{\partial \tau_i}}_{\mathrm{PE}^j_{\mathrm{d}\tau_i}} \underbrace{- m_j t^\pi_j \frac{\partial \pi_j}{\partial \tau_i}}_{\pi\mathrm{E}^j_{\mathrm{d}\tau_i}} + \underbrace{\left(\frac{\partial c_j}{\partial \mathbf{n}} \frac{\partial \mathbf{n}}{\partial \tau_i} - r_j \frac{\partial n_j}{\partial \tau_i} \right) + \left(\frac{\partial c_j}{\partial \mathbf{m}} \frac{\partial \mathbf{m}}{\partial \tau_i} - t^\pi_j \pi_j \frac{\partial m_j}{\partial \tau_i} \right)}_{\mathrm{LE}^j_{\mathrm{d}\tau_i}} \tag{12}$$

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 effect on the budget of a marginal increase in the tax t^b_i can be decomposed in five types of effects described in the subsections below: the mechanical effect $\mathrm{ME}^j_{\mathrm{d}\tau_i}$, the behavior effect $\mathrm{BE}^j_{\mathrm{d}\tau_i}$, the price and profit effects $\mathrm{PE}^j_{\mathrm{d}\tau_i}$ and $\pi\mathrm{E}^j_{\mathrm{d}\tau_i}$ and the locational effect $\mathrm{LE}^j_{\mathrm{d}\tau_i}$. Only the mechanical and behavioral effects are present in MVPF formulas derived in earlier literature (Hendren, 2016). The other effects can be regarded as resulting essentially from household and firm mobility.[25] In addition, (12) includes not only the local net government cost of the policy $NGC^i_{\mathrm{d}\tau_i}$ considered in closed-economy models but also the external fiscal externality on other jurisdictions absent from this earlier literature, i.e. $NGC^{j\neq i}_{\mathrm{d}\tau_i} = 0$. Due to mobility, the government cost on other jurisdictions may be affected.

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[23] Recall that the "star" superscript indicates that the equilibrium level of a variable is a function of the aggregate policy vector of the economy.

[24] $\partial \mathbf{v}/\partial y$ denotes the gradient of any vector function $\mathbf{v}$ with respect to any variable y, and $\partial f/\partial \mathbf{x}$ denotes the jacobian of any scalar function f with respect to any vector $\mathbf{x}$. For convenience, and with a slight abuse in mathematical notation, we denote for any three vectors $\mathbf{v} = (v_1 \, v_2 \, \ldots)$, $\mathbf{w} = (w_1 \, w_2 \, \ldots)$ and $\mathbf{x} = (x_1 \, x_2 \, \ldots)$ with identical length: $\mathbf{vwx} = \sum_k v_k w_k x_k$, which extends the concept of dot product to three vectors.

[25] The exception is the profit effect which, even considering immobile agents and thus exogenous prices, can be directly affected by public business services changes.

3.2.1. Mechanical Effect

The first effect that determines the marginal 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 marginal tax cut or marginal public good provision in i, the local mechanical effects on $NGC^{i}_{\mathrm{d}\tau_i}$ are:

$$\text{ME}^{i}_{-\mathrm{d}t^b_i} = \text{B}^b_i, \quad (13a) \qquad \text{ME}^{i}_{-\mathrm{d}t^\pi_i} = m_i \pi_i, \quad (13b) \qquad \text{ME}^{i}_{\mathrm{d}g_i} = \frac{\partial c_i}{\partial g_i}, \quad (13c) \qquad \text{ME}^{i}_{\mathrm{d}z_i} = \frac{\partial c_i}{\partial z_i}, \quad (13d)$$

where $b = \ell, h, x, n$ indexes the type of household tax bases and the tax bases B^b_i are as defined in (8). The mechanical effects on the external marginal deficit, $NGC^{j\neq i}_{\mathrm{d}\tau_i}$, are:

$$\text{ME}^{j\neq i}_{\mathrm{d}\tau_i} = 0. \qquad (13e)$$

The mechanical effects are the public budget counterpart of the direct effects on WTP (section 3.1.1). The local mechanical effects, $\text{ME}^{i}_{\mathrm{d}\tau_i}$, are also all positive because tax cuts and additional public service/good provision are budgetary costly, according and that an additional unit of any tax reduces the deficit by the size of the tax base. The local mechanical effects (13a) and (13c) are also present in closed-economy models (Hendren, 2016). The mechanical effects of business taxes (13b) and public business services (13d) extend their finding to firm-oriented public instruments, as prior literature focused on households.

However, even in an open economy, none of the policy instruments of jurisdiction i entail a mechanical budgetary effect on jurisdiction j, as (13e) makes clear. This reflects the obvious fact that as jurisdiction i changes its taxes or its public services provision, jurisdiction j does not incur mechanical changes in its tax revenues or budgetary costs.[26] There need to be private economic responses in j for the effect of i's policy to affect j's budget; our paper shows that these external economic responses are consequences of interjurisdictional spillovers.

[26] As a general rule, a jurisdiction i's policy does not entail mechanical effects on the net government cost of other jurisdictions. However, an exception is when other jurisdictions react to jurisdiction i's policy by changing the levels of their own policy instruments. Appendix C.5.1 and Appendix C.5 describe such external strategic mechanical effects.

3.2.2. Behavorial effect

The second effect on 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 $d\tau_i \in \Delta P_i$ implemented by jurisdiction i, the behavioral effect of jurisdiction j's marginal deficit is:[27]

$$\text{BE}^j_{d\tau_i} \equiv -n_j \mathbf{t}_j \mathbf{q}_j \frac{\partial \mathbf{x}_j}{\partial \tau_i} = -n_j \left(t^x_j \frac{\partial x_j}{\partial \tau_i} + t^h_j p_j \frac{\partial h_j}{\partial \tau_i} + t^\ell_i w_j \frac{\partial \ell_j}{\partial \tau_i} \right) \tag{14}$$

The local behavioral effect $\text{BE}^i_{d\tau_i}$ is present in closed-economy MVPF formulas (Hendren, 2016) and is also referred to as the "fiscal externality". Indeed, no mobility is required for, say, a tax to affect the consumption or labor supply choices of an individual, and thus change tax revenue.

The behavioral effects in (14) include a direct effect of the policy and any indirect effects via any general equilibrium changes in prices. With mobility, the typical case is the behavioral effect of a change in housing consumption, say in i, as jurisdiction i increases its public good provision (e.g., schooling expenditure): $t^h_i \partial h_i / \partial g_i$.[28] Estimation of the local MVPF in i requires to find estimates of the response $\partial h_i / \partial g_i$. What level and sign would a closed-economy model ignoring mobility and capitalization predict for this estimate? Probably, not much: if a school is built in a jurisdiction, will residents consume bigger or smaller houses in the absence of inter-jurisdictional mobility and exogenous housing prices? There is no straightforward answer. For example, consider a Cobb-Douglas utility function of the type $U_i = x^a_i h^b_i \ell^c_i g^d_i$ where direct effect is zero because demand is not a function of the level of public services. However, because changes in public services change housing prices, the equilibrium effect in (14) is not equal to zero. Intuitively, for the Cobb-Douglas case, the present open-economy model provides immediate intuition about this effect. Like any local amenity (Ahlfeldt et al., 2015), public good provision is likely to attract new residents resulting in positive housing price capitalization. One can therefore expect that this increase in housing rents spur the residents of i to reduce the housing consumption.

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

28 The two-jurisdiction example in section 5.1 shows that several other behavioral effects that would be particularly difficult to interpret in a closed-economy model, such as $\partial x_i / \partial g_i$, can easily be understood in an open-economy model.

3.2.3. *Price and Profit Effects*

The third type of effects of the policy on the NGC are general equilibrium effects affecting tax revenues through price and profit changes. The *price effects* on government j's NGC are:

$$\mathrm{PE}^{j}_{\mathrm{d}\tau_i} \equiv -n_j \mathbf{t}_j \mathbf{x}_j \frac{\partial \mathbf{q}_j}{\partial \tau_i} = -t^{\ell}_j L_j \frac{\partial w_j}{\partial \tau_i} - t^{h}_j H_j \frac{\partial p_j}{\partial \tau_i}, \tag{15}$$

which are the public budget counterparts of the disposable income effect on households' WTP (section 3.1.2). They result from the ad valorem nature of the taxes which implies that changes in the wage [housing rent] affect the labor [property] tax base. These effects, which are not in Hendren (2016), might be viewed as resulting essentially from household mobility, if individual housing consumption and labor supply are relatively inelastic. In the example of a public good increase in i described in section 3.1.2, a new household moves to reside and work in i, which increases both the housing price and the wage (assuming sufficiently strong agglomeration of business). Thus, government i receives additional tax revenues and its NGC decreases. These effects will be opposite in sign and different in magnitude in jurisdiction j.

