Cost Structure and Tax issues in Effective Public Transportation Investment

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Abstract

This paper has taken the initial effort to understand potential pitfalls and complexities that could rise in the public-private collaboration of public transportation investment, and tries to provide recommendations in terms of tax policies and impacts of cost structure in the investment model. By adopting concepts from macroeconomic theory and public finance, we provide a prescriptive framework to illustrate tax variations under different circumstances and emphasize the importance of cost structure, timing of decision-making, and funding adequacy. The idea of using high-speed rail as our model example originates from President Obama's stimulus plan, however, the insights generated from the model is useful in understanding other capital investment problems in transportation field.

Keywords: Cost structure, Tax, Investment, Public-Private Partnerships, Government Incentives, Equilibrium, ARRA 2009

1 Introduction

When it comes to infrastructure projects, such as public transit facility investment or highway maintenance, initiators usually become unduly reticent on the subject of the source of funding. We have to admit that the funding difficulties at both federal and state level are enormous. The recent economic crisis and the allocation of billions of federal dollars to support U.S. banks (and other industries) further expanded the gap between transit funding demand and money available. Even though President Barack Obama signed the $787-billion "American Recovery and Reinvestment Act of 2009" (the Stimulus Package) in February 2009, it may be wise for state and local government officials to explore alternative ways to finance transit projects.

One of the promising solutions that attracts most attention is for the government to involve private parties into investment and management process of infrastructures, with certain preferential treatment on policy. With the available funding issued from the *Stimulus Package*, government should take this chance to call for capable private investors to participate in this game, while being able to subsidize partial project costs to make the investment burden on private parties at a reasonable level. Our paper has taken the initial effort to understand potential pitfalls and complexities that could rise in the collaboration of public transportation investment, and tries to provide recommendations in terms of tax policies and impacts of cost structure in the investment model.

The contributions of this paper mainly are: (1) to serve as an incipient exploration of potential complexity among different parties *before* a successful investment project is carried out, and potential practicable stratigies that government may want to apply in certain situations by adopting concepts from macroeconomic theory and public finance. (2) to provide a prescriptive framework to illustrate tax variations under different circumstances and emphasize the importance of cost structure, timing of decision-making, and funding adequacy. We first showed the two-party game by assuming government needs private involvement and a satisfactory return can be gained, and proved why a passive government is unable to attract private party successfully. The result is in accordance with previous literatures. Then we attempt to differentiate the private party into private investors and labor suppliers to show the increasing complexity of the game that the government faces when making policy decisions. In this case, government needs to take more initiatives to appease the indefinite psychology from private investors. To maintain the original equalibrium achieved in two-party game, we incorporate the concept of nonbenevolent government to show the necessity of favoritism towards private investors. Finally, we analyze the details of cost structure and its influence in policy decision-making under different scenarios. We have shown that the final investment tax will have a fixed relationship with the returns to scale chosen by private party. In the mean time, we argue that, in the situation of insufficient funding, inferior quality of infrastructure may potentially generate deterioriated return. Therefore, to ensure private participation in the first place, the government has to lower corresponding tax rate to make up for the loss of private party.

The paper is organized as follows. Section 2 provides a public-private partnership overview and the example we use to present our work. Section 3 outlines the model and discussed various tax policies in the multi-party game, and section 4 presents detailed analysis with regard to cost structure issues. In section

5 we offer conclusions and recommendations for future research.

2 Public-Private Parternerships (PPP) and Our Example

Historically, transit projects generally employ a "design-bid-build (DBB)" approach. The public sector first designs the project, holds a bidding meeting to select the lowest bidder who is going to be in charge of project construction, then it will continue to operate and maintain the project, while using public money to finance it. In this approach, we have two flaws: one is that lacking sufficient transportation funding from federal, state or local government level will delay the implementation of beneficial projects, the other is that the competition for such limited funding has been increasing for the past few years.

