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Central Control of Regional
Budget: Theory with
Applications to Russia

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by
John M. Litwack

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ABSTRACT/RÉSUMÉ

Motivated by the recent experience in the Russian Federation, this paper examines the implications of imposing central control on the budgetary activities of a subnational government. In a highly stylised multi-task principal-agent model (Holmstrom and Milgrom (1991)), a central government cannot directly monitor the informal budgetary operations of a regional administration, but seeks to improve fiscal policies by exerting control over a “formal” regional budget and imposing (limited) costs on informal behaviour. In the static case of the model, the control of subnational budgetary operations by a benevolent central government may increase social welfare, but at the expense of higher (implicit and explicit) taxation of economic organisations in the region, lower output, and a strong orientation of informal policies toward rent seeking activities. The additional imposition of costs on regions for conducting informal budgetary operations has multiple (indeterminate) effects in general, but the imposition of small fixed costs has an unambiguously negative effect, leading to still higher informal taxation with no social benefit. Corruption, involving the payment of fixed bribes, is one interpretation of this case. Allowing for the possibility that the region may underfulfil the formal budget and divert resources “underground” creates still further problems, particularly in the Russian case of revenue sharing between budgets. Two other considerations also weaken the case for central control: a) a dependence of investment on future expected taxes in a context when long-term commitment to tax rates is politically difficult, b) a recognition that the central government is part “Leviathan,” with an agenda that does not completely coincide with the pursuit of social welfare. The results are generally consistent with what appears to be the situation in most Russian regions: central control of subnational taxes, high (unfunded) federal expenditure mandates, the widespread use of numerous costly informal policy instruments, and a high (formal and informal) tax burden on business and investment.

JEL Classification: H11, H39, H77, D83

Keywords: Intergovernmental Relations, Fiscal Decentralisation, Russian Economy.

Motivé par l'expérience récente de la fédération de Russie, cette étude examine les conséquences d'un contrôle central imposé sur les activités budgétaires des administrations locales. Dans un modèle principal-agent multi fonction (Holmstrom and Milgrom (1991)), le gouvernement central ne peut pas observer les opérations budgétaires informelles d'une administration régionale, mais il cherche à améliorer les politiques budgétaires en faisant un effort de contrôle sur le budget régional “officiel” et en imposant des coûts (limités) sur des activités informelles. Dans le modèle statique, le contrôle des opérations budgétaires locales par un gouvernement central bienveillant pourrait augmenter le bien-être social, mais au prix d'une taxation plus forte (implicite et explicite) des organisations économiques de la région, d'une production plus faible, et d'une orientation marquée des politiques informelles vers la recherche de rentes. L'imposition supplémentaire de coûts sur les régions qui pratiquent des opérations budgétaires officieuses a de nombreux effets (indéterminés) en général, mais l'imposition de petits coûts fixes définies a sans aucun doute un effet négatif, conduisant à une taxation informelle encore plus forte et sans bénéfice social. La corruption, impliquant le paiement de pots-de-vin fixes, est une interprétation de ce cas. La possibilité que la région ne remplit pas les objectives du budget officiel et détourne des ressources “en cachette” y ajoute des problèmes, particulièrement dans le cas russe dans lequel le revenu est partagé entre les budgets. Deux autres considérations affaiblissent aussi le cas du contrôle central: a) une dépendance de l'investissement par rapport aux taxes anticipées dans un contexte où il est difficile politiquement de s'engager à long terme sur des taux de taxation, b) une reconnaissance que le gouvernement central est une sorte de “Leviathan”, dont le but ne coïncide pas complètement avec la recherche du bien-être social. Les résultats sont généralement cohérents avec ce qui apparaît être la situation dans la plupart des régions russes : le contrôle central des taxes locales, les mandats de dépenses fédérales importantes (et sans source de financement), l'utilisation développée de nombreux instruments de politique économique officieux et coûteux, et une charge fiscale importante (formelle et informelle) sur les affaires et l'investissement.

Mots-clés: Relations intergouvernementales, Décentralisation fiscale, L'économie russe

Classification JEL: H11, H39, H77, D83

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CENTRAL CONTROL OF REGIONAL BUDGETS: THEORY WITH APPLICATIONS TO RUSSIA

John M. Litwack¹

I. Introduction

1. Relations between different levels of government in less-developed or transition economies often possess a common feature: a high degree of *formal* central control over local government finance that stands in contrast to significant *de facto* informal local autonomy. In China, the central government has tolerated a very high degree of (predominantly informal) autonomy at the provincial level. Some studies have linked the nature of this autonomy with strong incentives in subnational state organs for the pursuit of growth and reform-oriented economic policies (Monitola, Qian, and Weingast (1996), Jin, Qian, and Weingast (1999)). In Russia, fiscal federalist relations have resembled more of a cat and mouse game, in which the federal government has continually attempted to expand its presence and control in the regions, cracking down on informal behaviour, while subnational governments have devised numerous means to circumvent these controls. In this context, incentives at the subnational levels of government in Russia for growth and reform-oriented policies have appeared to be weaker than in China (Shleifer (1997), Zhuravskaja (1999), OECD (2000)).

2. Blanchard and Shleifer (2000) suggest that a primary difference between Russia and China is the political centralisation of the latter, which allows for the possible removal of regional and local political leaders who are highly oriented toward rent seeking and corruption. But the particular nature of formal central control in Russia itself can also be associated with important distortions in incentives (OECD (2000), Lavrov, Litwack, and Sutherland (2000)). Formal central control, along with a common unfeasibility of fulfilling all central regulations and mandates, provide subnational officials with an excuse to absolve themselves of much of the responsibility for formal budgetary management. The necessity of moving off budget for the pursuit of truly independent fiscal policies typically entails important additional costs of concealment and transactions. Once the cost of concealment has been paid, the hidden nature of such policies also naturally increases the temptation for corruption and rent seeking. The institution of long-term bilateral relations between subnational state organs and enterprises for the direct provision of public goods and services supports a policy bias toward large incumbent firms with the capacity to supply such goods and services. The combination of high federally mandated expenditures and the simultaneous conduct of independent informal fiscal policies feeds into a high overall (formal and informal) tax burden on businesses and investors.

1. OECD Economics Department (E-mail: John.Litwack@oecd.org). This work was carried out as part of a special work programme on fiscal federalism and regional finance in the Russian Federation, supported by the OECD Centre for Co-operation with Non-Members (CCNM). The author wishes to thank Douglas Sutherland, Val Koromzay, and Silvana Malle for helpful comments. The opinions expressed in this paper are those of the author, and do not necessarily coincide with those of the OECD.

3. This paper uses a highly stylised model, motivated by the Russian experience, to examine some of the effects of central control over regional budgets, placing particular emphasis on the last problem listed in the previous paragraph. The general framework is that of the multi-task principal-agent model (Holmstrom and Milgrom, 1991). A central government cannot monitor directly informal behaviour, but seeks to improve fiscal policies through the imposition of (imperfect) central control on the execution of a regional budget. This includes the possible creation of a formal regional budget under central control, as well as possible measures that increase the costs for regions of carrying out their own informal budgetary operations and rent seeking.

