Government Market Power and Public Goods Provision in a Federation

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Abstract

In standard models of fiscal federalism, tax competition among subnational jurisdictions depresses government expenditures. Centralization therefore increases government spending, assuming that both local and central governments are price takers in the market for public goods. If the central government has greater market power than constituent jurisdictions, then centralization may be associated with reduced government spending. Whether centralization or decentralization provides more public goods depends on the relative strengths of tax competition and market power. In an illustrative example, decentralized public goods spending can range from 25 percent to 120 percent of centralized spending.

Keywords: fiscal federalism, public goods, market power, tax competition.

JEL Codes: D43, H23, H41, H77

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1 Introduction

Federalism, the division of responsibilities between multiple levels of government, is an important feature of modern economies. For example, citizens of the United States or the European Union receive public services from at least three levels of government; the U.S. alone comprises one central government, fifty states, and thousands of local governments. The diverse possibilities for the provision of public goods and services has been a wellspring of questions for public economists. Decentralization and centralization exhibit multiple distinct features, each with a potentially different implication for public goods provision.

In his seminal book, Oates (1972) noted that a key disadvantage of centralization is the uniform nature of central policy, while some possible downsides of decentralization might consist of externalities or increased costs of decision making. Subsequently, papers by Besley and Coate (2003) and Lockwood (2002) emphasized political economy frictions as important sources of suboptimality for central policy makers. In these papers, the central government is constrained by political forces, whether they involve an aversion to heterogeneous policy or the power of a majority vote.

This paper analyzes the provision of public goods when the distinguishing feature of the central government is economic rather than political. Specifically, I consider a setting in which the central government exercises market power when purchasing inputs for public goods, allowing the central government influence over prices on the inputs market. A salient example of such a scenario might occur in the hiring of educators; if teachers are less elastic with respect to Michigan's demand than to Ann Arbor's demand, then provision of education at the state level will involve more market power on the part of the buyer. Market power on the part of the central government dampens its incentives to provide the public good, because in decreasing provision it can lower the price it pays for every unit. I contrast a central government "monopsonist" with provision by decentralized tax competitors and show that, contrary to the price-taking case, centralization may actually decrease public goods provision in some cases.

The tax competition model I use to highlight this result is the capital tax competition model of Zodrow and Mieszkowski (1986) and Wilson (1986). In the standard case, both local and central governments are price takers; i.e., the supply curve is perfectly elastic and fixed at a certain price from their perspective. Centralization in the standard case eliminates the downward pressure on taxes and spending of tax competition, shifting the demand curve for public goods to the right and increasing the provision of public goods relative to the decentralized case. In the market power case, the supply curve for public goods inputs slopes upward, and the central government can influence the price by its quantity decisions. In this case, I show that centralization involves trade-off between elimination of tax competition and the inefficiencies of market power. Whether centralization increases public goods provision in this case is impossible to determine; it is possible that sufficient market power erases entirely the positive effects from eliminating tax competition.

The effect of tax competition on the level of public goods provision has been well covered in the literature. Notably, Hoyt (1991) presents a model of tax competition in which a decrease in the number of districts unambiguously increases the level of public goods provision. Wilson (1999) summarizes various models of tax competition, emphasizing that tax competition tends to encourage underprovision public goods relative to centralization. This paper confirms the dampening effect of tax competition on public goods provision, but notes that centralization may also tend to underprovide if it can exert market power in the market for the public goods inputs. This trade-off analysis mirrors the spirit of Brueckner (2004), which pits the "good side" of decentralization, Tiebout sorting, against the "bad side," tax competition. This paper also speaks directly to the question of the number of jurisdictions, concluding that public goods provision need not be a monotonically decreasing function of the jurisdiction count.

In the next section, I review the baseline model of tax competition. Section 3 shows that centralization increases public goods provision in the price-taking, elastic supply case. In Section 4 I show that market power dampens this result, and may overturn it completely. Section 5 extends the model in two ways and shows that the basic ambiguity result holds in either extension of the model. Section 6 concludes.

2 Baseline model of tax competition

In order to study the effects of market power on public goods provision, I study the baseline tax competition model of Zodrow and Mieszkowski (1986) and Wilson (1986) (the ZMW model, hereafter). I focus on the version of the model presented in Keen and Konrad (2013), following their notation and exposition closely, with some slight modifications. The model features multiple regions, each of which is endowed with immobile labor and perfectly mobile capital. Tax competition, therefore, arises from the movement of capital away from relatively high-tax regions to relatively low-tax areas until returns to capital are equalized. Formal characterization of the model is given below.

The economy is populated by n regions, $i = 1, ..., n$, each of which is endowed with amount of labor h_i. The capital-labor ratio employed in production in region i is denoted by k_i, and the output-labor ratio $f(k_i)$, where output is in consumption goods units, is produced according to the production function f[1], which exhibits the standard behavior $f' > 0$ and $f'' < 0$. The representative household in each region is endowed with an amount of capital $\bar{k_i}$, and may invest its capital in any of the n regions, earning capital income for the regions in which it invests.

The government levies a unit tax $t_i \in [0, 1]$ on capital in each region, such that its revenue, in consumption goods units, collected from region i is given by $t_i k_i$. Capital is paid its marginal product $f'(k_i)$ in each region; therefore, the after-tax return to capital in region i is given by $f'(k_i) - t_i$. Since capital is perfectly mobile, it must be that the return to capital must be the same in every region:

$$f'(k_i) - t_i = \rho \ \forall \ i \in 1, ..., n. \tag{1}$$

As a result, the income from the endowment of capital is given by $\rho\bar{k_i}$. Additionally, the

[1]Keen and Konrad (2013) allow for the possibility of heterogeneity in this function such that it would be denoted by f_i. This distinction is not important for the present analysis, so I make the assumption that production functions are equal for simplicity of exposition.

income from the firm $f(k_i) - f'(k_i)k_i$ is transferred as income to the household in region i.