2.1 PPP Approach and Historical Return of Investment

Recently, Public-Private Parternership (PPP) has emerged as an important alternative for those traditional approaches. In this approach, private party begins to take more responsibilites, including financing, construction, operations and management, in exhange of higher return of its investment.

Currently, there are no published data of investment return in PPP infrastructure projects in the United States. However, the return is quite satisfactory in other regions that have already been actively investing in PPP projects.

In Europe, according to European Investment Bank (EIB), their Projects Directorate calculated an ex-ante economic internal rate of return ranging generally from 9% to 14% for the projects evaluated. (Thomson et al., 2005) HOCHTIEF, one of the leading international providers of construction-related services, its Concessions division applied a weighted discount rate of 12.3 percent for their PPP portfolio as of December 31, 2008.

In Asia, India has seen PPP projects of infrastructure climb in both number and value from 1995 to 2006. Even though the debt-equity ratio has been increasing, developers stated that, out of 22 cases, more than 70 percent sought expected equity returns exceeding 16 percent. (Harris and Tadimalla, 2008)

2.2 Benefits of Private Investment and Public Subsidization

The beneficial social alliance with private parterners in providing public transit service can be viewed in following ways:

First of all, scale of economy plays an important role in transit industry, high fixed cost (e.g. rolling stock, terminal, infrastructure facilities, etc.) makes the marginal cost of providing service to an additional user is quite low. As long as enough funding is provided to achieve a successful partnership in implementing the project, the cumulative public benefits are enormous.

Secondly, viewing it as a way of income redistribution, our government can virtually make a money transfer payment by providing funds to public transit systems to better serve those relatively underprivileged citizen groups; simultaneously, private company can potentially gain some preferential treatment from government as a result of its contributions to the public service.

Last but not the least, from a broader perspective, transit is viewed as an effective tool to promote the change of future land use, urban form, as well as population distribution and their interactions.

2.3 Investment Example of High-speed Rail

The selection of high-speed rail as our example is motivated by Obama's Stimulus Package. As noted in American Recovery and Reinvestment Act of 2009 (ARRA 2009), there is an amount of $8 billion funding for "intercity passenger rail projects and rail congestion grants, with priority for *high-speed rail*". From a practical perspective, with more and more cars running on the highway that generate excessive air pollution and congestion, our time, money and environment are "depreciated" on daily travel, and things even get worse as energy (gas, oil) prices keep increasing in recent years. Therefore, it would sound really exciting if there exists a 200mph train efficiently moving people and goods among cities. "High-speed rail integrates all these systems together and moves people from city to city at high speed. When the distance is only a few hundred miles, high-speed rail coupled with city transit beats airplane and car every time." commented by Addison (2009).

Fig. 1: Vision Map of High-speed Rail of America

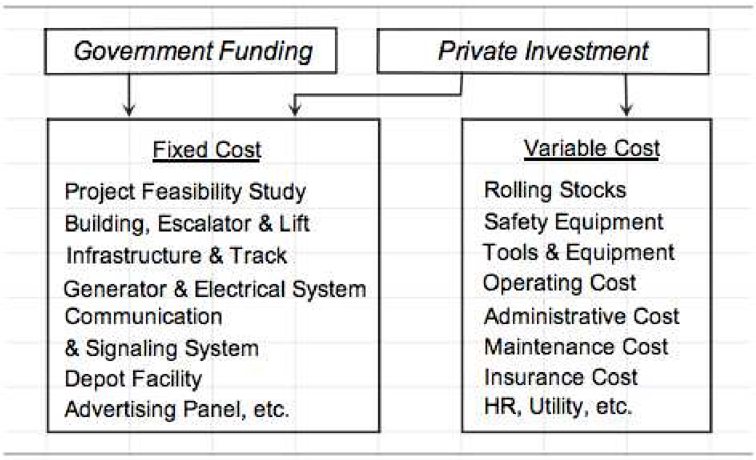
In above map, the 800-mile California highspeed rail corridor will be built in sections, such as "Orange County - Los Angeles", "San Jose - San Francisco", etc. This is based on local and public-private partnership funding, as well as state and federal funding. Southeast High Speed Rail Corridor, linking Washington D.C. with Charlotte, NC, is also working hard to secure funding to support its construction. Another example is *NJ TRANSIT*, which has been slowly privatized over the past years. As the nation's third largest provider of bus, rail and light rail transit, linking major points in New Jersey, New York and Philadelphia, NJ TRANSIT recently received $420 million from Stimulus Package to "accelerate more than a dozen key capital projects that will create and preserve jobs", these projects "will build system capacity, extend accessibility and ensure service reliability for decades to come". (NJ Transit Website)