4. In the static case of the model, the control of subnational budgetary operations by a benevolent central government may increase social welfare, but at the expense of higher (implicit and explicit) taxation of economic organisations in the region, lower output, and a strong orientation of informal policies toward rent seeking activities. The additional imposition of costs on regions for conducting informal budgetary operations has multiple (indeterminate) effects in general, but the imposition of small fixed costs has an unambiguously negative effect, leading to still higher informal taxation with no social benefit. Corruption, involving the payment of fixed bribes, is one interpretation of this case. Allowing for the possibility that the region may underfulfil the formal budget and divert resources “underground” creates still further problems, particularly in the Russian case of revenue sharing between budgets. Two other considerations also weaken the case for central control: (a) a dependence of investment on future expected taxes in a context when long-term commitment to tax rates is politically difficult, (b) a recognition that the central government is part “Leviathan,” with an agenda that does not completely coincide with the pursuit of social welfare. The results are generally consistent with what appears to be the situation in most Russian regions: high (unfunded) federal expenditure mandates, the widespread use of numerous costly informal policy instruments, and a high (formal and informal) tax burden on business and investment.

5. A first section of the paper motivates the analysis with a brief summary of relevant problems in fiscal federalist relations in the Russian Federation. Subsequent sections present the model and analysis. Concluding comments briefly consider implications for the current reforms of inter-budgetary relations in Russia. While this model is specifically tailored to the case of Russia, it also has potential applications to a number of countries where the dual presence of formal central control and informal autonomy exists.

II. Central control and informal autonomy: the case of Russia²

6. The Russian system of fiscal federalist relations has three main tiers: the federal government, 89 regions (Subjects of the Federation), and thousands of local administrations. Local administrations range from large cities or districts to small rural communities, often within the context of larger local government units. Some local administrations have the status of municipalities, while others do not. Only the federal and regional levels of government have the actual status of organs of state power.

7. Applied studies employ two common measures of the degree of fiscal decentralisation within a federation: the share of subnational revenue in all consolidated state revenue and the share of own revenue (as opposed to transfers) in subnational expenditures. By both of these two measures, Russia appears significantly decentralised. For example, Russia is quite close to China by the former measure, and actually ahead of China by the second. With respect to explicit autonomy (decision-making authority) over taxation and expenditure policies, however, the Russian system is notably more centralised, not only in comparison with China, but with other large countries such as the United States, Canada, India, and

2. This unavoidably brief summary of a complex phenomenon is based on OECD (2000) and Lavrov, Litwack, and Sutherland (2000), to which the reader is referred for details.

Brazil.³ In the Russian Federation, all taxes are collected by a single federal Ministry of Taxes and Collections and, for the most part, divided between budgets by the federal treasury. A higher level of government, most notably the federal level, sets the vast majority of subnational taxes and tax rates. The expenditure side of subnational budgets consists almost entirely of obligations according to various federal laws, regulations, norms, and mandates.⁴ Numerous federal organs in the regions are responsible for enforcing federal control. In addition to regional and local branches of Tax Ministry and the Federal Treasury, there are territorial divisions of the Anti-Monopoly Ministry, the Financial Rehabilitation and Insolvency Service, the Tax Police, the Federal Fiscal Inspectorate, and branches of the presidential administration. In 2000, another tier in the federal hierarchy was added at the level of seven large macro-regions for the purposes of further increasing monitoring and control.

8. The Russian system of inter-budgetary relations evolved within a particularly eventful historical context. Russian regions (Subjects of the Federation) began playing an increasing role in resource allocation in the mid-1980s with the weakening of the product-line ministries. This process intensified during the first wave of transition to a market economy in the early 1990s, leading to a significant devolution of effective power and authority to the regional (Subject of the Federation) level of government. For the most part, this process did not follow a specific plan or central reform strategy, instead deriving from strong autonomous centrifugal forces that followed a weakening of the central government, and its inability or unwillingness to meet a large part of former expenditure obligations. In a rather chaotic environment, regions lobbied for greater shares and control of revenue through bilateral agreements with the centre, while the federal government continually pushed expenditure responsibilities downward.

9. The current high degree of formal central control over subnational budgets in the Russian Federation can be understood as deriving from a primarily two factors: the legacy of the former Soviet system, which is reflected in basic legislation that grants ultimate authority to the federal government in almost all budgetary matters, and an attempted retrenchment of central authority following the chaotic, largely informal decentralisation of the late 1980s and early 1990s. This retrenchment included eliminating the rights of subnational administrations to introduce their own taxes in 1996, the restriction of subnational taxes in the Tax Code to a short list under federal control, an alarming growth in federal expenditure mandates, and crackdowns on subnational governments aimed at reducing tax exemptions and money surrogates in 1999 and 2000. Despite a general recognition of a need to create explicit subnational autonomy in a recently approved comprehensive economic program of the Russian government, measures in 1999 and 2000 have actually moved in the opposite direction. This includes a new law that allows the president to remove regional governors in the event of violations of federal law, the creation of a new tier in the federal hierarchy based on 7 macro-regions, and still further measures to reduce the already very limited degree of formal subnational discretion to set formal tax rates. There exist draft proposals in 2000 to move the formal execution of subnational budgets to the federal treasury and eliminate the only remaining significant purely regional tax: the sales tax. Significant differences of opinion currently exist within the Russian government, with one faction supporting the creation of genuine formal subnational autonomy and another faction envisioning a “unitary” budgetary system that virtually eliminates any explicit fiscal role for regions and localities.

3. On this subject, see Lavrov, Litwack, and Sutherland (2000).

4. OECD (2000) estimates that only 15 per cent of tax revenue derives from sources over which subnational governments have any discretion whatsoever. But even this 15 per cent is subject to strict federal regulations and ceilings. Russian law assigns expenditures to lower levels of government, but not autonomy over the determination of their size and execution, which is commonly determined at the federal level. OECD (2000) also estimates that the accumulation of unfunded federal expenditure mandates in Russian regions and localities in the latter half of the 1990s presents demands on subnational budgets that are simply unfeasible.

10. So far, measures aimed at bringing subnational finance under greater control have had mixed effects at best, and negative effects at worst. For the most part, they have encouraged subnational administrations to exercise their still formidable *de facto* autonomy in an increasingly informal manner. The various tools and schemes for supporting informal substantial regional and local budgets are numerous. These include extensive bilateral bargaining with “significant” firms on their territories for the direct provision of public (or private) goods and services in return for various benefits, such as (often implicitly arranged) tax exemptions, loan guarantees, protection from competition or bankruptcy, debt restructuring, cheap energy inputs, assured safety and supplies of utilities, and freedom from inspections and fines. Subnational administrations also typically participate heavily in the capital of many firms and financial institutions on their territories, either directly or through their affiliates. Various hidden or semi-hidden extra-budgetary funds and accounts, sometimes set up under the disguise of a non-profit organisation, are also important informal fiscal tools. In addition, OECD (2000) identified numerous advantages for subnational administrations in the use of various money surrogates, particularly tax and expenditure offsets, in budgetary operations. Although a crackdown by the federal government and some other factors have reduced the share of surrogates in reported tax revenue in 2000, they remain significant, even more significant than official tax figures might indicate.⁵ Federal organs operating in the regions are typically staffed with local personnel who are interested in maintaining good terms with the regional administration. Until recently, regional governors even had (informal) veto power of the selection of the territorial head of the federal tax administration.