Welfare for the representative consumer in each region is given by

$$W_i(x_i, g_i) = x_i + G(g_i), \tag{2}$$

where x represents the numeraire consumption good[2], and g is the quantity of inputs to the public good, purchased at price p[3], which is the amount of the consumption good needed to exchange for one unit of the public good. The function G satisfies $G' > 0$, $G'' < 0$, and represents the amount of utility generated by a level of public goods inputs g. G can be interpreted as a production function for final public goods, a utility function over public goods, or a combination of the two. Either interpretation is appropriate so long as concavity is ultimately satisfied. Furthermore, note that the strict negativity of the second derivative implies the following mathematical results: $G'(g_1) > G'(g_2) \Rightarrow g_1 < g_2$ and $G'(g_1) < G'(g_2) \Rightarrow g_1 > g_2$; this relation between G' and g will be key to the results below.

Combining the sources of income for the household and the government's budget condition $pg_i = t_i k_i$ yields the equation

$$W_i(x_i, g_i) = f(k_i) - f'(k_i)k_i + \rho\bar{k_i} + G\Big(\frac{t_i k_i}{p}\Big). \tag{3}$$

Combining endowments, equation 1, and the market clearing condition

$$\sum_{i=1}^{n} \sigma_i k_i = \sum_{i=1}^{n} \sigma_i \bar{k_i} = \bar{k} \tag{4}$$

where $\sigma_i \equiv h_i / \sum_{s=1}^{n} h_s$ represents the region's relative size, yields the equilibrium of the model. Given the tax rates in each of the n regions, an equilibrium is characterized by quantities k_i and return to capital ρ as functions $k_i(t_1, ..., t_n)$ and $\rho(t_1, ..., t_n)$ of the unit tax rates. Importantly, it can be shown that own-jurisdiction tax rates put downward pressure

[2]Both the consumption and public goods are in per-person terms, as labor is not explicitly considered in this model.

[3]I include the price of the public good input explicitly due to its key role in the analysis of market structures below.

on capital and its global return: $\frac{\delta k_i}{\delta t_i} < 0$ and $\frac{\delta \rho}{\delta t_i}$, where $\frac{\delta \rho}{\delta t_i} = f''(k_i)\frac{\delta k_i}{\delta t_i} - 1$.

3 Perfectly elastic supply: centralization increases provision

First consider the case of perfectly elastic supply, in which the price p of the public good input is taken as fixed by whichever government provides it. This is the case implicit in many models of public goods provision, which often do not explicitly model the supply side of public goods inputs. An example to keep in mind might be that of a local government buying asphalt to fix the roads; such a government is not likely to have influence over the world price of asphalt. The comparison of local vs central provision, then, could yield an interpretation in which a U.S. state, say Michigan, is the 'central' governmental unit and Michigan's cities and townships are the 'local' units. A comparison in the context of the ZMW model shows that centralizing the provision of such a public good will increase the level of provision of the good.

3.1 Decentralized case

Consider the problem of a local government setting tax rates to maximize the welfare of its constituents. The local government in locality i chooses a unit tax t_i in order to maximize welfare W_i, given the endowments and the tax profile of the other $n-1$ localities:

$$max_{t_i} f(k_i) - f'(k_i)k_i + \rho\bar{k} + G\Big(\frac{t_i k_i}{p}\Big). \tag{5}$$

Appendix A shows that, by solving this first order condition and imposing symmetry, $\bar{k}_i = \bar{k}$, the demand for public goods inputs g^l satisfies

$$G'(g^l) = \frac{p}{1+E_k}, \tag{6}$$

where $E_k = \frac{\delta k_i}{\delta t_i} \frac{t_i}{k_i}$, the elasticity of the capital input with respect to the tax rate.

When some tax competition exists, $E_k < 0$; furthermore, a high value (in absolute terms) of E_k implies a high value of G', which implies a low value of g^l. Note here that a decrease in the number of jurisdictions will bring E_k closer to zero, resulting in higher levels of public goods provision.

3.2 Centralized case

The central government maximizes the same welfare function as the local governments. Given that there is no *ex ante* uniformity restriction on the tax rates, the central government faces the same series of first order conditions faced by the local governments. However, the identical nature of the localities will cause the central government to simply search for a single tax rate t which applies to all capital.[4]

The central government, therefore, is not subject to the pressures of tax competition; because it chooses a single tax rate for all regions, it faces the elasticity $E_k = 0$. Plugging in to Equation 6, the familiar result

$$G'(g^c) = p \tag{7}$$

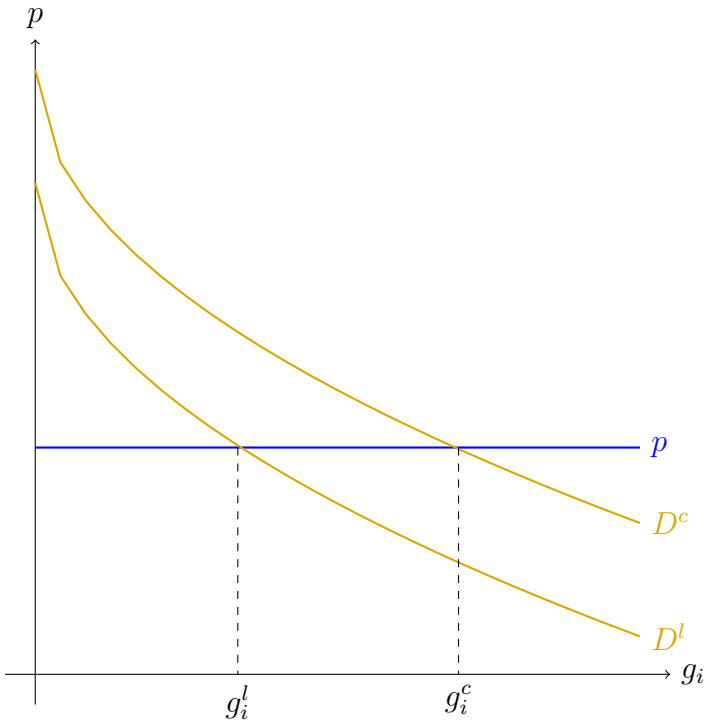
describes the demand curve for public goods, where g^c is the central government's demand for public goods. Note that this equation represents the social optimum in this economy.