The *profit effect* on government j's NGC is:[29]

$$\pi\mathrm{E}^{j}_{\mathrm{d}\tau_i} = -m_j t^{\pi}_j \frac{\partial \pi_j}{\partial \tau_i} = t^{\pi}_j L_j \frac{\partial w_j}{\partial \tau_i} - t^{\pi}_j m_j \frac{\partial f_j}{\partial \tau_i}. \tag{16}$$

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 entails a strong positive wage capitalization reduces the profit tax revenues. An exception is the case of public business 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 if it levies a profit tax.

If the profit and the labor tax rates are equal, wage changes have no effect on the NGC because the wage effect in (15) and the profit effect (16) cancel out each other: in case of a wage increase, the extra income tax revenues collected from workers are lost due to cut in profit tax revenues. However, in practice, it is likely that the price effect dominates the profit effect, as business tax

[29] The second equality in (16) uses the envelop theorem. See (A.3) in Appendix B.2 for more details about the derivation.

rates are generally significantly lower than income tax rates. Moreover, here we have assumed profit taxes follow the source principle, so one-hundred percent the profit increase in a jurisdiction accrues to that jurisdiction. However, profits are allocated according to formula apportionment (Suárez Serrato and Zidar, 2018), then this term would be scaled by the share of profits taxable in that jurisdiction according to the formula.

3.2.4. Locational Effect

The last effect on the NGC is the *locational effect* which aggregates a household and a firm locational effects:[30]

$$\mathrm{LE}^{j}_{\mathrm{d}\tau_i} \equiv \left(\frac{\partial c_j}{\partial \mathbf{n}}\frac{\partial \mathbf{n}}{\partial \tau_i} - r_j \frac{\partial n_j}{\partial \tau_i}\right) + \left(\frac{\partial c_i}{\partial \mathbf{m}}\frac{\partial \mathbf{m}}{\partial \tau_i} - t^{\pi}_j \pi_j \frac{\partial m_j}{\partial \tau_i}\right) \tag{17}$$

The household locational effect (first term in parentheses in (17)) 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. For example, a small lump transfer in i, $\mathrm{d}\tau_i = -\mathrm{d}t^n_i > 0$ in a two-jurisdiction economy is likely to entail a flow of resident from j to i. Focusing on the effect on i's budget, (17) indicates that, first, this policy increases the cost of public good provision by $(\partial c_i/\partial n_i)\partial n_i/\partial \tau_i > 0$ due to the new residents. These new residents may have been benefiting from i's public good (spillovers) when they were living in j. Subtract this opportunity cost, it follows that the net marginal congestion cost of the policy is $(\partial c_j/\partial \mathbf{n})\partial \mathbf{n}/\partial \tau_i = (\partial c_i/\partial n_i - \partial c_i/\partial n_j)\partial n_i/\partial \tau_i > 0$ which is likely positive because households typically consume a wider range of public services as residents than as nonresidents. As each new residents pays $r_i > 0$ dollars of taxation to jurisdiction i, the total household locational effect on i's NGC is $(\partial c_i/\partial n_i - \partial c_i/\partial n_j - r_i)\partial n_i/\partial \tau_i$ which might be positive or negative depending on the relative levels of the taxes and congestion costs. The interpretation of the external effect on $j \neq i$ is similar. The interpretation of the firm locational effect (second term in parentheses in (17)) is similar to that of the household locational effect, except that congestion costs and tax revenues are generated firms' mobility.

[30] By definition (footnote 24), $\frac{\partial c_j}{\partial \mathbf{n}}\frac{\partial \mathbf{n}}{\partial \tau_i} = \sum_k \frac{\partial c_j}{\partial n_k}\frac{\partial n_k}{\partial \tau_i}$ and $\frac{\partial c_i}{\partial \mathbf{m}}\frac{\partial \mathbf{m}}{\partial \tau_i} = \sum_k \frac{\partial c_j}{\partial n_k}\frac{\partial n_k}{\partial \tau_i}$.

4. Calculating The Marginal Corrective Transfer

This section reports the explicit formulas of the MVPF that can be calculated in a federation featuring spillovers and mobility. Section 4.1 reports the expressions of local and external MVPFs facing a given single jurisdiction. Section 4.2 defines the expressions the social MVPF facing a federal planner. Appendix E.1.5 discusses the some economic relationships of various effects. Appendix B.3 proves and discusses how to convert the open-economy MVPFs into welfare measures.

4.1. Local and External MVPFs

We next proceed by deriving the expressions for the local and external MVPFs for a small policy change by a single jurisdiction i. In a decentralized federation, this will result in I total MVPFs for each locality in the economy. Inserting the expressions of the marginal willingness to pay (7) and that of the marginal deficit (12) into the definition (5) of the MVPF in jurisdiction j, we obtain:

$$MVPF^j_{\mathrm{d}\tau_i} = \frac{\mathrm{DE}^j_{\mathrm{d}\tau_i} + \mathrm{IE}^j_{\mathrm{d}\tau_i} + \mathrm{OE}^j_{\mathrm{d}\tau_i}}{\mathrm{ME}^j_{\mathrm{d}\tau_i} + \mathrm{BE}^j_{\mathrm{d}\tau_i} + \mathrm{PE}^j_{\mathrm{d}\tau_i} + \pi\mathrm{E}^j_{\mathrm{d}\tau_i} + \mathrm{LE}^j_{\mathrm{d}\tau_i}}, \tag{18}$$

where the notation is as introduced earlier and summarized in the notation Table A.1. Expression (18) actually defines two different types of MVPFs depending on whether we are interested on the effect of the policy on i on itself (the local MVPF) or on another jurisdiction j (the external MVPF). Notice that for many policy instruments, the direct and mechanical effect have different forms on oneself versus external jurisdictions, and for this reason we do not substitute those terms. Given the complexity of the ownership effect, we do not make that substitution. Finally, for many of the other effects, although the functional form is the same in all jurisdictions, recall from the discussion above that the signs or magnitudes may be different depending on whether considering the local or external MVPF.

First, $MVPF^i_{\mathrm{d}\tau_i}$ is the "local" MVPF that government i would compute to assess the welfare impact of its policy from its own perspective. As government i cares only about the well being of its residents and the cost to its budget, it will not internalize any of the spillover or mobility effects on other jurisdictions. In the case where households and firms are immobile and wages and housing rents are constant, the local MVPF (18) becomes that in Hendren (2016):[31]

$$MVPF^{ci}_{\mathrm{d}\tau_i} = \frac{\mathrm{DE}^i_{\mathrm{d}\tau_i}}{\mathrm{ME}^i_{\mathrm{d}\tau_i} - n_i \mathbf{t}_i \mathbf{q}_i \dfrac{\partial \mathbf{x}_i}{\partial \tau_i},} \tag{19}$$

A basic comparison of (18) and (19) highlights that the open-economy MVPF has a similar form to the closed-economy MVPF derived in prior literature, but that it includes additional terms — due to mobility and spillovers and the capitalization they induce — which are likely to alter empirical MVPF estimates. In subsequent sections we discuss the potential biases of omitting these terms.

Second, $MVPF^{j\neq i}_i$ is the "external" MVPF in jurisdiction j, ignored by government i when measuring the welfare effect of its policy. In general, the external MVPF need not be zero as assumed in prior literature focusing on a single or national jurisdiction. Indeed, policies like public service provision to households and firms [profit taxation] entail direct benefits [costs] for nonresidents. Moreover, most policies conducted in one jurisdiction are likely to alter the number of residents and firms in surrounding jurisdictions. While these external spillovers might have limited use for local policymaking in i in its own right, as will become clear, they will be critical for a federal planner who internalizes spillovers and interjurisdictional fiscal externalities. These spillovers have been shown to be empirically important (Etzel et al., 2021).

4.2. Social MVPF

Because we consider a multiple jurisdiction framework, the MVPF of a local government will not internalize interjurisdictional externalities, while a federal planner will account for these spillovers. Given decentralized policymaking, one may want to know the MVPF accounting for effects on the own jurisdiction and on other localities. Therefore, one may be interested in considering the overall effect of policy changes on the entire federal economy and then comparing this to the decentralized planner's local MVPF. The federal planner's social welfare function is a weighted sum of utilities over all states in the federation given by $\sum_i \psi_i n_i V_i$ where ψ_i are positive social weights with unitary mean, i.e. $\sum_i \psi_i / I = 1$. The aggregate deficit of the federation is $\sum_j NGC_j$. We define the federal

[31] In the particular case of the head tax discussed at length in Finkelstein and Hendren (2020), (18) becomes $MVPF^{ci}_{t^n_i} = 1/(1 + FE^i_i)$ where $FE^i_i = \mathbf{t}_i \mathbf{q}_i \partial \mathbf{x}_i / \partial t^n_i$. That is, the MVPF is one over the mechanical effect plus the behavioral effect – or one over one plus the fiscal externality.

planner's MVPF, or "social" MVPF, as:[32]

$$SMVPF_{\mathrm{d}\tau_i} \equiv \frac{\sum_j WTP^j_{\mathrm{d}\tau_i}}{\sum_j NGC^j_{\mathrm{d}\tau_i}}, \tag{20}$$

which measures how much an individual of the economy is willing to pay for each dollar spent by the by the public sector as a result of the policy. Expression (20) makes clear that if jurisdictions are symmetrically affected by the policy, the social MVPF (20) is equal to the local MVPF (18). Moreover, the social MVPF is defined as the separate aggregation of the numerators [denominators] of all local MVPFs. The social MVPF is not the aggregation or average of all local MVPFs, but rather is the separate aggregation of the willingness to pay and the cost on the government budget. Intuitively, this is because the planner cares about the weighted sum of willingness to pay and the net cost to the government separately, just like a local planner.