11. Thus, despite the high degree of formal central control over subnational budgets, and measures aimed at solidifying this control since the mid-1990s, regional and local administrations continue to exercise a high degree of informal autonomy on their territories. Formal budgets have become even more overburdened with regulations and federal expenditure mandates in recent years, while federal crackdowns on informal activities have induced some adjustments in the behaviour of subnational administrations. Perhaps most notably, money surrogates appear to have been de-emphasised relative to the direct provision of public goods and services through enterprises. This transition may have been facilitated by a recent activation of tax debt restructuring, bankruptcy proceedings, and external management, which has increased the direct shareholding and control of regional administrations over firms in many cases. Russia currently stands at an important crossroads in the reform of fiscal federalist relations. Should the current strategy of applying ever-greater central control over formal subnational budgetary activities, together with crackdowns on informal behaviour, be continued or intensified? Or should Russia shift gears and attempt to create a feasible formal budgetary system that explicitly recognises a significant degree of subnational autonomy?

III. The model

12. In this exercise, we deliberately abstract from the usual concerns of fiscal federalist relations: tax and expenditure assignments between budgets, relative informational or administrative advantages of different levels of government, redistribution between regions, externalities created by policies of individual regions, problems of multi-tier hierarchies, and competition between regions. We look only at a

5. Money surrogates, including debt (tax and expenditure) offsets and bills of exchange came to account for the majority of subnational budgetary operations in the Russian Federation by 1998. The federal government has since forbidden the use of offsets by subnational administrations for most taxes and changed other rules to make the use of money surrogates in taxation more costly. By preliminary figures, the share of money surrogates in subnational tax revenues fell to 12 per cent in the first half of 2000, although remaining above 30 per cent in many regions. OECD missions to Russian regions in 2000, however, found that surrogates probably remain more important than these official figures would indicate. Various “schemes” allow for the continued use of surrogates at the same time that tax revenue is formally recorded in cash. See Lavrov, Litwack, and Sutherland (2000).

single region, where taxation and budgetary expenditures are assumed to be of purely regional significance. Proofs of all of the propositions are in the Appendix.

13. Suppose that, from the point of view of the central government, social welfare in a given region can be approximated by a function:

$$1) \quad W(t,e) = Y(t) + S(e)$$

“Y” is the value of economic “output” in the region, and is a function of the level of taxes, “t.” “S” represents the degree of satisfaction of certain social needs, and is a function of the level of budgetary social expenditures, “e.”

14. We postulate that a regional government is also concerned with these objectives, but receives additional utility, “U,” from the diversion of revenue to certain private benefits for itself, “b.” The most natural interpretation that we will give U(b) is utility from rent seeking activities. In a more general sense, it can be a proxy for the degree of the diversion of interests of the regional government from the centre.⁶ The objective function of the regional government can be written:

$$2) \quad G(t, e, b) = Y(t) + S(e) + U(b)$$

15. Social expenditures and private benefits are financed from the taxation of output. In the model, “taxation” is given a general interpretation that includes extortion by government organs, necessary bribes to government officials, etc., as well as explicit taxes.

$$3) \quad e + b - tY(t) \leq 0$$

We assume that Y(t) is continuously differentiable, weakly concave, and strictly decreasing in $t \in [0,1]$ with $Y(1) = 0$.⁷ S(e) and U(b) are both continuously differentiable, strictly increasing, and strictly concave. We also assume that S(e) and U(b) satisfy the “Inada Condition,” implying that the marginal return to the government from social expenditures or private benefits becomes extremely large as e or b approaches 0:

$$4) \quad \lim_{e \rightarrow 0} S'(e) = \lim_{b \rightarrow 0} U'(b) = \infty$$

16. These conditions guarantee convenient interior solutions to the maximisation problems considered below. The interpretation of (4) for social expenditures is straightforward. As these expenditures become extremely small, social distress increases greatly. This condition for U(b) also makes sense as an approximation for Russia, given the fact that official compensation for top regional officials is commonly less than the equivalent of \$300 a month. Under such conditions, the desire to supplement

6. It is common practice in incentive models for the term U(b) to also enter the social welfare function, as it represents benefits to one group of society. But all that is important to support the rationality of our more simple representation is that the social welfare function would put a lower weight on this term relative to Y and S than does the objective function of the regional government.

7. The only assumption here on Y that might be interpreted as needlessly restrictive is that of concavity. Actually, all that we require is a much weaker assumption that, in the range where revenue, $tY(t)$ is increasing, $Y'' < 2[Y']^2/Y$. For example, if Y is determined through a profit maximisation problem of the form $p(1-t)Y - C(Y)$, where $C(Y) = aY^b$, then this assumption will hold for any $b > 1$. This (rather weak) assumption is necessary only to guarantee unique solutions to the optimisation problems considered here, thus allowing for a precise interpretation of the comparative statics.

compensation informally by at least a little is very strong indeed. One would search in vain for a Russian region where $b=0$.

A) Complete central control under perfect information: the first best

17. As a point of reference, we consider first a hypothetical case where the central government has complete information, costlessly monitors all the actions of the regional government, and can punish the diversion of any revenue to private benefits in an unbounded manner. In this case, it can enforce $b = 0$ and the tax rate and budgetary expenditures will be chosen to maximise social welfare:

$$5) \quad \begin{aligned} & \max_{t,e} [Y(t) + S(e)] \\ & \text{s.t. } e - tY(t) \leq 0 \end{aligned}$$

Given our assumptions, this problem has a unique solution in optimal tax and expenditure levels: $\{t^*, e^*\}$. Since welfare is increasing in output, t^* will be strictly less than the value of “ t ” that maximises revenue, $tY(t)$, i.e. $Y(t^*)$ is strictly on the left-hand side of the Laffer Curve.

B) Complete decentralisation

18. A second benchmark case is that of complete decentralisation, in which the regional government has complete freedom in choosing $\{t, e, b\}$ without any interference by the centre. In this case, the problem becomes:

$$6) \quad \begin{aligned} & \max_{t,e,b} [Y(t) + S(e) + U(b)] \\ & \text{s.t. } e + b - tY(t) \leq 0 \end{aligned}$$

Under the above assumptions, there exists a unique solution to this problem, $\{t^d, e^d, b^d\}$. Given that the regional government uses revenue for private as well as social benefits, however, it sets a higher-than-socially-optimal tax rate and chooses a lower-than-socially-optimal level of social expenditures:

Proposition 1) Let $\{t^*, e^*\}$ be the socially optimal (first best) levels of taxes and social expenditure that solve problem (5) and $\{t^d, e^d, b^d\}$ the solution to the regional government maximisation problem (6). Then $t^d > t^*$ and $e^d < e^*$

C) Central control of the formal budget.

19. The divergence in objectives between the regional government and social welfare suggests possible measures by the central government to address this problem. The most obvious measures would target directly the diversion of regional revenue toward private benefits. As indicated above, if the central government could costlessly monitor $\{t, e\}$ or “ b ” and severely punish administrations that set any $b > 0$, it could implement the socially optimal $\{t^*, e^*\}$. In reality, however, this monitoring is costly and imperfect. We consider here one imperfect measure used by the federal government in Russia: the creation of a “formal budget” under central control. The formal budget consists of a regional tax rate set by the central government, regional taxes collected by the central government, and expenditures dictated and monitored

by the central government. We begin by assuming that the central government has the power to enforce the implementation of any feasible formal budget. But the regional government retains its ability to conduct additional informal taxation and expenditures.