3.3 Comparison

Each case under consideration results in a demand function; these functions are given by Equations 6 and 7 for the decentralized and centralized cases, respectively. Whether centralization or decentralization results in higher demand for public goods depends on a comparison

[4] Alternatively, one could impose the uniformity of the policy as a constraint on the central government, as in Oates (1972). The distinction is unimportant in the symmetric case presented here.

Figure 1: Perfectly elastic supply



between these two equations. In this price taking case, the only difference between the two is the value of the elasticity E_k.

When $n \geq 2$, $E_k < 0$ in the decentralized case; i.e., there is tax competition. Since $G'' < 0$ by assumption, this implies that $g^l(p) < g^c(p)$ for all positive values of p. In words, centralized provision of public goods produces a demand curve for public goods inputs which is shifted to the right relative to decentralized provision, resulting in a higher level of public goods provision. This result is illustrated in Figure 1, where D^l and D^c represent the demand curves arising from the decentralized and centralized cases, respectively.

4 Market power: ambiguous effect of centralization

Now suppose that the public goods input is not elastically supplied; rather, the price is determined by an upward-sloping supply curve. For ease of exposition, suppose that instead of being a small player in the market for the public good input, the central government is

the world's *only* buyer of that input (a monopsonist). For example, perhaps the geography of the economy in question requires roads to be a specific type of asphalt not used anywhere else. This is of course the extreme case of market power, but it serves to illustrate the effects of bargaining power. In this case, the central government will not be a price taker; rather, it will be able to exert full power on the market for the public good input.

Analysis of this case will proceed much like the elastic supply case, but with a couple of minor tweaks. First, assume n is large enough that, in the case of decentralized provision, no individual region may exert influence over the price. As a simplifying limiting case, we may take $n \to \infty$. Furthermore, the supply side of this environment must be modeled explicitly. Included in this section is a supply curve $p = p(g)$, where $p' > 0$. For now, the governments do not care about the welfare of the supplier, the implicit assumption being that the suppliers are not residents of the economy, despite being dependent on its market for these public goods inputs.

4.1 The government's problem

As before, in both cases, governments are faced with the following maximization problem:

$$max_{t_i} f(k_i) - f'(k_i)k_i + \rho\bar{k} + G\Big(\frac{t_i k_i}{p}\Big). \tag{8}$$

The only difference from the case above is the potential for a government to influence the price p: $\frac{\delta p}{\delta t}$ need not necessarily equal zero. In Appendix B, I show that the level of public goods inputs g in the symmetric equilibrium (in both cases) solves the equation

$$G'(g) = \frac{p(g)}{1 + E_k - E_p}, \tag{9}$$

where E_k is the elasticity of capital with respect to the tax rate as defined above, and E_p is the elasticity of the price p with respect to the tax rate, as changes in taxes result in changes in spending on the public good.

4.2 Comparison

The extreme case I consider for comparison is one in which $n \to \infty$, such that a local government is a price taker, and $E_p = 0$ in the decentralized case. In the centralized case, however, $E_k = 0$ as before, but E_p is determined by the central government's ability to set the price as a monopsonist. Therefore, the public goods demand equations for the local governments and the central governments, respectively, are given by

$$G'(g^l) = \frac{p(g^l)}{1 + E_k} \tag{10}$$

and

$$G'(g^m) = \frac{p(g^m)}{1 - E_p}. \tag{11}$$

In the case where the central government exerts monopsony power in the market for public goods, there are two opposing forces affecting whether centralization increases or decreases public goods provision. The first is the familiar presence of tax competition, which is the only force in the baseline ZMW framework. Centralization eliminates tax competition incentives, which tend to decrease the government's demand for public goods; therefore, the elimination of tax competition through centralization is a positive force on the level of public goods provision.

The second force at work is the market power that the central government is able to exert on the suppliers of the public good input. The marginal impact on total expenditure of an extra unit of public goods is higher than the price of the extra unit, because the price increases for every unit being purchased. Because local governments are not able to exert influence on the price, this mmarket power has a dampening effect on public goods provision under centralization relative to decentralization. The relative sizes of these two forces, tax competition and market, will determine whether centralization or decentralization provides a higher level of the public good.

To compare decentralization and centralization, we must return to the two equa-

tions determining the equilibrium quantity of public goods under the two cases. Here, it is impossible to say whether g^l or g^m will be greater. The functional forms of $f(.)$, $G(.)$, and $p(.)$ will determine the elasticities E_k and E_p, the relative sizes of which will determine which governmental structure results in a higher (and closer to the social optimum) level of public goods spending. The proposition below makes this clear.

Proposition 1. *In the full market power environment, $g^m < g^l$ if and only if $E_p > -E_k$.*

Proof. Define the function $h(g) = \frac{G'(g)}{p(g)}$. Note that $h'(g) = \frac{p(g)G''(g) - p'(g)G'(g)}{p(g)^2}$; from the previous assumptions $p(g) > 0$, $p'(g) > 0$, $G'(g) > 0$, and $G''(g) < 0$, it must be that $h'(g) < 0$. Equations 10 and 11 show that $h(g^l) = \frac{1}{1+E_k}$ and $h(g^m) = \frac{1}{1-E_p}$. Given these characteristics of the function h, the result follows:

$$g^m < g^l \Leftrightarrow h(g^m) > h(g^l) \Leftrightarrow E_p > -E_k.$$

□

Figures 2 and 3 illustrate two different cases which could result from this model, depending on the specifics of the model. The local provision of public goods g^l is determined by an intersection point with the supply curve. The centralized level g^m, however, is determined by the intersection of the demand curve not with the supply curve but with the 'marginal expenditure' curve ME, which reflects the effect of the central government's demand on the price of the public good input. When the gap between demand curves (tax competition) is large relative to the gap between $p(g)$ and $ME(g)$ (monopsony power), then centralization increases public goods provision. When tax competition is relatively small and monopsony power is large, the effect is reversed, and decentralization provides more public goods. To show this in a clear way, I present below a simple example to shed light on the fact that the result could go either way.