In our model, government has funding (i.e. Stimulus Package as a main source) for a potential highspeed rail project, and private company has capital that could potentially be used to invest in this project. If they form a partnership, our model woud assume that the funding from government would mainly be used to subsidize a portion of the fixed cost of project; private party will be responsible for the rest of fixed cost portion and the variable cost of the project. We assume the riders who use the transit service are mainly businessmen/workers frequently traveling between cities, which means that there will be a stable revenue source for providing this service, thus making this project attractive to private parties.

The reason that government has to cover certain portion of fixed cost is because the investment, especially the fixed cost part, of rail project is prohibitive, plus the concerns of cost recovery issues, it would be much less attractive for private parties to participate if they need to provide the entire funding to cover all the cost. As noted in a survey of North American light rail projects, the costs of most LRT systems range from \$14 million per mile to over \$100 million per mile. (Light Rail Now, 2002) Besides, it will also be beneficial to the government because if the partnership is successfully achieved, government can save a great deal of money as it doesn't need to worry about the rest of cost (fixed, variable, operating, managerial, etc.).

A sample of cost allocation plan that will be used by our model and related main cost items are shown in Figure (2).

Fig. 2: Possible Cost Allocation Plan of HLR Project Parternership



3 Optimal Policy Design for Private Investment Model

The goal of an effective contract is for the principal (the government or local authority) to allocate risks to the agent (private party) efficiently (who, for example, bears the burden of management), while providing appropriate performance incentives (reduction in service costs, quality of service, on-time percentage and so on) (Karlaftis, 2007). Nowadays, more attention is drawn to the issue of taxation in public-private partnerships. Selby and Hunter (2004) discussed the use of "Tax Increment Financing" method to create innovate public-private partnerships and its impact in allowing underutilized areas to fund their own redevelopment, which motivates the consideration of taxes's role in the investment model. The issue of tax on capital gains is brought up in a report of tax treatment guidelines by Central PPP Unit of Dublin (Central Guidelines, 2003). Association of American Railroads has already proposed the concept of "Investment Tax Credit" to promote freight rail infrastructure capacity expansion, in which it claimed that "a tax credit for projects that expand freight rail capacity would help bridge the funding gap and produce public benefits (like reduced highway gridlock and lower greenhouse gas emissions) that would far exceed the cost of the credit" (Association of American Railroads, 2008). A case study of the privatization project of Malaysia STAR light-rail transit system indicates that Malaysian government provided generous incentives to STAR concessionaire. Not only exempted from import duties and local sales tax, the project also had attractive investment tax credit allowances. (Abdul-Aziz, 2006) Recently, Matthew Rose, the Chairman, President & CEO of BNSF Railway, argued that "railroads should not be taxed for the public's share of investment, since railroads pay for any benefit they derive from a PPP project and because they bear the burden of funding all of the freight network (a $10 billion expenditure in 2008)" (Caruso, 2009).