20. Formally, suppose that the central government is able to choose directly and implement a “formal” tax rate and social expenditure level = $\{t^o, e^o\}$, but is still unable to prevent the regional government from conducting its own policies as well. The regional government will then solve the optimisation problem (6) subject to the additional constraints that the official budget is implemented:

$$\begin{aligned}
 7) \quad & \max_{t,e,b} [Y(t) + S(e) + U(b)] \\
 & \text{s.t.} \quad \text{i) } e + b - tY(t) \leq 0 \\
 & \quad \quad \text{ii) } e^o - e \leq 0 \\
 & \quad \quad \text{iii) } t^o - t \leq 0
 \end{aligned}$$

Without a loss of generality, we restrict attention here only to feasible and balanced formal budgets: $e^o = t^o Y(t^o)$. Although feasibility is indeed a major problem in Russia, this problem owes primarily to imperfect information about the functions $Y(t)$ and $S(e)$, as well as political institutional arrangements, which are not presently being considered.

21. The first simple observation about (7) is that, since the subnational government can freely execute its own informal policies, the presence of this formal budget alone cannot help reduce taxes in the region in the direction of the social optimum. Constraint 7iii only potentially restrains the regional government from lowering taxes. Constraint 7ii does have a potential use in that it can force the regional government to implement a higher level of social expenditures than e^d . Proposition 2 indicates that the central government will indeed use the official budget to push up social expenditures. But this will come at a high cost. The regional government will respond to such a policy, through (7), by increasing taxes even beyond the level associated with decentralisation and devoting all revenue above and beyond the official budget only to rent seeking:

Proposition 2) The maximisation of social Welfare, $Y(t) + S(e)$, with respect to $\{t,e,b,e^o,t^o\}$, subject to the constraint that $\{t,e,b\}$ solve problem (7) yields values of t , e , and $b = \{t^r, e^r, b^r\}$ that satisfy $e^r = e^o > e^d$, $t^r > t^d$, and $b^r = t^r Y(t^r) - e^o$, where e^d, t^d are part of the solution to the complete decentralisation problem (6).

22. Thus, the presence of a controlled formal budget under these conditions produces an overall regional budget that is strictly larger than in the case of complete decentralisation. Both taxes and expenditures are higher and output is lower. Furthermore, under these conditions, the regional government will devote its own (informal) policies only toward rent seeking. It should be noted that the intuition behind Proposition 2 is *not* the fact that the central government has a direct incentive to increase “ e ” in the direction of the first best social optimum, e^* . Given the higher implied tax rate in this context, there is no general reason why the central government should consider e^* to be optimal in any sense. But it is even possible that $e^r > e^*$. The correct intuition is that the central government treats mandated formal expenditures as an imperfect means of inducing the regional government to reduce rent seeking and reallocate revenue toward “ e .” But it must weigh this beneficial reallocation effect with the negative effect on output from higher taxes. The regional government responds to a higher e^o by both reducing “ b ” and increasing “ t .” Proposition 2 states that, at the optimum, the central government tolerates an even higher tax than under decentralisation due to the strength of this reallocation effect.

23. Despite these negative effects, Proposition 2 implies that the presence of central control and the choice of $e^o > e^d$ can increase social welfare in the simple static case of this model. There are several factors in reality that could decrease or negate these benefits, however. A number of these factors are considered in subsequent sections of this paper. For the present, it is important to keep in mind that creating and maintaining an apparatus of central control over the regional budget implies costs that must be weighed against any potential benefits. Furthermore, it is possible that the regional government has better information and monitoring technologies for determining an efficient allocation of expenditures in the region, and that centrally determined mandates might be less efficient than decentralised expenditures on “e” for this reason.

D) Central control and imposed costs on informal budgetary activities

24. We now consider a further possibility that, while the centre may not be able to monitor “t” or “b” effectively at permissible cost, it still has some imperfect limited means for increasing the costs to subnational administrations of conducting informal budgetary operations. For example, federal control of a large portion of cash flows and bank accounts in many regions has supported a strong reliance on money surrogates, especially budgetary offsets in chain barter arrangements, which entail high transaction costs. Federal crackdowns on surrogates in 1999 and 2000 have further increased these costs for remaining surrogate operations. Other costs of concealment, including bribes and hidden extra-budgetary funds, were noted in the previous section of this paper. Another quite specific example from recent Russian experience is a policy of continually closing and reopening new bank accounts for tax delinquent firms as a means of preventing confiscation of these accounts by federal tax authorities. Federal crackdowns on one channel of informal budgetary activity lead regional administrations to seek out new holes to exploit. In fact, the need to adjust to constantly changing federal policies and monitoring can be viewed as a type of cost in itself.

25. We consider a problem where any additional imposed costs of conducting informal regional policies must be financed out of regional resources. Of course, there exist other possible types of costs, such as the probability of removal from an official post. We will come back to this question below. The new maximisation problem for the region becomes:

$$\begin{aligned}
 & \max_{t,e,b} [Y(t) + S(e) + U(b)] \\
 8) \quad & \text{s.t.} \quad \text{i) } b + e - [tY(t) - K(t)] \leq 0 \\
 & \quad \quad \text{ii) } e^o - e \leq 0 \\
 & \quad \quad \text{iii) } t^o - t \leq 0
 \end{aligned}$$

where $K(t)$ represents some cost to the regional government of conducting informal budgetary operations: $K(t)$ is non-decreasing in t and $K(t) = 0$ for $t \leq t^o$.

26. First note that if $K(t)$ is made large enough (for example, $K(t) = tY(t) - e^o$ for $t > t^o$), we are in the case of the first best. This would imply that the centre can perfectly identify informal policies and impose such enormous costs on them as to eliminate rent seeking altogether. We are therefore only interested in examining the effects of a $K(t)$ that is, in some sense, “small,” reflecting only limited monitoring abilities and highly imperfect measures for cracking down. A purpose of this exercise is to illustrate that, even if central monitoring and administrative costs are ignored, the benefits from marginally increasing the costs to the regional government of conducting informal budgetary activities, beginning from a “small” $K(t)$, are dubious at best and quite possibly negative.

27. In general, increasing the significance of $K(t)$ at the margin has two conflicting effects on the incentives of the regional government. These can be viewed as income and substitution effects. On the

one hand, increasing the costs of conducting informal budgetary operations implies a greater tax burden on output for a given level of private benefits, encouraging the regional government to consume more in the form of higher output and less in private benefits. This is the substitution effect, which works in the direction of social welfare. On the other hand, as private benefits are reduced, their marginal utility to the regional government becomes greater and greater. The regional government therefore has an incentive to maintain at least minimal levels of benefits, even if that requires heavy taxation on output sufficient to cover both these benefits and the additionally imposed costs. That is the income effect, which works against social welfare. Which of these two effects will dominate generally depends on the specific functional forms of the model. For example, the curvature of marginal benefits, $U''(b)$, is important.

28. This trade-off will also depend on the particular nature of the imposed costs, $K(t)$. One interesting question concerns the breakdown of $K(t)$ into fixed and variable components. It turns out that, while an increase in (small) variable costs gives rise to both income and substitution effects, (small) fixed costs induce only an income effect, thereby having an unambiguously negative impact on social welfare (Propositions 3 and 4 below). This result is interesting since the actual nature of these costs in the Russian context has an important fixed component. For example, setting up and concealing an extra-budgetary fund under the guise of a non-profit organisation with a complicated ownership structure may entail some initial costs. But once the fund is set up, the marginal costs of concealment might increase only very slowly with its size. Obtaining a controlling stake in an enterprise will generally require an up-front cost for the administration (debt restructuring, assumption of the enterprise's debts, purchase of shares, defence from bankruptcy, etc.). Once the controlling stake is acquired, however, the use of this enterprise for quasi-fiscal purposes may entail relatively low variable costs of concealment. Also, once federal officials in the regions are bought off with bribes, they may require little additional compensation depending on "t." Even the use of money surrogates, which does entail (variable) transaction costs relative to cash, also requires important fixed costs in setting up barter networks, intermediaries, pricing policies, creating various bills of exchange, etc. Once this network is created, it can be used repeatedly.