Figure 2: Market power case 1: centralization increases provision

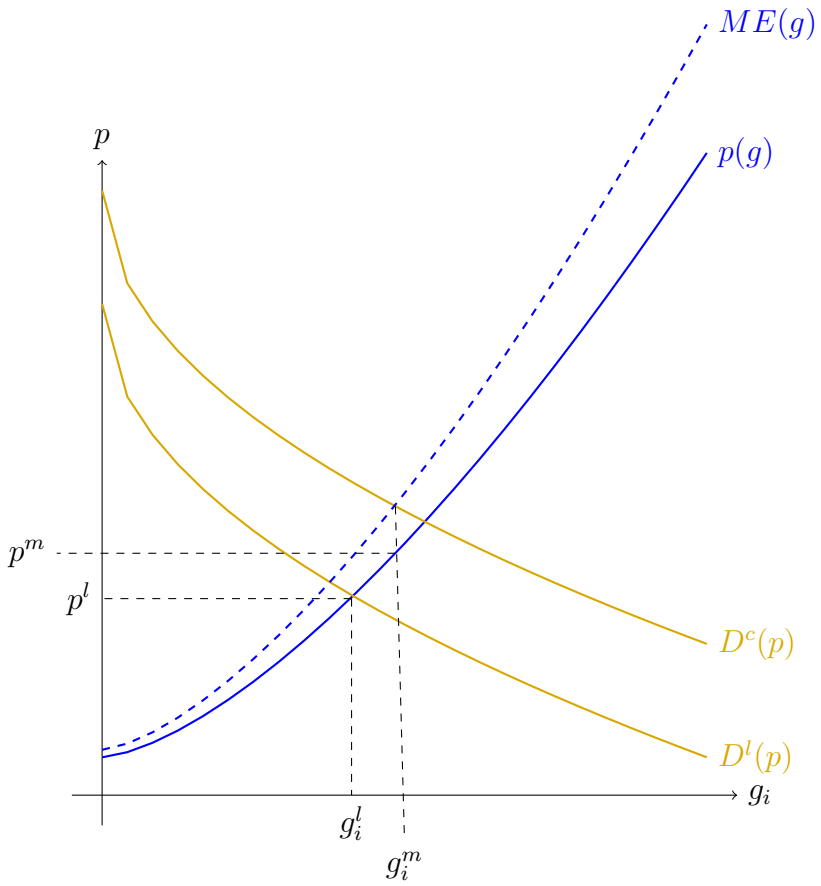
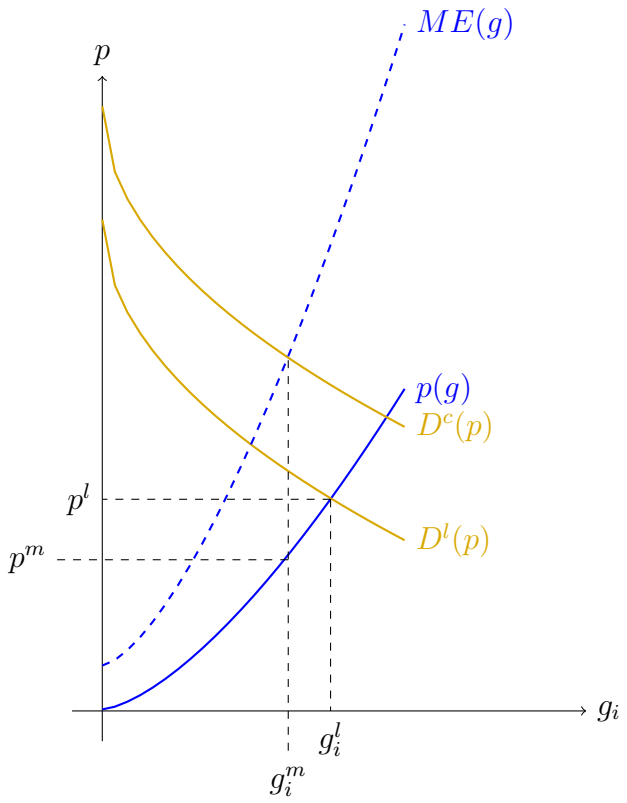


Figure 3: Market power case 2: centralization decreases provision



4.3 A simple example

Consider the simple example of a symmetric tax competition model with full market power at the central level and the following functional forms: $G'(g) = \frac{1}{g}$, $p(g) = e^g$, $f''(k) = A < 0$, $\bar{k} = 1$, and $n \to \infty$. In Appendix C, I show that plugging in and solving Equations 10 and 11 results in equilibrium quantities for public goods inputs that solve the equations:

$$e^{g^l} = \frac{1}{g^l}\left(\frac{A}{A-1}\right)$$

$$e^{g^m} = \frac{1}{g^m} - 1.$$

In this case, whether centralization increases public goods provision clearly depends on the second derivative of the production function A.