Motivated by above arguments, we are going to focus on the taxation and capital structure issues in private investment. The problem we are targeting is: if a government with limited funding wants to involve private parties in a project, which is beneficial for public in the long run, then how to induce private party to take initiatives in the investing in the first place, and what government should do to form a successful partnership with private parties. The following model will investigate the implications in public transit investment projects, as they have a relatively higher demand of labor, and the cost required is generally quite high. In addition, depending on the type of projects, the level of fixed cost in the investment plan can influence the implementation of the project (the variable cost will play a role here, too).

Our model is built and expanded on previous work in the field of economics. Particularly, the idea is originated from Ramsey (1927), which describes the related taxation issues in public finance tradition. He proposed the question as "a given revenue is to be raised by proportionate taxes on some or all uses of income, the taxes on different uses being possibly at different rates; how much should these rates be adjusted in order that that the decrement of utility may be a minimum?" (Ramsey, 1927). In this static, representative consumer economy with many goods, he investigated the decision that the government should make in a competitive equilibrium when choosing tax rates to maximize the welfare of the representative consumer, given a set of determined taxes, prices and quantities. Fischer (1980) introduced a particularly interesting capital taxation model for discussion, he investigated the circumstances under which the problem of dynamic inconsistency arises, and discussed its implications for control theory and optimal policy-making. He stressed that the problem will arise when the government does not have commitment instruments and when expectations of future variables are relevant to current private sector decisions. Chari (1988) and Chari et al. (1989) extended the discussion of the time consistency problem and related optimal policy design in detail with the illustration of taxation model and government debt model, where they focused on sustainable equalibriums based on certain sequential rationality conditions. Further, Atkeson et al. (1999) brought up the idea that capital income tax should be driven to zero over long term, with another example considering a production economy with many identical consumers. Baron and Myerson (1982) discussed the case of regulating a monopolist with unknown costs, and showed the effects of treating consumers and firm differently by maximizing a weighted sum of utility functions. Later, Borger et al. (2009) stressed the importance of cost structure and related welfare benefits in infrastructure investment for a region or a country. Specifically, he considered a region that invests in infrastructure used by both local demand and through traffic. By comparing transport systems that have, for a given capacity, the same total infrastructure cost but different cost structure, their result showed that, compared to a benchmark infrastructure which has zero fixed costs, an infrastructure which has (ceteris paribus) a higher share of fixed costs leads to higher welfare for the regional government building it. He also pointed out that due to the existence of through traffic and high fixed cost of capacity expansion, the investment incentives may be low and the cost recovery can be a problem.

4 Two-Stage Model Specification

We consider a two-stage investment and spending regime, with the interaction of government and one private firm, which potentially supplies both capital and labor, represented by investors (capitalists) and labor providers (workers). The government wants to build up a lightrail transit project, however, it doesn't have sufficient funding. The private company has capital to finance the project, provided with certain level of government subsidy. The government now is reaching out to private party to seek potential partnership in this project, meanwhile, it has to set the policy to satisfy its own budget.

Assumption 1 (Cost Allocation Assumption)**.** *In the financing plan, we assume that government funding "f" will be used to disburse partial fixed cost of the project, which is allocated according to the contract, i.e.* $f = C^{Gov}$*; similarly, private investment will cover the rest of fixed cost and variable costs, i.e.* $i = C^{Private}$*. Thus, total cost needed by the project* $W = C^{private} + C^{Gov} = i + f$*.*

The game goes in two stages. Major definitions are adopted from Chari (1988).

1. For the government, it can announce its policy in either stage.

   Definition 2 (Policy)**.** Policy is a definite method selected among alternatives and in light of given conditions to guide and determine present and future decisions, which is instituted by the government.

   A policy(π) is simply a choice of tax rates (θ, τ), denoted by $\pi(\theta, \tau)$. θ is the tax rate for investment return, while τ denotes the labor tax rate. For practical reason, we assume that θ is in the interval of [0, 1] and $\tau < 1$.[1] The possible policy is chosen from the policy set Π, which contains a variaty of possible policies. [2]

2. For the private company, it announces allocation of resources based on certain choice function in each stage.

[1] When τ is negative, it means that government issues a tax refund to the labor.
[2] One implication from tax rates is that government can send incentives by reduce some rate below its normal level, in this case, it can be considered as a tax subsidization.