29. To formalise this conjecture, we consider the case where $K(t)$ consists only of a fixed cost: $K(t) = 0$ if $t \leq t^0$ and $K(t) = a > 0$ if $t > t^0$. As discussed above, if "a" can be made sufficiently large, this is equivalent to assuming that the central government has the information, monitoring and punishment capabilities to implement the first best. We therefore postulate that the central government can impose these fixed costs only up to some sufficiently "small" limit, " γ ."

Proposition 3) Let $t(e^0, t^0, a)$ be part of a solution to problem (8), where $\{e^0, t^0\}$ satisfy $e^0 \leq t^0 Y(t^0)$ and $e^0 < \max [tY(t)]$. Furthermore, let

$$K(t) = \begin{cases} 0 & \text{if } t \leq t^0 \\ a & \text{otherwise} \end{cases}$$

Then $\exists \gamma > 0$ such that $t(e^0, t^0, a)$ is a strictly increasing function of a on $[0, \gamma]$ for fixed $\{e^0, t^0\}$.

Proposition 3 states that the region will respond to the imposition of (small) fixed costs on informal budgetary activities by increasing (informal) taxation for any given formal budget. The assumption $e^0 < \max [tY(t)]$ is necessary only to ensure that there exists additional potential revenue that the region could procure over and above e^0 . In fact, it can be easily verified that the central government would never actually want to choose an e^0 that high.

30. Given this assumed form of $K(t)$, we now consider the choice of an optimal central policy that simultaneously chooses a formal budget and a level of costs for conducting informal policies, $\{e^0, t^0, a\}$, subject to a constraint that $a \leq a^u$ for some $a^u > 0$. Proposition 3 indicates that the tax rate chosen by the region will be an increasing function of "a" over a domain where "a" is "small" for a fixed formal budget,

$\{e^0, t^0\}$. But Proposition 3 leaves open the question of the degree to which the centre might be able to make constructive use of a strictly positive “a” as an element chosen simultaneously with a formal budget. For example, increasing the enforced expenditure target, e^0 , can make a given level of costs to informal policies, “a,” bite harder on the budget constraint of the region, (8)i. Proposition 4 confirms, however, that, unless “a” can be made sufficiently large, it will not be optimal for the centre to choose any fixed costs to informal policies at all:

Proposition 4) Let

$$K(t) = 0 \text{ if } t \leq t^0 \\ a \text{ otherwise}$$

Consider the problem:

$$(9) \quad \max [Y(t) + S(e)] \\ t, e, e^0, t^0, a$$

$$\text{s.t. i) } \{t, e\} \text{ are part of a solution to problem (8)} \\ \text{ii) } e^0 \leq t^0 Y(t^0) \\ \text{iii) } a \leq a^u$$

Then $\exists \gamma > 0$ such that $a^u < \gamma \Rightarrow$ the solution to problem (9) sets $a = 0$ and $\{t, e, b\}$ at the same levels as those defined in Proposition 2: $\{t^f, e^f, b^f\}$

31. Proposition 4 states that imposing zero fixed costs on informal budgetary operations is a local maximum to the problem of the central government, i.e. it is better to impose no fixed costs than “small” fixed costs. The intuition behind Propositions 3 and 4 is as follows: As long as the fixed costs are small enough that the regional government considers them worth paying, the presence of these costs tightens the regional government’s budget constraint. Paying the fixed costs “a” reduces revenue left over for private benefits for a given tax rate and expenditure target, e^0 , to $tY(t) - e^0 - a$. This implies that, for a given tax rate, the marginal return to private benefits, $U'(tY(t) - e^0 - a)$, is increasing in “a,” i.e. a higher “a” can be associated with smaller benefits, “b,” at a given tax “t,” implying a higher U’. Therefore, the regional government will set a higher tax rate, “t,” in response to a higher “a” for any given e^0 . But a higher tax for a given level of expenditures unambiguously reduces welfare. In the case that e^0 does not bind constraint 8ii, not only will the tax level increase in “a,” but social expenditures will fall as well (Proposition 5 below). Therefore, the central government would optimally choose $a = 0$.

32. This result offers an interesting interpretation of the cost of corruption in this context. Consider the following example: the central government decides to crack down on rent seeking with the goal of improving the business environment. It sends new federal officials to the regions to monitor the behaviour of the regional administration, and work together with the federal prosecutor to bring guilty officials to justice. In the absence of corruption, this would directly increase the risks of making “b” large, leading the regional administration to reduce rent seeking and, correspondingly, informal taxes, generating a lower overall tax burden, “t.” In the presence of corruption, however, the regional administration might offer a fixed bribe of amount “a” to the federal officials and continue rent seeking activities. In the latter case, Proposition 4 states that this will have the exact opposite of the intended effect. Regional officials will finance “a” partly by choosing an even higher “t,” leading to a deterioration of the business environment. The mere fact that regional officials are willing to pay the bribe implies that “a” is low enough for Proposition 3 to be valid. Thus, corruption can transform non-pecuniary incentive devices, such as the probability of removal from an official post, into fixed pecuniary costs, thereby reversing the policy implications of an attempted crackdown on informal activity.

E) Underfulfilment of the formal budget

33. We have been assuming so far that the central government is able to enforce a formal budget with any feasible expenditure level. In reality, this ability is very imperfect. In 1998, for example, Russian regional governments fulfilled the 25 most important federal expenditure mandates by only roughly 30 per cent (OECD (2000)). In fact, the selective sequestration of expenditures can be considered another important informal policy tool in the Russian Federation, as the complete fulfilment of all federal regulations and mandates is often not feasible in any case. This is not to suggest that the power of the federal government to enforce expenditure targets is entirely negligible. For example, a number of local governments have had their accounts impounded by the courts pending the satisfaction of claims according to federal mandates. But regions and localities still have numerous means at their disposal for manipulating formal expenditure targets, including means that go beyond explicit sequestration. Overvaluing deliveries of commodities (as money surrogates) in satisfaction of budgetary outlays is one of the most common such means.⁸

34. What are the consequences of the possible underfulfilment of the official budget in the current model? If the centre is unable to enforce any $e^o > e^d$ and no costs are imposed on informal budgetary operations, then we are in a case equivalent to that of complete decentralisation. Any administrative costs to the centre of central control would be pure dead-weight loss. If small fixed costs are imposed on informal budgetary operations in the absence of an enforced formal budget, we are in the worst of all possible worlds. The regional government will not only increase taxes, but decrease social expenditures as well:

Proposition 5) Let $t(a)$, $e(a)$ be part of a solution to problem (8), where $e^o = t^o = 0$ (No formal budget is enforced). Furthermore, let

$$K(t) = \begin{cases} 0 & \text{if } t \leq t^o \\ a & \text{otherwise} \end{cases}$$

Then $\exists \gamma > 0$ such that $t(a)$ is a strictly increasing function and $e(a)$ is a strictly decreasing function on $[0, \gamma)$.

35. An implication of Proposition 5 is that, if central government is unable to enforce a formal budget, it will still be sub-optimal to impose any small fixed costs on informal budgetary operations. The implementation of the decentralised solution would thus be optimal in such a case.