4.3. Marginal Corrective Transfer

Significant divergences might exist between the local and social MVPFs of local policies. These divergences raise normative concerns, because they imply that policy decisions made by a local government based on its own (local) MVPFs could dramatically differ from decisions made by the society grounded on social MVPF measures that internalize the spillovers of local policies. The local MVPF of a policy differs from its social MVPF because it ignores the spillover effects on other jurisdictions. Therefore, in line with Pigou (2017), a natural question is the extent to which the central government can implement a corrective fiscal instrument to spur the local government to internalize the interjurisdictional externalities induced by its policies, thus making local and social MVPFs coincide. The goal of this section is to define the level of this instrument.

We call this instrument the *marginal corrective transfer* (MCT) which is the amount of dollars the central government is ready to provide to the local government for each dollar spent by these local authorities. The MCT can be positive that is a subsidy supporting the local policy or it can be negative in which case it is a tax aiming to limit local policies. Importantly, the level of the MCT can be compared across policies so it can be regarded as a guide to allocate national public funds so as to help local policies internalizing interjurisdictional spillover effects.

[32] Following Hendren and Sprung-Keyser (2020), we define the (social) MVPF as a pure monetary measure so that its definition does not include the social weights. However, these weights become key for converting the social MVPF into social welfare units, as will be seen in equation (A.9) below.

Computing the MCT is remarkably simple. Consider a policy conducted by local government i consisting in a small change $\mathrm{d}\tau_i$ in the level of the policy instrument τ_i. Suppose that the central government provides a (matching) grant $S_i(\tau_i)$ to government i that depends on the level of τ_i.[33] Thus, jurisdiction i's net government cost is $NGC_i - S_i(\tau_i)$ where NGC_i is as defined in (3), so that jurisdiction i's local MVPF is $WTP^i_{\mathrm{d}\tau_i}/(NGC^i_{\mathrm{d}\tau_i} - S^i_{\mathrm{d}\tau_i})$ where $S^i_{\mathrm{d}\tau_i} = \partial S_i/\partial \tau_i$ is the marginal grant, $WTP^i_{\mathrm{d}\tau_i}$ is as defined in (7) and $NGC^i_{\mathrm{d}\tau_i}$ is as defined in (12). By construction, the matching grant $S_i(\tau_i)$ is chosen by the central government to correct government i's valuation of its policy to account for interjurisdictional spillovers. Formally, the $S_i(\tau_i)$ is chosen to equate the local MVPF of i including the marginal grant to the social MVPF without marginal grant, $SMVPF_{\mathrm{d}\tau_i} = SWTP_{\mathrm{d}\tau_i}/SNGC_{\mathrm{d}\tau_i}$. The socially desirable level of the marginal grant $S^i_{\mathrm{d}\tau_i}$ is characterized by:

$$\frac{WTP^i_{\mathrm{d}\tau_i}}{NGC^i_{\mathrm{d}\tau_i} - S^i_{\mathrm{d}\tau_i}} = \frac{SWTP_{\mathrm{d}\tau_i}}{SNGC_{\mathrm{d}\tau_i}} \tag{21}$$

Alternatively, we can re-express (21) as

$$\frac{S^i_{\mathrm{d}\tau_i}}{NGC^i_{\mathrm{d}\tau_i}} = 1 - \frac{LMVPF_{\mathrm{d}\tau_i}}{SMVPF_{\mathrm{d}\tau_i}} \tag{22}$$

where, for $NGC^i_{\mathrm{d}\tau_i} > 0$, the relationship between the sign of the transfer and the ratio of the local and social MVPF's is apparent – when $LMVPF_{\mathrm{d}\tau_i}$ is less than [greater than] $SMVPF_{\mathrm{d}\tau_i}$ we have $S_{\mathrm{d}\tau_i} >$ [<] 0. As is also apparent, the greater the difference between $LMVPF_{\mathrm{d}\tau_i}$ and $SMVPF_{\mathrm{d}\tau_i}$, the greater the subsidy (tax) as a share of $NGC^i_{\mathrm{d}\tau_i}$ providing a ranking of policies based the divergence (ratio) of local and social MVPF. Finally, to operationalize the marginal corrective transfer, MCT, and to facilitate comparisons across policies using it we rescale the marginal subsidy $S_{\mathrm{d}\tau_i}$ with respect to the mechanical cost $ME_{\mathrm{d}\tau_i}$ to give:

$$MCT_{\mathrm{d}\tau_i} = \frac{S^i_{\mathrm{d}\tau_i}}{\mathrm{ME}_{\mathrm{d}\tau_i}} = \frac{NGC^i_{\mathrm{d}\tau_i}}{\mathrm{ME}_{\mathrm{d}\tau_i}} \left(1 - \frac{LMVPF_{\mathrm{d}\tau_i}}{SMVPF_{\mathrm{d}\tau_i}}\right), \tag{23}$$

which makes clear how easy it is to recover the MCT when the researcher has already estimated the components local and social MVPFs. For example, if $WTP^i_{\mathrm{d}\tau_i} = NGC^i_{\mathrm{d}\tau_i} = SNGC_{\mathrm{d}\tau_i} = 1$, and $\mathrm{ME}^i_{\tau_i} = SWTP_{\mathrm{d}\tau_i} = 2$, then $S^i_{\mathrm{d}\tau_i} = 0.5$ from (21) and $MCT_{\mathrm{d}\tau_i} = 0.25$ from (23) which means that

[33] In line with the standard pigovian approach, the subsidy $S_i(\tau_i)$ is assumed to be financed by the central government via a nondistortive instrument which does not affect private agents' behavior.

for each marginal dollar government i mechanically spends on this policy, the central government is ready to provide a grant of \$0.25.[34] In other words, government i's policy exerts positive externalities on other jurisdictions that the central government values at \$0.25 per marginal dollar.

There is a strong link between the sign of the MCT and the levels of the local and social MVPFs described in the following proposition (see Appendix F.5 for the proof):

Proposition 1. *Consider a local policy consisting of a marginal spending (e.g. public good/service provision or tax cut). Assume that the local marginal willingness to pay for this policy is positive. Then, if the social MVPF of this policy is higher [lower] than its local MVPF, the marginal corrective transfer associated to this policy is positive [negative].*

Intuitively, this proposition states that if the local government's MVPF ignores mainly positive spillover effects on other jurisdictions, the central government is ready to pay dollars to encourage the local initiative. On the opposite, if the local government ignores mainly negative spillovers, then the optimal pigovian correction is a matching tax that aims at discouraging the local initiative.

5. MVPF comparisons in a Two-Jurisdiction Model

In the fully fexible model introduced in section 2, the responses to policy changes —and thus the signs of the effects in the MVPF (18)— are by nature ambiguous and depend on the specification (e.g. different utility, housing supply, and production functions) and the calibration of the model.

To gain intuition into how the MVPF applies in a federation and how local and social MVPFs differ, in this section, the economy described in section 2 is simplified as follows. The economy includes only two jurisdictions. The individuals' labor supply and housing demand are inelastic and equal to one, so that rent and wage variations only result from household and firm mobility. Housing and firm profits accrue to absentee owners, so that the non-labor income is exogenous, which eliminates the ownership and profit effects from the MVPF formulas. Finally, the only imposed specification is on the individuals' and firms' jurisdiction-specific preferences e_i and productivity ϵ_i that are assumed to follow Gumbel distributions.

These assumptions allow to compare the closed-economy, local and social MVPFs of a variety of policies. In line with the MVPF literature, we focus on policies that entail net costs to government:

[34] If the central government actually provides the subsidy to the local government, the marginal mechanical cost for the local government decreases from \$2 to \$1.75, but the marginal mechanical cost for the society as a whole increases from \$2 to \$2.25. That is, as expected, correcting the valuation of the local government entails a cost for the society.

tax cuts and public good/services provision. Section 5.1 deals with the MVPFs of household policies and section 5.2 focuses on business policies. Appendix D formally derives the results summarized in this section.

5.1. Household Policies

To focus on the MVPFs of household policies, we ignore profit taxation and public business services; this eliminate the profit effect from the MVPF formulas. To compare the levels of the closed-economy, open-economy, and social MVPFs, we first derive general equilibrium comparative statics result which allow us to sign and provide intuition into the key effects in the MVPFs (18). These comparative statics will provide useful intuition to discuss how researchers must account for open economy concerns when estimating the MVPF of policies at the local level.