Definition 3 (Allocation)**.** Allocation is a vector of actions $A = (a_1,\ a_2,\ ...,\ a_n)$ which can be chosen by private company when facing a policy provided by the government. The action set is Λ.

In this model, the actions faced by private company are expenditure (e), investment (i), and labor supply (l).

Definition 4 (Choice Function)**.** A choice function F specifies optimal behavior at some arbitrary policy $\tilde{\pi}$, which results contingent optimal allocation rule A^*. The mapping process can be viewed as $F(\tilde{\pi}) \to A^*\,(a_1,\ a_2,\ ...,\ a_n)$, where $a_i \in \Lambda,\ \tilde{\pi} \in \Pi$.

Each stage, private company has to make desicion based on its available resources.

Definition 5 (Resource Constraint)**.** Resource constraint is the capital limit within which private company can freely choose its allocation actions.

Here the resource constraint is the money available to private company.

In the first stage it has a total capital of C, from which they allocate e for corporate expenditure and use the rest as investment i in the transit project. If the invesment i is positive, there will be a return rate R for its investment, which can be viewed as a technology that transforms the investment i into iR. Here the R is different from Fischer (1980)'s setting with an after-tax rate of return on investment, as we need to consider the implications of capital tax. For simplicity, we assume here that $R > 1$.[3]

At the second stage, private company has to set a portion of its total return to finance working labor, and the rest will be considered as the return from investment. By assuming the marginal productivity of labor is $1 \cdot w = w$, where w is the wage rate per unit of labor, we can consider that if a worker works l units of labor, the monetary output is wl.[4]

The government has to finance a budget spending, which is raised from propotional taxes on private investment return and labor. In this situation, the resource constraint for private company in the second stage is: $(1 - \theta)\, iR + (1 - \tau)\, wl$.

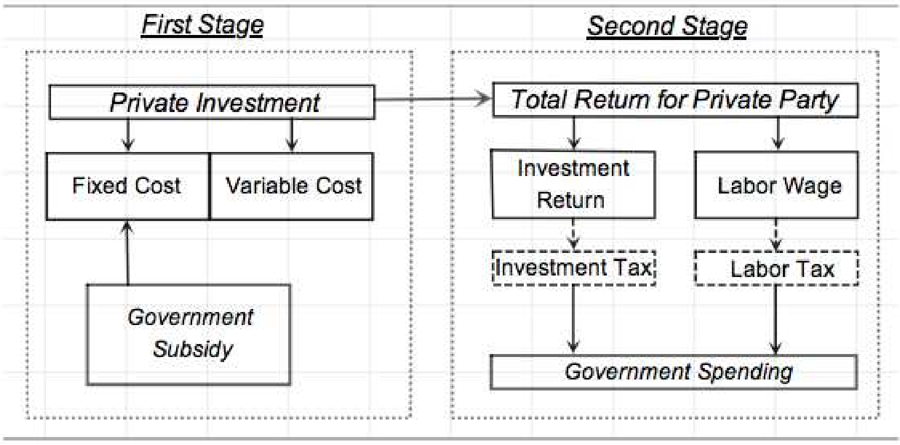
Assumption 6 (Investment Return Assumption)**.** *We assume that the gross return generated by private parties' investment will be divided into two parts: one is used for labor wage, the other is considered as adjusted investment return after labor wage ("investment return" for short, hereafter).*

Above assumptions can be summarized in Figure (3).

[3] This paper's intention is to show under a situation with $R > 1$, how government should behave to achieve a successful partnership with private company.

[4] In this paper, we only consider workers as a whole, so when we say the labor supply is l, it refers to the total labor supply.