Figure 4

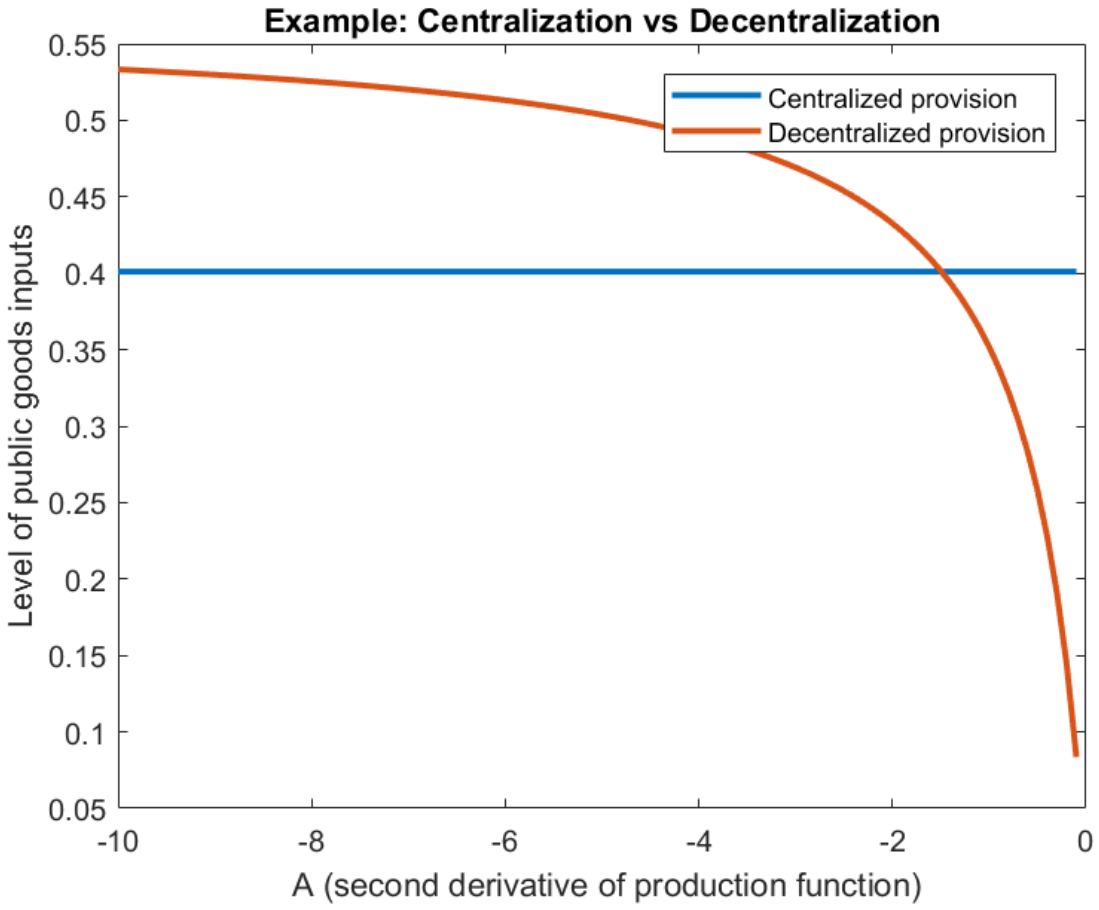


Figure 4 shows the level of public goods under decentralized and centralized provision as the concavity of the production function A is varied. When $|A|$ is high, capital does not move much in response to tax changes, i.e., $|E_k|$ is low, causing the market power effect–which doesn't change with A–to dominate such that $g^m < g^l$. When f is close to linear, however, $|A|$ is high, as capital responds strongly to tax incentives. In this case, tax competition forces are strong enough that centralization increases public goods provision, even in the presence of a high level or market power. In this example, depending on the value of A, decentralized public goods levels can range from 25 to 120 percent of the centralized level.

The takeaway from this simple example is the impossibility of determining whether centralization of public goods provision increases or decreases the level of the good in any

general sense. To know the answer, we must specify both functional forms and values for the parameters. This runs in contrast to the result from the price-taking world, in which centralization always increases public goods provision.

5 Extensions

5.1 Decentralization with finite regions

The preceding analysis of market power on the part of a government purchaser of public goods focused solely on the two extreme cases: perfect competition and full market power (centralized monopsony). In reality, of course, a government unit may have some degree of influence over the price of public goods, depending on the number of jurisdictions which are purchasing the public good. The model above can be extended to an model with a discrete number of buyers, in which the quantity demanded relevant to equilibrium price is given by

$$g_{total} = \sum_{i=1}^{n} \frac{1}{n} g_i. \tag{12}$$

In this case, the effect of government i's demand on price is given by

$$\frac{\delta p}{\delta g_i} = p'(g_{total}) \frac{1}{n}. \tag{13}$$

Instead of comparing two possible government structures, decentralization and centralization, we can compare the decentralized outcome under different numbers of jurisdictions n. This is the exercise in Hoyt (1991), in which the level of public goods increases as n decreases. When price influence over the public good is considered, however, this may not necessarily be the case.

The local government's problem in this case is exactly as before, in Equation 8.

And, as before, the equilibrium level of public goods provision is given by Equation 9:

$$G'(g) = \frac{p(g)}{1 + E_k - E_p}.$$

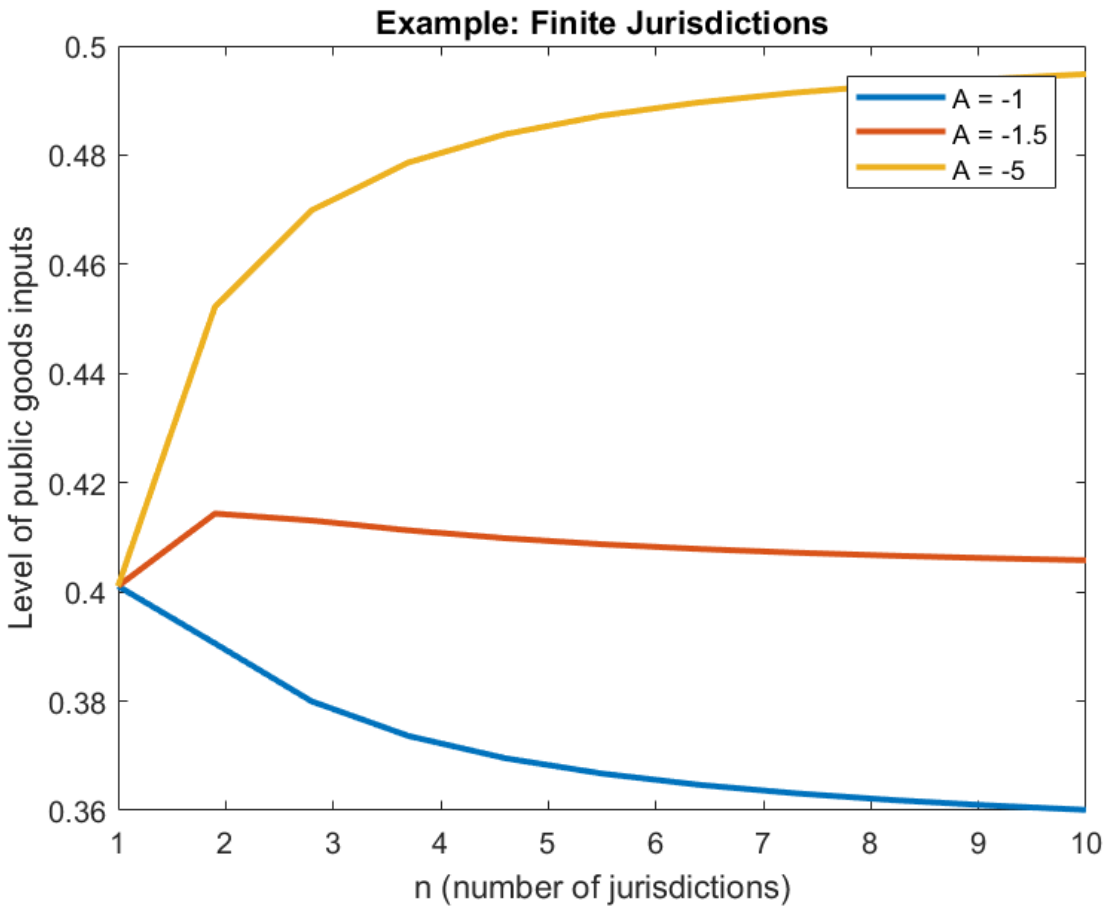
As $n \to \infty$, the model approaches exactly the perfectly competitive case where $E_p = 0$; likewise, when $n = 1$, the full monopsony case in which $E_k = 0$ is replicated. In the middle, however, with n finite and decentralized provision, each individual government will be able to exert some control over the price of the public good ($E_p \neq 0$) and tax competition will still be present ($E_k \neq 0$).

Just as in the comparison of centralization and decentralization, little can be said about the relationship between n and g. Depending on the parameters of the model, this relationship could be negative (as in Hoyt (1991)), positive (in a case of immobile capital, for instance), or nonlinear. To highlight this point, Figure 5 illustrates this relationship for some different selections of model parameters in the simple example given above.[5]

Different curvatures for the production function f result in vastly different implications for the relationship between public goods and number of governments in the economy. When $A = -1$, i.e., f is closer to linear, tax competition effects are stronger, and public goods levels decrease as the number of jurisdictions increases. This is the standard result. On the other hand, alternative parameterizations of the model yield different results: when $A = -1.5$, g is maximized at $n = 2$, and when $A = -5$, g is monotonically increasing in n. As the concavity increases, $|E_k|$ decreases, and market power effects begin to dominate. I confirm in this example that, when market power is available to governments as purchasers of public goods, parameterization is needed to determine the relationship between public goods provision and the number of jurisdictions.

[5] Appendix C provides more details on the elasticities in the simple example.

Figure 5


Example: Finite Jurisdictions
Level of public goods inputs
n (number of jurisdictions)
A = -1
A = -1.5
A = -5
0.5
0.48
0.46
0.44
0.42
0.4
0.38
0.36
1
2
3
4
5
6
7
8
9
10

5.2 Domestic supplier

One assumption implicit in the preceding analysis is the presence of an *outside* supplier. Admittedly, this is a somewhat strange thought experiment: the central government is the only buyer in a market, but none of the suppliers exist under its jurisdiction. The example would be a U.S. state that requires a unique type of asphalt used nowhere else, but manufactured in China.

A more realistic setting would be one in which the public goods inputs are supplied from within the region itself. In this case, however, a benevolent government should care about the suppliers; it may not wish to extract as much surplus from them via its market power as it would for outside suppliers it didn't care about. The example in mind here might be public school teachers; the government's desire to economize will be offset somewhat by its desire to pay its teachers (citizen-suppliers) well.[6]

In order to compare centralization and decentralization for a case in which the government cares about the supplier of the public good, it is useful to return to the $n \to \infty$ case. While the local governments in the decentralized economy take p and g_{total} as given, and therefore take the producer's welfare as given, the central government's objective function needs to be augmented with a term describing producer surplus[7][8]

$$W = f(k) - f'(k)k + \rho\bar{k} + G(g) + S(g), \tag{14}$$

where the last term $S(g)$ is the producer surplus from quantity g and price $p(g)$. Appendix D shows that the equilibrium condition for the monpsonist central government's provision

[6] Of course, the original assumption of neutrality toward the supplier may not be egregiously heroic in the first place. Would any governor refuse an offer from a teacher's union to accept a *lower* wage?

[7] I abstract from the subscripts i in this section, since I continue with the assumption of symmetry and the central government sets policy uniformly in every jurisdiction.

[8] One may alternatively interpret this producer surplus term as a generalization of a case in which the households own a representative profit-maximizing firm.

of public goods satisfies the equation

$$G'(g) + p'(g)g = \frac{p(g)}{1 - E_p}. \tag{15}$$

Note that this equation is the same as before; however, the marginal benefit term is further augmented by the marginal benefit to producers of another unit of g, $p'(g)g$. While this term does increase the quantity of public goods provided in the centralized economy, it does not necessarily guarantee that centralization will increase public goods provision. The overall effect of centralization remains ambiguous without further specification of functional forms and parameters.

6 Conclusion

This paper has shown that whether centralization increases or decreases public goods provision relative to decentralization in a model of tax competition might depend on the market power of the central government as a purchaser of public goods. When the central government is a price taker, centralization unambiguously increases provision. However, when the central government is a buyer of public goods inputs with market power, it may be that centralization actually decreases public goods provision; the strength of the dampening effect depends on model parameters.