F) Tax sharing and the diversion of resources

36. Formal budgetary relations in the Russian Federation are strongly based on tax sharing. Under this arrangement, a region only receives a fixed share of revenue collected from individual (formal) taxes collected on its territory as well as (perhaps) a transfer from the federal government. As long as the central government is assumed able to enforce any feasible formal budget, $\{t^o, e^o\}$, a consideration of tax sharing does not add much to the present model. Consider, for example, a case where a share k of a formal budget, $kt^o Y(t^o)$ is centralised and then returned to the region in the form of a transfer of the same size for augmenting social expenditures: $T = kt^o Y(t^o)$. The optimisation problems (7) and (8) remain the same, as

8. "Barter" or "offset" prices in the Russian Federation are roughly double cash prices for most commodities. Budgetary recipients receiving payment in kind therefore only receive roughly half of the cash value of the commodities delivered, even separate from additional liquidity problems. These expenditures are written off the budget at full value, however. See OECD(2000) for details.

the amount of revenue submitted and equal-sized transfer are just added to, and subtracted from, the budget constraint. In fact, a possible interpretation of the “formal budget” in the previous section is that all formal revenue is centralised and $e^0 = T$ is a transfer of equal size. If we allow the region to be a net donor, so that $T < kt^0Y(t^0)$, it is straightforward to show that the region will respond to the imposition of this regime by increasing informal taxes, but reducing “b” and (perhaps) “e” somewhat due to a higher marginal cost of (informal) taxation on output. Similarly, if a region is a net recipient, so that $T > kt^0Y(t^0)$, it will decrease informal taxes, but will also increase rent seeking, “b,” somewhat and, depending on the chosen target e^0 , possibly expenditures as well. The comparative statics summarised by Propositions 1-5 would remain valid in each of these cases.

37. The situation becomes much more complicated if the centre cannot perfectly enforce the formal budget, leaving the regional government with means to divert resources to the informal sector. In this case, as long as $k < 1$ and the transfer, “T,” is determined independently of $kt^0Y(t^0)$, the regional government will always have an incentive to divert as many resources as possible from the formal to the informal budget, making the actually realised t^0 as small as possible relative to “t.” Here, the region has an incentive to finance “e” as well as “b” off budget, something that corresponds to what we observe in Russia. This is due to the simple fact that the region is a full residual claimant for informal tax revenue, but can keep only a $1-k$ share of formal revenue. A typical scheme for accomplishing such a diversion at the regional level in Russia involves the toleration of (formal) tax arrears and the protection from bankruptcy for a firm that makes substantial contributions to the social infrastructure of a region (or to “private benefits” for the administration). This includes the direct provision of public goods, voluntary contributions to extra-budgetary funds, and participation in various schemes involving money surrogates.

G) Dynamics and investment

38. Expectations of tax rates affect not only current output decisions, but investment decisions as well. This can give rise to the so-called “ratchet effect.”⁹ The government may wish to commit to a relatively “low” tax in order to create incentives for businesses to sink a high level of investment. Once this investment is sunk, however, the incentives of the government change due to the temptation to increase taxes on capital that is no longer perfectly mobile. If investors anticipate this increase, however, the high level of investment will never be sunk in the first place. Thus, the government would like to make a credible commitment to investors to maintain low taxes, even if these tax rates will appear lower-than-optimal ex post.

39. This type of commitment has been a chronic political problem for Russia during the reform period, even dating back to the last years of Soviet power.¹⁰ Most tax rates are subject to annual adjustment as part of the process of drafting the yearly budget. In addition, numerous adjustments to tax rates, regulations, and methodologies are made throughout the year, sometimes with conditions that have been applied retroactively. This instability and discretionary nature of taxation in Russia has been a primary complaint of businesses operating in the country. Since the tax rate is lower in our model under decentralisation than central control (with a limited ability to impose (fixed) costs on informal behaviour), this suggests the possibility that decentralisation might serve as an institutional commitment device to keep taxes lower, thereby stimulating higher rates of investment and output.

40. Formally, suppose that investment in the region is a decreasing function, $I(t^e)$ of a expectation of the future tax rate. We postulate that higher investment increases the future level of output at any given

9. See Freixas, Guesnerie, and Tirole (1985) and Laffont and Tirole (1988).

10. See, for example, OECD (1997).

future tax rate: $Y(t | I(t^c))$. Assuming that investors rationally project the tax, we can take $t^c = t$. If the central and regional governments could commit to a long-term tax rate, this would not change the problem that has so far been considered in this paper, as it would be possible simply to redefine $Y(t) = Y(t | I(t))$. If commitment is not possible, however, and the optimal policies of the central and regional government are chosen after $I(t)$ is already sunk, decentralisation can even yield outright higher social welfare than optimal central control of the regional budget. In the case of no commitment, the central and regional government will optimise under the assumption that investment is fixed at its sunk level, $I(t)=I$ and $Y(t) = Y(t | I)$. For this reason, tax rates will be chosen that are “too high” from the point of view of dynamic optimisation.

41. We know, however, from the analysis so far that the prevailing tax will be lower under decentralisation than under (imperfect) central control. Let I^d be the level of investment chosen under decentralisation and I^r the level chosen under central control. The anticipation of a higher tax rate in the latter case implies that $I^d > I^r$. Then social welfare will be higher under decentralisation than under central control if:

$$(10) \quad Y(t^d | I^d) + S(e^d) > Y(t^r | I^r) + S(e^r)$$

Where $\{t^d, e^d\}$ are part of the solution to (6) with $Y(t) = Y(t | I^d)$ and $\{t^r, e^r\}$ are part of a solution to the problem considered in Proposition 2 with $Y(t) = Y(t | I^r)$. This inequality can hold due to the fact that $I^d > I^r$. The greater the effect of the expectation of the tax rate on investment, and investment on output, the more likely will be the case that (10) will hold.

H) The central government as Leviathan and competition between regions

42. So far, this paper has actually abstracted from the primary advantage of decentralisation that has been stressed in recent literature: the fact that the central government may be part “Leviathan” and motivated by concerns other than the maximisation of social welfare. The behaviour of central governments also reflects political bargaining and interest group pressures. In the Russian Federation, for example, the alarming degree to which regional and local budgets have become increasingly crippled by unfunded federal expenditure mandates owes partly to efforts by various factions in the parliament to take credit, but not responsibility, for populist measures. Brennan and Buchanan (1980) view decentralisation, in the context of competition between regions for business and investment, as a socially useful means of erecting an institutional barrier to the over-expansion of the central government. This theme has been further developed under the rubric of “market-preserving federalism” by North and Weingast (1989), Weingast (1995), Monitola, Qian, and Weingast (1995), and McKinnon (1997). Roland and Qian (1998) provide a partial formalisation of how such competition between regions can discipline economic policy.

43. Although the model of this paper abstracts completely from intergovernmental competition, it nevertheless suggests another rational for decentralisation in the case of the central government as “Leviathan.” A consequence of central control in this model is an inflated regional budget and a corresponding higher tax burden on output. At least in the static case, this supports a higher payoff of the central government than under decentralisation. But this payoff may not properly measure actual social welfare. We could postulate that, in addition to necessary social expenditures, $S(e)$ could measure the satisfaction of the interests of special constituents or interest groups close to the dominant political party. In such a case, decentralisation could also emerge as an outright socially optimal arrangement relative to imperfect central control, even without a consideration of the administrative costs of control.