Consider a small cut in any of the household taxes of the model or a small increase in public good provision in jurisdiction i. In a stable general equilibrium, this policy attracts new residents/workers and firms from j to i. The new residents generate a demand pressure on the housing market of i so that the rent increases there; on the opposite, the rent decreases in j. The policy can either increase or decrease the wage in either jurisdiction depending on the magnitudes of the local labor demand shocks and local labor supply shocks. Specifically, as workers and firms relocate to i, the wage increases [decreases] in i if the positive labor demand shock is larger [smaller] than the positive labor supply shock. Similarly, if the negative demand shock in j dominates the negative supply shock, the wage decreases in j; otherwise, it increases. Finally, as private consumption is the difference between the wage (which increases or decreases) and the rent (which increases), its response to the policy is also ambiguous in either jurisdiction.

These comparative statics indicate that comparison of the local, closed-economy and social MVPFs requires us to identify states of the economy in which the spillover effects induced by household mobility unambiguously improve or deter both the marginal willingness to pay and the net government revenue. Appendix D.1 identifies several such states of the economy, which allow to unambiguously compare the MVPFs and that can be summarized as follows.

Two opposite states allow to unambiguously compare the local closed-economy MVPF which ignores mobility and the local open-economy MVPF. The first is characterized by *locally beneficial mobility responses* to the policy, which means that the policy induces, in the jurisdiction that conducts the policy, a significant wage increase and a relatively low congestion cost. In this case, the disposable income effect on the local WTP is positive and the price and locational effect on the local

NGC are negative because the jurisdiction benefit from additional net tax revenues as attracting marginal residents. It follows that ignoring mobility leads to unambiguously underestimates benefits to the jurisdiction conducting the policy, so that the closed MVPF understates the local MVPF. On the opposite, in the case of *locally costly mobility responses*, i.e. small wage increase (or decrease) and relatively high congestion costs, the closed MVPF overstates the local MVPF.

Two similar opposite states allow to unambiguously compare the local and social MVPFs. First, if household and firms mobility responses to the policy are said *externally beneficial* —i.e. the policy induces, in the jurisdiction that does not conduct the policy, a significant wage increase and a relatively low congestion cost— then, the local MVPF ignores benefits to non-residents and thus understates the social MVPF. On the opposite, in case of agents' mobility responses are *externally costly* so that they entail a small wage increase (or decrease) and relatively high congestion costs in the other jurisdiction, the local MVPF overstates the local MVPF. An exception to this last statement occurs if direct public good spillovers are sufficiently important, that is, non-residents consume a significant amount of public goods provided in the other jurisdiction. In this case, even if mobility responses are externally costly, the local MVPF of a public good provision understates the related social MVPFs.

5.2. Business Policies

A common theme in the local tax competition literature is that jurisdictions "bid" for firms by offering subsidy deals that consist of either business-tax breaks or the provision of added public business services by the locality. Thus, this section compares the levels of the local and social MVPFs with respect to a small increase in the public business service z_i or a small cut in the profit tax t_i^π of jurisdiction i.[35] In order to focus on business policies, we assume that households are immobile so that, each jurisdiction's housing stock and housing rent are exogenous, because individuals' housing demand is inelastic. Moreover, for simplicity, firms are assumed to be perfectly mobile across jurisdictions, because imperfect mobility does not alter the following results. Appendix D.2.4 proves the following results. First, for profit tax cut or an increase in public business services exerting relatively low spillover effects, the local MVPF overstates the social MVPF. Second, for an increase in public business services exerting relatively high spillover effects, the local MVPF understates the social MVPF. This highlights an asymmetric outcome of two types of business incentives (tax

[35] Unlike MVPFs of household policies, studies of MVPFs of business policies are scarce in the literature, so that it not of significant interest to contrast closed-economy and open-economy MVPFs like in the previous section.

reduction and public service provision) in an open economy with important public service spillover effects. When cutting its business tax rate, a jurisdiction essentially ignores the cost imposed on other jurisdictions which lose firms: the social MVPF is overstated by the local MVPF. However, when providing public services which entail important spillover effects, a jurisdiction mainly ignore social spillover benefits to other jurisdictions: the social MVPF is understated by the local MVPF.

6. Empirical Applications

In this section, we 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 and social MVPFs of various policies: wealth tax cuts, bidding for firms, higher education spending and K-12 spending. We use the parametric bootstrap to construct confidence intervals on the estimates.

6.1. Decentralized Wealth Taxation and Fraudulent Relocations

6.1.1. Institutional Context

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. While some regions took not action, some regions also raised marginal tax rates by a small amount. Only the region of Madrid 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. We use these estimates plus summary statistics from their administrative data on wealth and income taxes.

To evaluate the closed, local (Madrid's), and social MVPF we consider treatment as Madrid's deviation to zero from the centralized default schedule. To construct this MVPF 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) and follow Hendren and Sprung-Keyser (2020) using a 3% discount rate. Acknowledging our model does not have a wealth tax, its MVPF would be similar to other household taxes.

6.1.2. Local MVPF

Letting the subeffects be denoted in Euros per initial wealth tax resident of Madrid, let us construct the local MVPF for the region of Madrid yields.

LWTP. The willingness to pay for the wealth tax decreases is equal to the taxes saved by Madrid adopting the zero tax rate instead of the default tax schedule. Using the wealth tax simulator from Agrawal et al. (2021), we determine the tax liabilities of each pre-reform resident of Madrid who was eligible to pay wealth taxes. Calculating this in each year and aggregating the discounted values over five years, the local marginal WTP is €47,457 per resident (direct effect $\text{DE}^i_{\text{d}\tau_i}$).

LNGC. Given Madrid's tax rate is zero, the mechanical effect $\text{ME}^i_{\text{d}\tau_i}$ is also €47,457. The lower wealth tax rate results in savings behavioral response that increase taxable wealth via capital accumulation. However, because the wealth tax rate is zero, the added wealth tax base does not increase wealth tax revenues. Nor does it affect labor income taxes, as most wealth tax filers are rentiers. But the expansion of capital potentially translates into capital income tax revenues. To calculate the behavioral effect, we use the estimate (5.910, se: 0.813) of the elasticity of taxable wealth from Jakobsen et al. (2020). We then calculate the amount of capital income taxes in the data due to expansion of capital in Madrid, assuming capital gains on that added wealth are realized proportionally over time. Because the elasticity of taxable wealth is relatively small and most capital gains are not realized, this results in €1,154 of added capital income tax revenue per resident (behavioral effect $\text{BE}^i_{\text{d}\tau_i}$).

The household locational effect has revenue consequences. Because the wealth tax rate is zero, movers to Madrid contribute no wealth tax revenue. But, because labor and capital income taxes are also sourced to the same region, Madrid realizes a tax revenue gain. To calculate the magnitude of the effect we use the causal estimates that show the cumulative increase in Madrid's stock of high-wealth individuals increased 1.5% one year later, 3.2%, 6.4%, 7.9% and 8.5% by five years later. Then, using these causal effects and the baseline number of residents in Madrid prior to decentralization, we calculate the cumulative amount of new residents in Madrid each year. To obtain the added amount of capital and labor income tax revenue, we multiply this number by the average income taxes of movers to Madrid.[36] This yields €1,611 more revenue per initial resident

[36] Ideally, one would want to use the average taxes paid by individuals who move for tax reasons, however, this is unobservable. We assume individuals who move to Madrid for any reason are similar to individuals who move

(locational effect $\text{LE}^i_{\mathrm{d}\tau_i}$).

LMVPF. This yields a MVPF of $\text{DE}^i_{\mathrm{d}\tau_i}/(\text{ME}^i_{\mathrm{d}\tau_i}+\text{BE}^i_{\mathrm{d}\tau_i}+\text{LE}^i_{\mathrm{d}\tau_i}) = 1.062\ [1.042, 1.083]$, represented in Figure 2. That is, for each euro spent by Madrid's government cutting its wealth tax, Madrid's residents are willing to pay €1.062. The local MVPF of Madrid exceeds the closed economy MVPF that ignores the household locational effect. This is because the mobile tax base spurs added tax revenue for Madrid from other tax instruments. This confirms the general result stated in section 5: as mobility is locally beneficial, for a tax cut, the closed-economy MVPF understates the local MVPF. Finally, in the calculation above, several components of the general MVPF formula (18) are absent; Appendix F.1 provide arguments.

6.1.3. Social MVPF and MCT

The social MVPF is obtained by summing the Madrid WTP and net cost to the government of Madrid with the aggregate of each of these external effects.

SWTP. As there is no capitalization effect (Appendix F.1), the social marginal WTP reduces to the local marginal WTP which reduces to the local direct effect $\text{DE}^i_{\mathrm{d}\tau_i}$ of €$47,457$.