One immediate value added from the ideas in this paper is to lend further insight into conflicting empirical evidence on the effect of decentralization on the size of the public sector. A number of papers have set out to test the hypothesis that decentralization will decrease the size of the public sector, which is the baseline prediction of the tax competition model without market power, to mixed results. Many papers have found evidence for this decentralization, or "leviathan," hypothesis; some examples include Marlow (1988), Grossman (1989), Ehdaie (1994), Stansel (2006), and Prohl and Schneider (2009). Others, however, including Jin and Zou (2002), Oates (1985), Stein (1998), and Cassette and Paty (2010),

find the opposite result that decentralization increases the size of the public sector. Additionally, Liberati and Sacchi (2013), Fiva (2006), and Busemeyer (2011) find different results depending on the type of decentralization or the sector in which decentralization happens. The presence of market power in the input market for central governments *vis-a-vis* regional and local governments may be a contributing factor to the wide variety of results obtained in the empirical literature; future research could benefit from investigating the effects of market power on the decentralization hypothesis.

The results of this paper clearly carry implications for public policy. Given the potential ambiguity of centralization as it relates to government spending, policy makers might consider the degree to which different levels of government exert influence over the price of goods and services. For example, a U.S. state government might be a near-monopsonist buyer of educators located in the state, while local governments might search for teachers in a more competitive market. The difference in bargaining power between the two could be an important consideration in the debate about the degree of centralization of education.

More research remains to be done on market power in public goods markets. First, I showed in this paper that imperfect competition further muddles the picture on the effect of centralization; more research is needed into the effect of incomplete market power on the demand side of public goods. Furthermore, I have abstracted from heterogeneity or the effect of market power in other models of federalism and public goods provision; work in these areas promises to yield insights into the potential effects of market power. In any event, this paper puts forth a potentially important source of deviation from the standard results on centralization, and adds another wrinkle into the complex study of fiscal federalism.

Standard tax competition results conclude that tax competition reduces the level of public goods spending under decentralization. Furthermore, models comparing decentralization and centralization tend to characterize the inefficiencies due to centralization as political in nature. This paper contributes to both strands of literature by showing an *economic* mechanism by which centralized provision of public goods might be inefficiently low, and by pointing out that in such a model, decentralization can lead to higher levels of public

goods than centralization.

References

[1] Timothy Besley and Stephen Coate. "Centralized versus decentralized provision of local public goods: a political economy approach". In: *Journal of public economics* 87.12 (2003), pp. 2611–2637.

[2] Jan K. Brueckner. "Fiscal Decentralization with Distortionary Taxation: Tiebout vs. Tax Competition". In: *International Tax and Public Finance* (2004).

[3] Marius R. Busemeyer. "The Impact of Fiscal Decentralisation on Education and Other types of Spending". In: *Swiss Political Science Review* (2011).

[4] Aurelie Cassette and Sonia Paty. "Fiscal decentralization and the size of government; a European country empirical analysis". In: *Public Choice* (2010).

[5] Jaber Ehdaie. "Fiscal decentralization and the size of the government: an extension with evidence from cross-country data". In: *The World Bank Policy Research Working Paper Series* (1994).

[6] Jon H. Fiva. "New Evidence on the Effect of Fiscal Decentralization on the Size and Composition of Government Spending". In: *Public Finance Analysis* (2006).

[7] Philip J. Grossman. "Fiscal decentralization and government size: An extension". In: *Public Choice* (1989).

[8] William H. Hoyt. "Property taxation, Nash Equilibrium, and market power". In: *Journal of Urban Economics* (1991).

[9] Jing Jin and Heng-fu Zou. "How does fiscal decentralization affect aggregate, national, and subnational government size?" In: *Journal of Urban Economics* (2002).

[10] Michael Keen and Kai A. Konrad. "The Theory of Internationn Tax Competition and Coordination". In: *Handbook of Public Economics*. 2013.

[11] Paolo Liberati and Agnese Sacchi. "Tax decentralization and local government size". In: *Public Choice* (2013).

[12] Ben Lockwood. "Distributive politics and the costs of centralisation." In: *Review of Economic Studies* (2002).

[13] Michael L. Marlow. "Fiscal decentralization and government size". In: *Public Choice* (1988).

[14] Wallace E. Oates. *Fiscal Federalism*. 1972.

[15] Wallace E. Oates. "Searching for Leviathan: An Empirical Study". In: *The American Economic Review* (1985).

[16] Silika Prohl and Friedrich Schneider. "Does Decentralization Reduce Government Size? A Quantitative Study of the Decentralization Hypothesis". In: *Public Finance Review* (2009).

[17] Dean Stansel. "Interjurisdictional Competition and Local Government Spending in U.S. Metropolitan Areas". In: *Public Finance Review* (2006).

[18] Ernesto Stein. "Fiscal Decentralization and Government Size in Latin America". In: *IDB Working Paper* (1998).

[19] John D. Wilson. "A theory of interregional tax competition". In: *Journal of Urban Economics* (1986).

[20] John Douglas Wilson. "Theories of Tax Competition". In: *National Tax Journal* (1999).

[21] George R. Zodrow and Peter Mieszkowski. "Pigou, Tiebout, property taxation, and the underprovision of local public goods". In: *Journal of Urban Economics* (1986).

Mathematical Appendices

A Basic tax competition result

This section shows the equilibrium condition for public goods provision in a model with tax competition and price taking, which follows closely the exposition of Keen and Konrad (2013). The welfare function in jurisdiction i is given by $W_i = f(k_i) - f'(k_i)k_i + \rho\bar{k} + G\left(\frac{t_i k_i}{p}\right)$, and the first order condition with respect to t_i is $\frac{\delta W_i}{\delta t_i} = -f_i''(k_i)k_i\frac{\delta k_i}{\delta t_i} + G_i'(\frac{t_i k_i}{p})\frac{1}{p}(k_i + t_i\frac{\delta k_i}{\delta t_i}) + \frac{\delta\rho}{\delta t_i}\bar{k}_i = 0$. Plugging in $\frac{\delta\rho}{\delta t_i} = f_i''(k_i)\frac{\delta k_i}{\delta t_i} - 1$, this becomes $-f_i''(k_i)k_i\frac{\delta k_i}{\delta t_i} + G_i'(\frac{t_i k_i}{p})\frac{1}{p}(k_i + t_i\frac{\delta k_i}{\delta t_i}) + f_i''(k_i)\frac{\delta k_i}{\delta t_i}\bar{k}_i - \bar{k}_i = 0$.