IV) Concluding comments

44. OECD(2000) and Lavrov, Litwack, and Sutherland (2000) emphasise problems in fiscal federalist relations in the Russian Federation that derive from the coexistence of (imperfect) central control over subnational budgets and significant *de facto* subnational autonomy. These problems include the difficulty of delegating responsibility to lower levels of government when subnational officials have little formal decision-making authority, as well as strong incentives for taking subnational fiscal activities off budget. This paper has explored some, but not all, of the problems associated with the existence of an informal budget that operates in avoidance of central control. In particular, a different sort of model would be required to formalise the important implications for fair competition of a policy bias toward large incumbent firms with a capacity to supply public goods and services.

45. The results of this paper indicate that (imperfect) central control of regional budgets in the presence of informal autonomy will likely produce a higher overall tax burden on business and investment and, consequently, lower output. Social expenditures will also be higher, although the efficiency of these higher expenditures might be questioned on both informational and political grounds. The imposition of (small) costs on the conduct of informal budgetary policies has uncertain effects, while the imposition of small fixed costs has an unambiguously negative effect. The possibility of underfulfilment of the formal budget presents further problems, particularly in the case of revenue sharing between budgets. Even in the presence of a completely benevolent central government, decentralisation may generate higher social welfare than central control if investment depends strongly on future expected taxes and government commitment is difficult. These results are consistent with what appears to be the situation in most Russian regions: a high level of unfunded mandated federal expenditures (either as explicit mandates, or norms and regulations pertaining to various subnational budgetary categories), the use of various costly instruments for the realisation of informal subnational policies, and a high (explicit plus implicit) tax burden on business and investment.

46. This paper offers a word of warning to those advocating a continuation of the current strategy of maintaining or increasing the high degree of central control over subnational finance in the Russian Federation. Unless this control is accompanied by a crackdown that is actually severe enough to eliminate informal budgetary activity, it may very well have an adverse effect on the business and investment climate of the region. Crackdowns of limited severity can have precisely the opposite of the intended effects. The very high degree of leverage that regions and localities currently have over economic organisations on their territories implies that the actual elimination of both formal and informal autonomy would require rather extreme measures of questionable feasibility, not to mention possible inconsistencies with the development of democratic institutions. Making the equivalent of “K(t)” sufficiently high for this purpose would require radical political changes indeed. While the recent legislation that allows the president to remove regional governors in the event of repeated violations of federal law may be interpreted as a step in this direction, and reflects the spirit of Blanchard and Shleifer’s analysis cited above, it is far from sufficient for this purpose.

47. But even to the degree that the elimination of both formal and informal subnational autonomy is feasible in Russia, it is likely to be sub-optimal. In a country as large and diverse as the Russian Federation, such a highly centralised administrative apparatus would be associated with numerous inefficiencies. Perhaps most important, Russia would not be able to reap any of the benefits of intergovernmental competition between regions and localities for business and investment, a process that could be critical for supporting an improved business climate in Russia.

48. An alternative strategy for Russia is outlined in OECD (2000), the Economic Programme of the Russian Government (Programma...2000), and Lavrov, Litwack, and Sutherland (2000). This strategy calls for creating genuine subnational autonomy within well defined bounds and freeing regions and

localities completely from unfunded federal expenditure mandates, while at the same time centralising a larger share of tax revenue and expenditure obligations at the federal level, particularly in the area of social policy. This would allow the delegation of genuine responsibility to lower levels of government for budgetary management and an exploitation of the benefits from fiscal decentralisation, while the central government would have an even greater capacity to address directly problems of poverty, inequality between regions, and macroeconomic stabilisation. While the chronic problems of informal rent seeking and corruption cannot be eliminated in the near future in the Russian Federation, a feasible budgetary framework with formal regional autonomy and responsibility would also provide a better foundation for addressing these issues, as well as for reducing their social and economic costs.

APPENDIX: PROOFS OF THE PROPOSITIONS

Definitions:

$$H(t) = \frac{-Y'(t)}{Y(t) + tY'(t)} \quad (1.1)$$

$$\tilde{t} = \underset{t}{\operatorname{argmax}} [tY(t)] \quad (1.2)$$

then for all $t \in [0, \tilde{t})$

$$\begin{aligned} \text{(i)} \quad & H(t) > 0 \\ \text{(ii)} \quad & \lim_{\substack{t \rightarrow \tilde{t} \\ t.h.s.}} H(t) = \infty \\ \text{(iii)} \quad & H'(t) > 0 \end{aligned} \quad (1.3)$$

(1.3)i follows from $Y' < 0$, $Y(t) + tY'(t) > 0$ for $t < \tilde{t}$ and $Y(\tilde{t}) > 0$ (1.3)ii comes from $Y(\hat{t}) + \hat{t}Y'(\hat{t}) = 0$
 (1.3)iii Follows from the concavity of $Y(t)$ (or the weaker condition $Y''(t) < 2[Y'(t)]^2/Y(t)$)

Proposition 1

$\{t^*, e^*\}$ are determined by the necessary (and in our case sufficient) first order condition and the budget constraint

$$\begin{aligned} \text{(i)} \quad & S'(e^*) = H(t^*) \\ \text{(ii)} \quad & t^* Y(t^*) = e^* \end{aligned} \quad (1.4)$$

Similarly, $\{b^d, e^d, t^d\}$ must satisfy

$$\begin{aligned} \text{(i)} \quad & S'(e^d) = U'(b^d) = H(t^d) \\ \text{(ii)} \quad & t^d Y(t^d) = e^d + b^d \end{aligned} \quad (1.5)$$

Let $\{e(t), b(t)\}$ be the unique values of $\{e, b\}$ that maximise (6) for a given $t \in (0, 1)$. By the Inada conditions (4), $e(t), b(t) >> 0$. Consider the first best tax, t^* , determined by conditions (1.4) above. Then for all $t \leq t^*$, we have

$$S'(e(t)) = S'(tY(t) - b(t)) > S'(tY(t)) \geq S'(t^* Y(t^*)) = H(t^*) \geq H(t) \quad (1.6)$$

The first inequality comes from $S'' < 0$ and $b(t) > 0$. The second is due to $S'' < 0$ and the fact that revenue, $tY(t)$, is increasing for $t \leq t^*$. The last inequality comes from (1.3) iii.

Since by construction, $e(t^d) = e^d$, (1.6) and (1.5)i together imply that $t^d > t^*$. Therefore

$$S'(e^d) = H(t^d) > H(t^*) \quad (1.7)$$

which implies that $e^d < e^*$. \square

Proposition 2

Without a loss of generality, we can take $t^\circ = \{t \mid tY(t) = e^\circ\}$ and eliminate the redundant constraint (7)iii.