SNGC. The component of the social marginal NGC is the local marginal NGC, €$47,457$. The second component is the external household locational effect $\sum_{j\neq i}\text{LE}^j_{\mathrm{d}\tau_i}$ equal to €$2,767$. Other regions of Spain lose wealth tax revenue, labor income tax revenue and capital income tax revenue. To obtain these, we use the causal estimates of the movers, and use a wealth tax simulator to calculate what their liabilities would have been had they stayed in their home region and faced that region's wealth tax simulator. Taking the average counterfactual taxes paid by a mover to Madrid, which assumes tax-induced moves to Madrid are proportional to all moves to Madrid,[37] we aggregate over the five years, to find a discounted loss of €1,124 in wealth tax revenue. In other words, even though movement to Madrid increases its tax base by 8.5%, the decrease to the rest of Spain is much smaller because Madrid is only a small fraction of all of Spain. In addition, the other regions use personal income tax revenues from labor and capital. As the capital tax schedule in all regions is the same, this is simply the causal estimate of the number of movers times the average capital taxes paid by movers to Madrid. The same is true for labor income taxes, but labor income tax rates differ across regions, so we adjust these upward by the average differential, though this differential is quite small for a rentier with limited labor income. This yields personal income

to Madrid for tax reasons.

[37] Given regional tax differentials among other regions is small, this is reasonable.

tax losses of €1,642. As is clear, income taxes are mainly a transfer between the rest of Spain and Madrid and so this cancels the household locational effect in Madrid's fiscal net cost. The loss in wealth tax revenue to the rest of Spain is, by coincidence, similar to the behavior effect gain in Madrid.

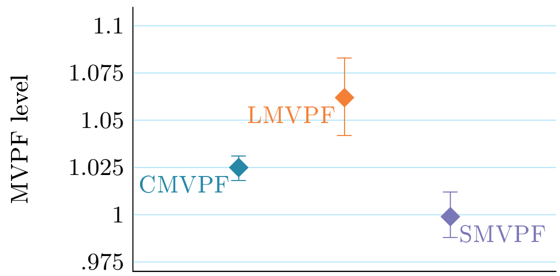


Figure 2. Wealth tax cut in Madrid: Closed-economy local MVPF, open-economy local MVPF and social MVPF.

SMVPF. This entails a social MVPF of $\text{DE}^i_{\text{d}\tau_i}/(\text{ME}^i_{\text{d}\tau_i} + \text{BE}^i_{\text{d}\tau_i} + \text{LE}^i_{\text{d}\tau_i} + \sum_{j\neq i} \text{LE}^j_{\text{d}\tau_i}) = 0.999$ $[.988, 1.012]$, represented in Figure 2. For the above reasons, especially with respect to the government budgets, the social MVPF is very close to 1, the closed economy MVPF. Critically, for our purposes, the SMVP is significantly lower than the local MVPF of Madrid, highlighting the importance of interjurisdictional policy spillovers for welfare analysis.

MCT. The marginal corrective transfer is $(SNGC/\text{ME}^i_{\text{d}\tau_i}) \times (1 - LMVPF/SMVPF) = -0.06$ that is, for each euro spent by Madrid in cutting by its wealth tax, the national government is willing to impose a tax of €0.06 to the government of Madrid. This small corrective tax would allow Madrid to correctly internalize the small negative fiscal externality induced on other municipalities when valuating its wealth tax cut.

6.2. Bidding for Firms

6.2.1. Institutional Context

The practice of states and local governments to "bid for firms," that is, to provide subsidies, tax concessions, worker training, and public services to attract large employers is an example of how local and social MVPF may differ for a policy, in this case, the bid (subsidy) for a firm. Generally, these efforts by state and local governments — in most cases the bids involve both levels of government — are an effort to increase employment and earnings in the locality in which the firm may locate its new plant. For our discussion here, we focus on states and their policies.

In this section, we consider a bid — in the form of firm-specific subsidies — by the state of Tennessee (TN) 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 based on its local MVPF and the social MVPF? 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 (AL). 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). A purpose of this section is to highlight the difference in the social and local MVPF, but also to demonstrate to researchers how estimating all of the individual components of the MVPF can be simplified extensively using the auction structure.

Much of the literature on bidding for firms has focused on the competition between the winning "bidder," the state in which the firm decides to locate and the runner-up state (Slattery, 2020; Slattery and Zidar, 2020; Greenstone et al., 2010). External impacts of where a firm chooses to locate are not necessarily limited to the locality that it did not choose to locate, that is, the runner-up. However, the runner-up is presumably the alternative location, if the winning state did not bid. Hence, to determine the MVPF's for a bid by the winning state, we need to know the opportunity cost of that bid if the firm located in the runner-up state. We assume that ownership of the firm is distributed among all the states, so that the share in any one state (winner or runner-up) is negligible.

6.2.2. Local MVPF

LWTP. Slattery (2020) and Slattery and Zidar (2020) estimate the value of the plant v_i to state $i = \text{TN}, \text{AL}$, as this states provides a subsidy b_i. In MVPF terms, $LWTP_{b_i} = v_i$ is the willingness to pay of state i for attracting Volkswagen as state i provides a subsidy of b_i. The valuation of the Volkswagen plant, i.e. the local WTP, is \$227 millions to Tennessee (Appendix F.2). This state's valuation of the plant certainly reflect benefits (willingness to pay) to current residents – increased employment, earnings, and appreciation in housing values. Moreover, because the state has a negligible share of ownership of the firm, the direct effect—the extra profits equal to the value of the bid— accrues to the firm's owners not the state's residents. Thus, the local WTP includes a direct effect and a disposable income effect, i.e. $v_i = \text{DE}^i_{b_i} + \text{IE}^i_{b_i}$.

LNGC. The net cost of state i to attract Volkswagen is its bid, b_i, that is the mechanical effect, $\text{ME}^i_{b_i}$ plus the fiscal externality, $\text{FE}_i = \text{BE}^i_{b_i} + \text{PE}^i_{b_i} + \pi\text{E}^i_{b_i} + \text{LE}^i_{b_i}$, including behavioral, price and profit, and locational effects. Tennessee's realized bid is a mechanical cost $\text{ME}^{\text{TN}}_{b_{\text{TN}}}$ of \$558 millions. To obtain the fiscal externality, in line with Slattery (2020), we take two approaches detailed Appendix F.2.

The first approach utilizes *ex ante* available information from impact studies which traditionally assume that all created jobs are new (additional) jobs and that each promised job has a multiplier effect on employment. We then estimate sales tax revenue and personal income tax revenue from those created jobs. Thus, Tennessee benefits from a fiscal externality FE_{TN} of \$57 millions and its local NGC is 501 millions dollar. Thus, Tennessee benefits from a fiscal externality FE_{TN} of \$1,583 millions and its local NGC is $558 - 1,583 = -1,025$ millions dollar, so that bidding pays for itself.

The second approach utilizes *ex post* information from causal estimates of winning the plant on economic outcomes. Under the causal estimates approach, we use the difference-in-differences estimate of the new jobs created by VW from Slattery and Zidar (2020): 3854 new jobs. In addition, these authors show that for the full sample of all bids they consider, that the overall employment levels of the winning jurisdictions do *not* increase. The implication is that added jobs in the transportation equipment manufacturing sector are offset in other sectors, without any noticeable multiplier effects. Then, the added sales and income tax revenue is only based on the difference in wages in VW's sector and average wages under this approach. Thus, Tennessee benefits from a fiscal externality FE_{TN} of \$57 millions and its local NGC is 501 millions dollar.

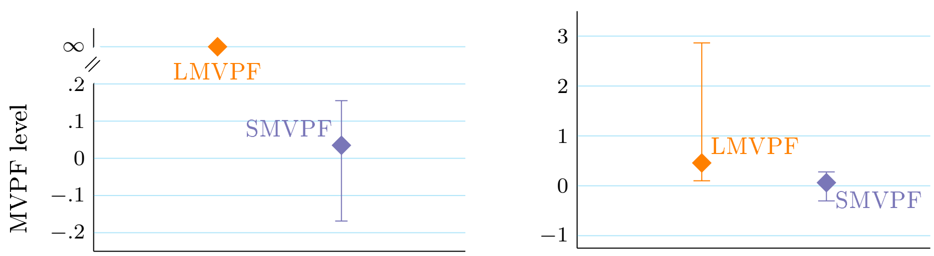
LMVPF. Then, the local MVPF from an ex ante (impact study) perspective is infinite (literally, it is $227/(-1,025) = -0.22$, and the local MVPF from an ex post (causal effect) perspective is $227/501 = 0.458$ $[0.101, 2.864]$. These local MVPF estimates are represented in Figure 3. In the impact studies, Volkswagen promised 2000 new jobs The impact study estimates imply the added tax revenue more than pays for the bid, resulting in an infinite MVPF. This results from the fact that the 2000 new jobs promised by Volkswagen are assumed to generate many additional jobs due to a jobs multiplier for the sector of 14.28. This is consistent with politicians using these impact studies to justify bidding for the plant. The causal estimates suggest a different story. On average, the overall increase in jobs in winning counties is negligible, so that the fiscal externality is calculated based on the wage increase for each job.