Fig. 3: Capital Flow in two-stage model



Definition 7 (Budget Constraint)**.** Budget constraint is the expenditure requiement that government has to meet. This spending is denoted by G.

In this model, the budget constraint is the tax revenue government collects from private company's investment earnings and labor wage, which has the form as:

$$TR = iR\theta + wl\tau \geq G \tag{1}$$

this means that the tax revenue from investment return and labor output has to exceed government's necessary budget spending G. One thing important to indicate here is that the government is also trying to maximize the private company's utility because, on the one hand, private company is included in his jurisdiction and perform a key role in providing future public transit service; on the other hand, the government is also trying to set an exemplary case for future public-private cooperation. The only thing restricts government's benevolence is the budget constraint.

According to the theory of preference, private company is going to maximize its own utility subject to its resource constraints in each stage.

Definition 8 (Utility Function)**.** The preferences of each party is given by a utility function $U(A, \pi)$.

In this model, we assume that the utility function is quasi-concave and twice differentiable. Specifically, we assume the utility of either party within the private company is strictly increasing in its expenditure, and strictly decreasing in its labor supply.

Let's check the models for different types of participants in this game.

For investors, they can either spend its capital or invest it in the first stage, and their expenditure budget in the second stage is decided by their investment in the first stage. We assume there is no second order utility effect in expenditure here, and we just assume money can change people's feeling of happiness in a linear way. The utility of investors is denoted by $U^C\left(e_1, e_2^C, i\right) = e_1 + e_2^C$. They solve the problem:

$$\max_{e_1,\, i,\, e_2^C} \quad U^C\left(E^C,\, i\right) \tag{2}$$

$$\text{subject to} \quad e_1 + i \quad \le C \tag{3}$$

$$e_2^C \quad \le (1-\theta)\, iR \tag{4}$$

For workers, they cannot do anything in the first stage – we can consider that they are unemployed initially; in the second stage, they choose their expenditure and level of labor supply to the transit service. Considering the existence of marginal decreasing utility of labor supply that can be attributed to people's increasing value of leisure time along with the increasing portion of their time being allocated to work, the utility of workers is denoted by $U^W\left(e_2^W,\, l\right) = e_2^W - \frac{1}{2}l^2$. They solve the problem:

$$\max_{e_2^W,\, l} \quad U^W\left(E^W,\, l\right) \tag{5}$$

$$\text{subject to} \quad e_2^W \quad \le (1-\tau)\, wl \tag{6}$$

For the government, it maximize the social welfare which includes both investors and workers for this transit project. The utility of government is denoted by $U^G\left(U^C,\, U^W\right) = U^C + U^W$, it solves the problem:

$$\max_{\theta,\, \tau} \quad U\left(U^C,\, U^W\right) \tag{7}$$

$$\text{subject to} \quad G \quad \le \theta iR + \tau wl \tag{8}$$

In our initial exploration of the model, let's assume *private company will make decision as a single* entity, i.e. we can simplify its utility function as $U\left(F(\pi)\right) = U\left(A, \pi\right) = U\left(E,\, i,\, l\right),\ E = e_1 + \delta e_2 = e_1 + \delta(e_2^W + e_2^C)$,[5] where δ is a discount factor representing the opportunity cost for delayed value of expenditure. So a private company, confronted with tax rates θ and τ, chooses an allocation of $(e_1,\, i,\, e_2,\, l)$ to solve

$$\max_{e_1,\, i,\, e_2,\, l} U\left(E,\, i,\, l\right) \tag{9}$$

subject to

$$e_1 + i \le C \tag{10}$$

$$e_2 \quad \le (1-\theta)\, iR + (1-\tau)\, wl \tag{11}$$

Therefore, for this maximization problem, at the first stage, the expenditure and investment together cannot exceeds the total capital available to the private company; and at the second stage, the expenditure cannot exceeds the after-tax investment return plus after-tax labor production.