Imposing symmetry, such that $k_i = \bar{k}_i = \bar{k}$, and recognizing that $t_i = t$ for all i, this simplifies to $G'(\frac{t\bar{k}}{p})\frac{1}{p}(\bar{k} + t\frac{\delta k}{\delta t}) - \bar{k} = 0$. Dividing both sides by $\bar{k}$ results in $G'(\frac{t\bar{k}}{p})\frac{1}{p}(1+E_k) - 1 = 0$, which simplifies to the standard result $G'(g) = \frac{p}{1+E_k}$.

B Main result

The main results in this paper consider a price that is determined by a supply curve $p(g)$. The welfare function remains the same, but the first order condition now includes the possibility that the government may be able to influence the price of the public goods. The first order condition is now $\frac{\delta W_i}{\delta t_i} = -f_i''(k_i)k_i\frac{\delta k_i}{\delta t_i} + G'\left(\frac{t_i k_i}{p}\right)\left(\frac{p(k_i + t_i\frac{\delta k_i}{\delta t_i}) - t_i k_i\frac{\delta p}{\delta t_i}}{p^2}\right) + f_i''(k_i)\frac{\delta k}{\delta t_i}\bar{k}_i - \bar{k}_i = 0$, which incorporates the effect of the tax rate on the price via its effect on public goods expenditures.

Imposing symmetry as before, this becomes $G'(\frac{t\bar{k}}{p})\left(\frac{p\bar{k} + tp\frac{\delta k}{\delta t} - t\bar{k}\frac{\delta p}{\delta t}}{p^2}\right) - \bar{k} = 0$. Then dividing by $\bar{k}$ and rearranging, this is $G'(\frac{t\bar{k}}{p})(\frac{1}{p} + \frac{1}{p}E_k - \frac{1}{p}E_p) = 1$, which simplifies to the main result $G'(g) = \frac{p}{1+E_k-E_p}$.

C Simple example

The simple example provided in the body of the paper considers the case in which $\bar{k}_i = 1$, $f''(k) = A < 0$, $G'(g) = \frac{1}{g}$, and $p(g) = e^g$. In this section I solve for the equations describing equilibrium quantities of the public good under both decentralized and centralized provision for the $n \to \infty$ case, and for the decentralized, finite n case.

For the decentralized $n \to \infty$ case, g^l solves the equation $G'(g) = \frac{p(g)}{1+E_k}$. Keen and Konrad (2013) shows that, in the symmetric case, the elasticity is given by $E_k = \frac{1}{f''}(1-\frac{1}{n})\frac{t}{k_i}$. Plugging in $t = \frac{gp}{k}$, this becomes $E_k = \frac{1}{f''}(1-\frac{1}{n})\frac{gp}{k_i^2}$. Recognizing that $p = p(g)$ in equilibrium, plugging in parameters, and taking the limit as $n \to \infty$, the equation becomes $\frac{1}{g} = \frac{e^g}{1+\frac{1}{A}ge^g}$, which simplifies to $e^g = \frac{1}{g}\left(\frac{A}{A-1}\right)$.

Similarly, in the centralized case, g^m solves the equation $G'(g) = \frac{p(g)}{1-E_p}$. By definition $E_p = \frac{\delta p}{\delta t}\frac{t}{p} = \frac{\delta p}{\delta g}\frac{\delta g}{\delta t}\frac{t}{p}$. In the centralized case, $\frac{\delta k}{\delta t} = 0$, so differentiating $g = \frac{tk}{p}$ with respect to t simply results in $\frac{\delta g}{\delta t} = \frac{k}{p}$. Along with $\frac{\delta p}{\delta g} = p'(g)$, this results in the equation $\frac{1}{g} = \frac{e^g}{1-\frac{ge^g}{e^g}}$, which simplifies to $e^g = \frac{1}{g} - 1$.

In the case of a finite number of jurisdictions with decentralized provision of the public good, the equilibrium quantity g^n solves the equation $G'(g) = \frac{1}{1+E_k-E_p}$, as usual. In this case, however, both elasticities are nonzero due to the dual presence of tax competition and market power. Using the formulas above, and recognizing that from the perspective of government i, $\frac{\delta p}{\delta g_i} = \frac{1}{n}g'(g_{total})$, where $g_{total} = \sum_i \frac{1}{n}g_i$, the elasticities are given by $E_k = \frac{1}{A}(1-\frac{1}{n})ge^g$ and $E_p = e^g\frac{1}{n}\frac{1}{e^g}g(1+ge^g\frac{1}{A}(1-\frac{1}{n}))$. Plugging in and simplifying, it must be that the equilibrium g^n solves the equation $(1-g\frac{1}{n})(1+\frac{1}{A}(1-\frac{1}{n})ge^g) = ge^g$.

D Producer Surplus

If the central government cares about producer surplus in the economy, the welfare function is augmented with $S(g)$, where $S(g) = \int_0^g [p(g) - p(s)]ds$. The first order condition is augmented with $\frac{\delta S}{\delta t} = \frac{\delta S}{\delta g}\frac{\delta g}{\delta t}$. By Leibniz rule, $\frac{\delta S}{\delta g} = (p(g) - p(g)) * 1 - (p(g) - p(0)) * 0 + \int_0^g p'(g)ds = p'(g)g$. Plugging in $\frac{\delta S}{\delta t}$ to the first order condition, along with the previously assumed symmetry, the first order condition becomes $G'(g)\left(\frac{p(k+t\frac{\delta k}{\delta t}) - tk\frac{\delta p}{\delta t}}{p^2}\right) - k + p'(g)g\left(\frac{p(k+t\frac{\delta k}{\delta t}) - tk\frac{\delta p}{\delta t}}{p^2}\right) = 0$, which reduces in a familiar fashion to the final result $G'(g) + p'(g)g = \frac{p(g)}{1-E_p}$, remembering that $E_k = 0$ for the central government.