6.2.3. Social MVPF and MCT

To obtain the social MVPF of Tennessee winning the bidding competition for Volkswagen, we need to determine the external benefit/cost. Given that if Tennessee does not bid, then Volkswagen would locate in the runner-up state (Alabama), the social planner sees any benefit [cost] of Alabama attracting the Volkswagen as an opportunity cost [benefit] (see Appendix F.2 for more details).

SWTP. The social WTP for a bidding competition won by Tennessee is $v_{\text{TN}} - v_{\text{AL}}$ that is, the difference between Tennessee's valuation of attracting Volkswagen ($227 millions) and Alabama's one ($210 millions). Thus, the social WTP is $17 millions.

SNGC. The social NGC of a bidding competition won by Tennessee is $b_{\text{TN}} + FE_{\text{TN}} - (b_{\text{AL}} + FE_{\text{AL}})$ that is, the difference between Tennessee's NGC (-$\$1,025$ millions ex ante and $501 ex post) and Alabama's NGC. Alabama's bid is of $386 millions. Its fiscal externality which includes Alabama's sales and income tax revenue, is of $\$1,890$ millions ex ante and $156 millions ex post.



(a) Impact estimates. **(b)** Causal estimates.

Figure 3. Impact and causal estimates of the local and social MVPFs of Tennessee bidding and attracting Volkswagen.

SMVPF. Thus, the social MVPF of Tennessee winning the bidding competition for Volkswagen is $17/479 = 0.035$ $[-0.169, 0.155]$ ex ante and $17/271 = 0.063$ $[-0.303, 0.278]$ ex post, as represented in Figure 3 which summarizes the above results. Both social MVPFs make a striking point: compared to both local MVPFs, the social MVPFs are close to zero. While the local MVPF using impact study estimates suggest the bid pays for itself, the social planner views the bid highly unfavorably. The intuition is simple: the local planner believes the fiscal externality accrues to Tennessee with no cost elsewhere, but the social planner sees the revenue gain of Tennessee as simply a transfer of revenue that would have accrued to the runner up (e.g., "stealing" from Alabama). This combined with the fact that the valuation of the plant in both states is similar,[38] implies a social planner

[38] Even though the valuation in each state must be positive, the difference in the valuation may be negative, and

would not support the bid, even though a local planner would view the bid as highly cost-effective ex ante. Ex post, the social and local are closer, but still the state of Tennessee's MVPF is much larger than the social. These results confirms Proposition 3 which established theoretically that for a tax cut (or provision of public business services) the local MVPF overstates the social MVPF.

MCT. The marginal corrective transfer is $-(1025/558) \times (1 + 0.22/0.035) = -13.3$ ex ante, and it is $(501/558) \times (1 - 0.45/0.063) = -5.59$ ex post. Like in the wealth tax example (section 6.1), 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. The marginal corrective taxes are high: the federal government is willing to tax Tennessee at least 5.59 dollars for each dollar spent by Tennessee bidding. This is due to the substantial divergence between the local and social MVPFs: the federal government needs to impose a large tax for Tennessee's high valuation to become zero.

6.3. Higher Education Scholarship Programs

6.3.1. Institutional Context

In this section, we consider community college districts in Texas. Community colleges in Texas are financed partially by property taxes. 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 that is equal to 349.5.

But changes in the local provision of community colleges change household location decisions. Household mobility then imposes externalities on the housing markets and budgets of neighboring jurisdictions in the MSA. As other areas become relatively more attractive, the community college expansions possibly result in a divergence of local and social MVPFs. Simon (2021) estimates the general equilibrium spillover effects we need to know to calculate our local and social MVPFs. While a literature estimating capitalization traditionally studies effects of a policy on the jurisdiction enacting it, Simon uses a structural model to obtain the spillover effects. In addition to price externalities, after attending college, graduates do not necessarily stay in the local area, meaning

thus the confidence intervals on the social MVPF can include zero.

that the benefits of higher wages may accrue to the areas that they move to. We adjust the MVPF for these moves using estimates from Conzelmann et al. (2021).

To derive the local MVPF, we focus on the Austin Community College, segmenting the Austin metropolitan area into areas within the community college taxing district, areas that are annexed into the taxing district, areas in the MSA that remain outside the district, and the rest of the U.S. We define the annexed areas as our "local" region. In this way, the local MVPF reflects the returns to these municipalities from deciding to join the district.[39] The external effects then include the existing areas and other areas of Texas not annexed into the district. In terms of the reform we study, the Austin C.C. 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. Our MVPF thus considers the existing areas as those in the C.C. district in 2015 and the annexed areas are those that he identifies as necessary to annex to optimize the size of the district. Figure A.9 shows the geography of the policy experiment. Our calculations of the MVPFs are based on several conceptual assumptions detailed in Appendix F.3.

6.3.2. Local MVPF

First, we present the local MVPF where "local" is defined as annexed areas. In order to present consistent numbers, we first calculate the total WTP or cost to government, rather than a value per beneficiary. Then we scale all values to be per households in the *metropolitan area*, which implies that the actual gains or losses per household or beneficiaries in the annexed areas are substantially larger.[40]

LWTP. The WTP is the direct benefit of the program —the earning gains for marginal individuals ($116.06) plus the value of the change in tuition for infra marginal individuals ($12.72)— net of any increase in rental prices for renters ($10.74). Thus, the local marginal WTP is $118.05.

LNGC. The net government cost is the mechanical costs due to increased education attainment ($18.39) plus the direct cost to inframarginal individuals ($12.72) net of the fiscal externality. The fiscal externality is the increase in sales tax revenue from higher earnings (adjusted to account for the share of college graduates that stay in Austin) ($0.09) plus increases in property tax revenue for owner-occupied and rental property values ($7.04). Thus, the local marginal NGC is $23.98.

[39] Alternatively, one might consider the existing areas in the taxing district as the "local" areas, in which case the interpretation would then become the MVPF of admitting new areas into the taxing district.

[40] As all numbers in the numerator and denominator are scaled by the same factor, this does not affect the MVPF.

LMVPF. It follows that the local MVPF is 4.92, as represented in Figure 4. The individual components of the local MVPF are not directly comparable to those in Hendren and Sprung-Keyser (2020) because the magnitude of the commuting college savings is different in the Austin district. But, as this scales many elements of the numerator and denominator proportionally, we can cautiously compare the MVPFs. The local MVPF is substantially smaller because the WTP is offset due to higher rental prices in the area and the net cost to the government is substantially larger. The latter effect is a result of excluding federal tax revenues, Texas not having an income tax, and changes in property tax revenues from capitalization not bringing in enough tax revenue to fund the direct cost of the program.

6.3.3. Social MVPF and MCT (MSA)

There are many possible ‘social” concepts. Let us first consider an urban planner who cares about the entirety of the urban area. Here, the assumption of absentee landowners is critical as rent increases accruing to them are windfall gains not accounted for by the social planner. Moreover, the urban planner does not care about tax revenues accruing to the state or federal governments. The external effects for other places in the metro area are the effect on existing areas in the taxing district and other areas in the MSA. As Simon (2021) estimates price effects separately, we present these as two distinct concepts, but the total external effect is the separate summation of the numerator and denominator of both.

SWTP. The external willingness to pay is simply the gain to renters from lower rental prices in these areas, assuming that there are no expenditure spillover benefits,so that owner-occupied price changed need not be included. Again, scaling all numbers to be per household in the metro area, this induces a marginal WTP of \$8.309 in the taxing district and a marginal WTP of \$0.52 in the other areas. The WTP in non-treated areas of the MSA is positive: rents fall in these areas as they become relatively less attractive. Noticeably, this fall is substantially smaller in other outlaying areas of the MSA suggesting those residents that move from the annexed areas would have preferred to living in core existing areas. In sum, the social marginal WTP is of $118.05 + 8.309 + 0.52 = 126.879$ dollars.

SNGC. The net cost is the loss in property tax revenues from lower prices on housing in the area. As house prices in these areas fall, property tax revenues decrease, imposing a net cost to the government. This entails a marginal NGC of \$4.01 in the taxing district and a marginal NGC of \$0.88 in the other areas. In sum, the social marginal NGC is of $23.98 + 4.01 + 0.59 = 28.58$ dollars.

SMVPF and MCT. It follows that the social MVPF is 4.43 which is represented in Figure 4.

The marginal corrective transfer is $\$-0.08$ which is a tax, as the social MVPF is slightly smaller than the local MVPF. The reason is that house price appreciation or depreciation in neighboring areas is small relative to the direct benefit of the program. The same is true in terms of changes in property tax revenues. Although the WTP increases, so too does the denominator relative to the LMVPF. But, the social MVPF falls because the change in the numerator is only from renters, while the change in property tax revenues accrues from owners and renters, thus amounting to a larger percentage of the direct cost than the direct benefit.

MCT.