If $e^\circ \leq e^d$, constraint (7) ii would not be binding and the region would choose the exact same optimal policy as under decentralisation $\{b^d, e^d, t^d\}$. We can therefore, without a loss of generality, restrict the choice of the centre to $e^\circ \geq e^d$. In this case, the region will choose b and t according to the first order condition and the budget constraint:

$$\begin{aligned} \text{(i)} \quad & U'(b) = H(t) \\ \text{(ii)} \quad & b = tY(t) - e^\circ \end{aligned} \quad (1.8)$$

substituting (1.8)ii into (1.8)i and treating t as an implicit function of e° gives

$$\frac{dt}{de^\circ} = \frac{1}{Y(t) + tY'(t) - \frac{H'(t)}{U''}} \quad (1.9)$$

From (1.9) $t < \tilde{t} \Rightarrow \frac{dt}{de^\circ} > 0$, since $Y(t) + tY'(t) > 0$, $H' > 0$, and $U'' < 0$

Given the optimal response by the region of $t(e^\circ)$, social welfare can be written:

$$W(e^\circ) = Y(t(e^\circ)) + S(e^\circ) \quad (1.10)$$

Using (1.9), the change in $W(e^\circ)$ from a higher e° is

$$W'(e^\circ) = Y'(t) \frac{dt}{de^\circ} + S'(e^\circ) = \frac{Y'(t)}{Y(t) + tY'(t) - \frac{H'(t)}{U''}} + S'(e^\circ) \quad (1.11)$$

Consider a possible choice of $e^\circ = e^d$, which we know implements the decentralised solution: $t(e^d) = t^d$. Using the left-hand side derivative of $t(e^\circ)$ at $e^\circ = e^d$, we have from (1.9) and the definition of $H(t)$:

$$\begin{aligned}
W'(e^d) &= \frac{Y'(t^d)}{Y(t^d) + t^d Y'(t^d) - \frac{H'(t^d)}{U''}} + S'(e^d) \\
&> \frac{Y'(t^d)}{Y(t^d) + t^d Y'(t^d)} + S'(e^d) = -H(t^d) + S'(e^d) = 0
\end{aligned} \tag{1.12}$$

The last inequality comes from (1.5). (1.12) demonstrates that social welfare is increasing in e° at $e^\circ = e^d$. Therefore, the centre will choose $e^\circ > e^d$. Since $\frac{dt}{de^\circ} > 0$, $t^r > t^d$. Also, since $e^r = e^\circ$, $b^r = t^r Y(t^r) - e^\circ$ \square

Proposition 3

Again, without a loss of generality, take $t^\circ = \{t \mid tY(t) = e^\circ\}$ and eliminate the third constraint from the region's optimisation problem. Given this particular form of $K(t)$, the region will choose between two options. First, it could pay the cost "a" and solve:

$$\begin{aligned}
&\max_{t,b,e} [Y(t) + U(t) + S(e)] \\
&\text{s.t. (i) } tY(t) - a - b - e \leq 0 \\
&\quad \text{(ii) } e \geq e^\circ
\end{aligned} \tag{1.13}$$

The condition $e^\circ < \max_t [tY(t)]$ ensures that this option is feasible for a small enough "a." The second option is not to pay the cost, set $b=0$, and maximise

$$\begin{aligned}
&\max_{t,e} Y(t) + S(e) \\
&\text{s.t. (i) } tY(t) - e \leq 0 \\
&\quad \text{(ii) } e \geq e^\circ
\end{aligned} \tag{1.14}$$

For a large enough "a," (1.14) will be the preferred (and maybe the only feasible) option. But $a \rightarrow 0$ implies that $Y(t) + U(b) + S(e)$ evaluated at the solution to (1.13) converges to maximal regional welfare for the case of problem (7) where $K(t) = a = 0$. On the other hand, (1.14) is invariant with respect to a, and therefore bounded below this value.. Therefore $\exists \gamma$ such that $a < \gamma$ implies that $\{t,b,e\}$ will be chosen by problem (1.13). In this case, by the first order conditions and budget constraint:

$$U'(tY(t) - e(t) - a) = H(t) \tag{1.15}$$

Treating t as an implicit function of "a" and differentiating yields

$$\frac{dt}{da} = \frac{1}{[Y(t) + tY'(t)] - \frac{de}{dt} - \frac{H'(t)}{U''}} \tag{1.16}$$

Two cases are possible. If constraint (1.13)ii is binding, then $e = e^\circ$ and $\frac{de}{dt} = 0$. If (1.13)ii is not binding, the first order conditions for (1.13) imply that $U'(tY(t) - e(t) - a) = S'(e(t))$ and

$$\frac{de}{dt} = \left[\frac{U''}{U'' + S''} \right] [Y(t) + tY'(t)] < Y(t) + tY'(t) \quad (1.17)$$

In either case, $\frac{de}{dt} < Y(t) + tY'(t)$, which implies that $\frac{dt}{da} > 0$. □

Proposition 4

First note that the centre would never choose $a > 0$ for a case in which the regional maximisation of (8) would set $b > 0$. Indeed suppose the centre chose a policy $\bar{a}, \bar{e}^\circ, \bar{t}^\circ$ such that the region chooses $\{b(\bar{a}, \bar{e}^\circ, \bar{t}^\circ), e(\bar{a}, \bar{e}^\circ, \bar{t}^\circ), t(\bar{a}, \bar{e}^\circ, \bar{t}^\circ)\}$ with $\bar{a}, b(\bar{a}, \bar{e}^\circ, \bar{t}^\circ) \gg 0$ then the region must be solving the problem (1.13) and, by (1.16) and (1.17), $\frac{dt}{da} > 0$. Choose a new policy $\{a', e', t'\}$ where $a' = \bar{a} - \varepsilon$, $e' = e(\bar{a}, \bar{e}^\circ, \bar{t}^\circ)$, $t' = \bar{t}^\circ$.

This policy is feasible and implements at least the same level of social expenditures "e" at lower cost "t," increasing social welfare. Thus, $\bar{a}, \bar{e}^\circ, \bar{t}^\circ$ cannot be optimal.

Now consider a policy that chooses $a > 0$ and implements $b = 0$. By the nature of the region's choice of optimisation between (1.13) and (1.14), $\bar{a} \rightarrow 0 \Rightarrow e^\circ \rightarrow \max_t [tY(t)] = \tilde{t}Y(\tilde{t})$ and $W(t, e) \rightarrow Y(\tilde{t}) + S(\tilde{t}Y(\tilde{t}))$. This holds by both the feasibility constraint $e^\circ \leq \tilde{t}Y(\tilde{t})$ and the fact that, as $a \rightarrow 0$, the region would choose $b > 0$ unless $e^\circ \rightarrow \tilde{t}Y(\tilde{t})$. But, by revealed preference, we know that

$$Y(t^d) + S(t^d Y(t^d)) > Y(\tilde{t}) + S(\tilde{t}Y(\tilde{t})) \quad (1.18)$$

where $t^r, e^r = e^\circ$ are solutions given by Proposition 2 (the case of $K(t) = 0 \forall t$). This is because $e^\circ = \tilde{t}Y(\tilde{t})$ was a feasible policy for the previous case of $K(t) = 0$, but suboptimal. By the budget constraint ((1.14)ii), $e^\circ \rightarrow \tilde{t}Y(\tilde{t}) \Rightarrow t \rightarrow \tilde{t}$.

Thus, $\exists \gamma$ such that $\bar{a} < \gamma$ implies that $a > 0$ will not be optimal either as a policy that implements $b > 0$ or $b = 0$. Therefore $a = 0$ will be the optimal choice. If $a = 0$, we are back in the case of Proposition 2 for the choice of $\{t^\circ, e^\circ\}$.

Proposition 5

The condition for $t(a)$ follows immediately from Proposition 3 for the case of $e^\circ = t^\circ = 0$. In this case, the regional government will be solving problem (1.13). $e(a)$ will then satisfy the first order condition:

$$e(a) = \{e \mid S'(e) = H(t(a))\} \quad (1.19)$$

Since $t(a)$ and $H(t)$ are both increasing and $S'' < 0$, it follows that $e(a)$ is decreasing. □

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