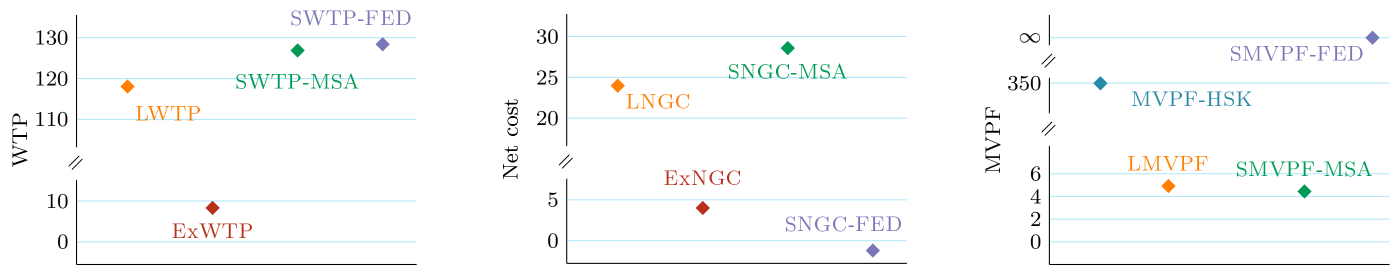
6.3.4. Social MVPF and MCT (FED)

An alternative social concept would be that considered by a federal government planner, which accounts for benefits and costs to individuals outside of the metro area.

SWTP. We have assumed that all rental properties are owned by absentee landlords outside of the metro area, so any rent increases that are losses to renters are valued by external landowners. As a result, if all properties are domestically owned and absent income taxes, the rent changes in the MSA are entirely offset by opposite signed effects to landlords. Federal taxes on rental property income (\$1.53) imply that this cancellation is not complete. The social marginal WTP is $126.879 + 1.53 = 128.409$ dollars.

SNGC. First, federal income tax revenues increase by the federal tax rate on the added earnings from attending community college (\$25.30). Second, we use estimates from Conzelmann et al. (2021) to also calculate the added state income tax revenue for the share of graduates moving out of state (\$1.07). Third, we similarly calculate changes in Texas state sales tax revenue and other state sales tax revenue from the share of movers leaving the state (\$3.05). Fourth, as landlords must declare rental income as personal income, assuming that the costs of renting do not change, federal income tax revenues change by the rental price change time the marginal tax rate (\$0.38). Subtracting these components from the social marginal NGC of the MSA yields a social marginal NGC of $28.58 - (25.30 + 1.07 + 3.05 + 0.38) = -1.21$ dollars for the federation. Thus, the policy pays for itself, mainly because the tax revenues collected by the federal government exceed those collected locally.

SMVPF. As the policy pays for itself, the social MVPF is infinite (literally, it is equal to -105.31), as represented in Figure 4 which summarizes all the above results. Unlike for the MSA, taking the view of the federal government, the marginal corrective transfer is a subsidy of \$0.81 per dollar spent locally. The federal government is willing to pay for students to benefit from local cuts in tuition fees because their higher earnings will generate federal income tax revenues not accounted for by the localities.



(a) Marginal willingness to pay. **(b)** Net cost to government. **(c)** MVPF.

Figure 4. MVPFs, higher education scholarship programs.

6.4. K-12 Education Spending

6.4.1. Institutional Context

Next, we plan to take off-the shelf estimates of the effects of local K-12 school spending. There's a large literature on the sorting effects, house price effects, and long-run effects on kids (e.g., Jackson et al. 2016). Thus, we hope our paper will be a nice way to think about summarizing the results in that large literature and to highlight the resulting divergence of local and social MVPFs. We will combine with with recent evidence on sorting and capitalization (Bayer et al., 2020). See Appendix F.4 for a discussion of the main findings and challenges of this this literature.

The theoretical framework used to derive the MVPF formulas is detailed in Appendix F.4. To operationalize these measures we consider, following Jackson et al. (2016), a 1 dollar increase, in perpetuity, in educational spending. We begin with using Bayer et al. (2020) estimate of 0.943 for the (constant) elasticity of the price of housing with respect to educational spending (spending/pupil). As we are interested in the change in price of housing (rent) from an increase in $1 in educational spending which is given by $\widehat{p}_i = .943(1/e)$, where e is educational spending (e).[41]

We present our estimates of MVPF an annual measure for a single household. To do so, requires that we convert house value to an equivalent annual rent. We do so using Poterba (1992).[42]

[41] From Jackson et al. (2016) we use $4,800 as mean educational spending per student for 1990 in $2000. For the value of owner-occupied housing in 1990 we use three alternatives: the median value of $81,200, again, in $2000; the 25%, $137,800, and the 75%, $200,681. We also consider the effect of educational spending on rental propermity. In 1990 median (monthly) rent was $1016 in $2000, the 25% was $684, and the 75% is $983.

[42] Other parameters for which we need values are children per household (0.49 from 1990 Census), a property tax

6.4.2. Local MVPF

First, we present the local MVPF of an increase in education spending by municipality i with a population market share of its metropolitan area given by n_i. In addition, we consider the case where all rental properties are locally owned or where all rental properties are owned by absentee landlords; although these may sound extreme, recall that 2/3 of households are owner-occupiers so that a large share of property is locally owned even in the absentee case. For purposes of the equations in the text, we will focus on a medium size city with $n_i = 0.20$ and absentee ownership, although we will present figures showing these for arbitrary values. To present consistent numbers, we normalize everything to be on annual basis per household in the jurisdiction, which is a slightly different approach than the prior section do to data availability.

LWTP. The local WTP is simply the revealed valuation of how \$1 in education spending translates into house prices changes. Because we do not estimate the benefit directly and rely on capitalization as a sufficient statistic, we use the price change of renters and owners, with the latter converted to rental dollars. The increase in rental prices received by owners, i.e. the ownership effect $\text{OE}^i_{\mathrm{d}\tau_i}$, is of \$3.51. While renters with children in school receive the direct benefits of increased educational quality, with the capitalization of this increased quality they also pay higher rents. Then with absentee landlords, we adjust the willingness to pay downward reflecting the higher rents paid by renters (\$0.45) that is, the disposable income effect $\text{IE}^i_{\mathrm{d}\tau_i}$. Thus, the local marginal WTP is $3.51 - 0.45 = 3.06$ dollars.

LNGC. The net cost to the local government is simply the cost per household of spending \$1 on each child (a mechanical cost $\text{ME}^i_{\mathrm{d}\tau_i}$ of \$0.49) net of the fiscal externality, which is the change in property tax revenue due to housing price changes (a price effect $\text{PE}^i_{\mathrm{d}\tau_i}$ of \$0.23). Thus, the local marginal NGC is $0.49 - 0.23 = 0.26$ dollar.

LMVPF. This yields a local MVPF of 11.85 $[6.14, 22.30]$, as represented in Figure 5. Recall Hendren and Sprung-Keyser (2020) finds an infinite MVPF. The individual components of the local MVPF is are directly comparable to those in Hendren and Sprung-Keyser (2020) because their willingness to pay is based on the valuation of the wage gains, while ours is based on a market price. But, we see that our local WTP is substantially smaller, perhaps because people perceive the benefits or because of imperfections in the housing market. Moreover, our cost to the government

rate of (0.025) from Poterba (1992) and the assessment to market ratio we use an 52.5%, the midpoint of Twait (2011) survey of assessment ratios.

is larger because we exclude federal income tax revenue on the wage gains.

6.4.3. Social MVPF and MCT (MSA)

The external effects are calculated as the effect on other jurisdictions in the metro area (or commuting zone). We first consider a centralized urban planner for the social MVPF. In this view of the world, assuming equal dollar value to each region.

SWTP. The marginal WTP in non-treated areas of the MSA is positive because rents fall in these areas as they become relatively less attractive. The social marginal WTP is the sum of the local marginal WTP ($3.06) and the rental capitalization times the share of absentee owners ($0.45). Thus, SWTP is $3.51.

SNGC. The social marginal NGC is the sum of the local marginal NGC ($0.26) and the cut in property tax revenue as a result of housing price cuts (a price effect $\text{PE}^{j}_{\mathrm{d}\tau_i}$ of $-\$0.23$). That is, SNGC is $0.49.

SMVPF and MCT. Again, expressed per household yields a social MVPF for the MSA of 7.17 $[4.81, 9.52]$, as represented in Figure 5. In line with the higher education example (section 6.3), at the MSA level, a marginal corrective tax of $0.34 per dollar spent locally is needed, because the social MVPF is slightly smaller than the local MVPF. The primary explanation for the lower social MVPF is due to the fact that the lower net cost to the government arising from increased property tax revenues in the district enacting the policy cancel with decreased property tax revenues in the rest of the district (see Appendix F.4 for more details). This cancellation of price effects also explains why the social NGC simply equals the mechanical cost, and also why the $SWTP$ is only the direct effect of an increase in education as given by (A.104) – the lower benefits from the increase in spending to renters from increases in rents there are entirely offset by increases in benefits to renters elsewhere in the MSA from lower rents there.

6.4.4. Social MVPF and MCT (FED)

Finally, we consider an alternative social concept that would be that considered by a federal government planner, which accounts for benefits and costs to individuals outside of the metro area.

SWTP. In terms of the willingness to pay, we need to adjust for the change in the after-tax rental income of landlords, which partially cancels the rent price changes of residents. The rental income increase of landlords (and thus their federal tax payment changes) is zero. In the case of symmetric values of homes across the jurisdiction enacting the policy and other towns in the MSA, the rent gains in one are exactly offset by the rent losses in the other. The federal MVPF is larger than the local because of the fiscal externality imposed on the federal budget. It follows that the social marginal WTP of the federal government is equal to the social marginal MVPF for the MSA that is, \$3.51.

SNGC. In terms of government revenues, we account for the added income tax revenue resulting from higher wages that students realize later in life. Here we use the causal estimates from Jackson et al. (2016). Moreover, as landlords must declare rental income as personal income, federal income tax revenues change by the rental price change time the marginal tax rate. The sum of these two sources of tax revenue is \$0.99. Because we assume a closed metro area, we do not include any mobility of graduates outside the MSA, so the locational effect $\sum_{j \neq i} \mathrm{LE}^{j}_{\mathrm{d}\tau_i}$ is zero. Recalling that the social marginal NGC for the MSA is \$0.49 yields a social marginal NGC of the federal of $0.49 - 0.99 = -0.50$ dollar, so that the policy pays for itself.

SMVPF and MCT. As the policy pays for itself, the social MVPF is infinite (literally, it is equal to -3.55 $[-39.684, -2.593]$), as represented in Figure 5 which summarizes all of the results above. Again, in line with the higher education example (section 6.3), the federal government is ready to provide a marginal corrective subsidy of \$1.55 per dollar spent locally. The prior analysis shows that, under reasonable assumptions (mobility in response to the policy is limited to a metropolitan area; location of work is independent of residence), researchers can calculate both the social and local MVPF by relying extensively on house price capitalization. The first of these assumptions implies that the metropolitan area is closed and the second implies the wage in the region will be unaffected by local policies. One may wish to relax these by relying on an open city model. Then, in this case, changes in wages need to be considered as well, as in a standard Rosen (1974)-Roback (1982) model. Appendix F.4 extends the analysis in this section to cases of nonsymmetric valuations by the jurisdiction; it also investigates different degrees of market power of the jurisdictions; and it discusses how these findings are related to those in Bayer et al. (2020).

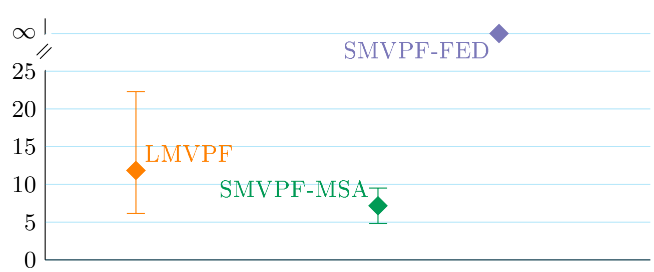


Figure 5. MVPFs, K12 education spending.

6.5. A Normative Typology of Decentralized Policies

Sections 6.1 to 6.4 show that significant divergences might exist between the local and social MVPFs of local policies. These divergences raise normative concerns, because they imply that policy decisions made by a local government based on its own (local) MVPFs could dramatically differ from decisions made by the society grounded on social MVPF measures that internalize the spillovers of local policies. The goal of this section is to develop a typology of local policies according to the magnitude and direction of the bias between their local and social MVPFs.

Suppose that the local government is considering marginally changing the level of its spending policy. This is this policy change that the central government aims at redirect through the MCT. Under reasonable assumptions, it is possible to infer from the level of the local MVPF the direction of the policy change the local government is willing to make. Similarly, the level of the social MVPF gives determines the socially desirable direction of the local policy change. As the following proposition states, these inferences can be made by comparing the levels of these MVPFs to one (see Appendix F.5 for the proof):

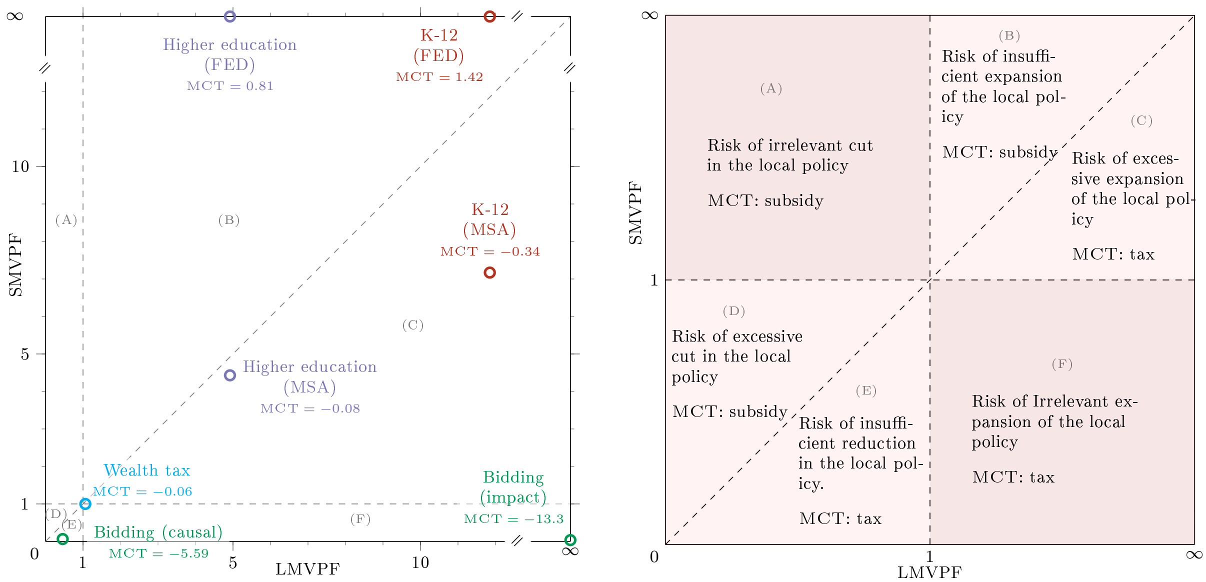
Proposition 2. *Consider a local policy consisting of a marginal spending financed through a local lump-sum tax. Assume that the local marginal willingness to pay for this policy is positive. Then:*

1. *If a utilitarian local government chooses the level of this policy optimally, the local MVPF is one. However, if the local MVPF is lower [higher] than one this local government wants to marginally expand [contract] this policy.*

2. *The same is true for a utilitarian social government comparing the social MVPF to one.*

The intuition behind this proposition is straightforward if the marginal willingness to pay for a policy is larger than its marginal net government cost (i.e. MVPF>1), then there are benefits to increase the level of this policy.[43] The opposite reasoning applies if the marginal WTP is lower than the marginal NGC. Propositions 1 to 2 allow to describe local policies depending on the levels of their local and social MVPFs, as represented in Figure 6.

[43] This case includes the case where both marginal WTP and marginal NGC are positive, MVPF$\rightarrow \infty$.



(a) Local MVPFs, social MVPF and MCT.

(b) Risks of decentralized spending policies and central corrections.

Figure 6. Local and social MVPFs of empirical applications. "MSA" ["FED"]: the SMVPF is estimated at the MSA [federal] level. "Causal" ["Impact"]: the LMVPF and SMVPF are estimated using causal [impact] estimates. Impact estimates assume the existence of strong multiplicative effects of the policy (section 6.2).

Figure 6b describes for each value of estimated of the local and social MVPF of a decentralized policy, the conclusions that can be drawn from a social viewpoint. For example, for policies located in rectangle (A), the local MVPF critically understates the social MVPF. Indeed, according to proposition 2, as the local MVPF is lower than one, the local government is willing to cut marginally its spending policy, although from a social viewpoint, the policy should be expanded because the SMVPF exceeds one. The role of the MCT, a subsidy (we are located above the 45 degree line), is precisely to encourage the local government to spend more. The five other parts of Figure 6b are interpreted in a similar way.

Figure 6a summarizes the levels of the local MVPF, the social MVPF and the MCT of the empirical applications of sections 6.1 to 6.4. We observe that two types of policies can be distinguished. First, the 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 (MCT<0). 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. Second, the education spending policies, which exert significantly higher social MVPFs and which, at the federal level, require encouraging subsidies (MCT>0). Indeed, education increases the income and housing prices in other jurisdictions and thus brings extra tax revenues there. Noticeably, in line with Hendren and Sprung-Keyser (2020), our results indicate that the federal government should subsidize more K12 education ($1.42 for each dollar spent by the local government) than higher education (only $0.81 per dollar spent locally) because the former generates more beneficial (interjurisdictional) spillovers.

7. Conclusion

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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