Now, the simplified form of utility function for private company as a single entity is

$$U\left(E,\, i,\, l\right) = e_1 + e_2 - \frac{1}{2}l^2$$

The decreasing utility of labor here means that the private company is held back in providing labor, because company not only has to split a share of the

[5] For now, we are going to assume the perfect substitutability of first-stage expenditure and second-stage expenditure, which means that $\delta = 1$.

return to pay for labor wage, but also need to take care of all other issues, such as insurance, labor union affairs, and disputes initiated by the workers, which overall affects negatively on the company's utility. And to make our discussion simple, unless otherwise noted, we assume interior solution can be achieved by solving first-order conditions to maximize the utility.

Assumption 9 (Labor Tax Necessity). *We assume that the government spending is significant enough, so that even if the private company invest all of their capital in the first stage ($e_1 = 0$) and is taxed optimally on its return ($\theta = \theta^*$), labor still has to be taxed to finance the government expenditure.*[6] *Formally, this requires*

$$(R-1)\,C < G < (R-1)\,C + \frac{w^2}{4} \tag{12}$$

The right-hand side is the upper bound of the maximum possible goverment spending, which guarantees the existance of solution to our problem.

Currently, to make things simple, we first consider the case where the private investment is enough to finance the transit project ($W \leq C^{private} + C^{Gov} = i + f$). Thus we can see from the following context, only the investment and associated spending and labor supply decisions made by private parties will play important roles in this regime.

4.1 Private Entity's Decisions

For this section, we are going to show that it is necessary for the government step up first to make a commitment to induce private parties to participate in public transit investment projects. Thus we define two types of governments: (1) Proactive government, and (2) Reactive government.

The difference between two governments is: Proactive government (first-type government) will take initiatives to make its tax policies ahead of private investment and expenditure decisions; while reactive government (second-type government) prefer to wait until second stage to announce its tax policies. This decision making process is in line with Chari et al. (1989)'s paper.

Specifically, the different government will induce different choice functions:

1. In the first-type (proactive) government situation, government announces its π ahead of each decision by private company, i.e. announcing θ at the beginning of first stage before investment decision is made; and anoucing τ at the beginning of the second stage before labor decision is made.[7]So the choice function will operate as $F^1(\pi) = (A_1,\, A_2) = ((e_1(\pi),\, i(\pi))\,,\; (e_2(\pi),\, l(\pi)))$. Superscript 1 (or 2) denotes that this choice function works for the first-type (or second-type) government.

2. In the second-type (reactive) government situation, government announces its π, i.e. both θ and τ, at the beginning of second stage, so at the

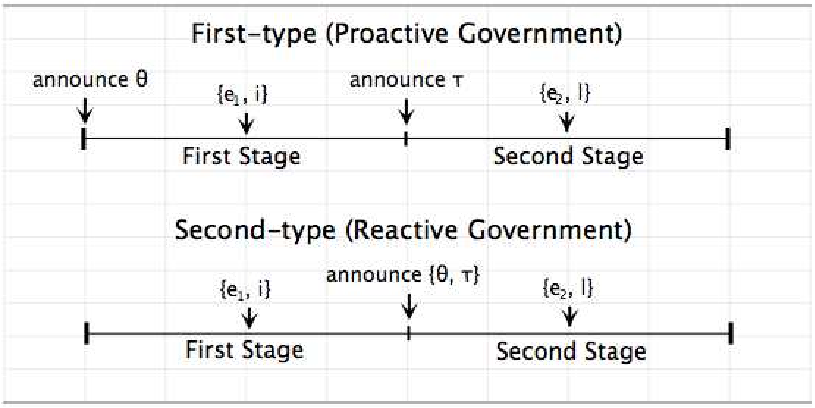
[6] If the tax from investment return can fully satisfy the demand of government spending, then we don't need to consider labor role thereafter, which is actually the focus of this paper. The related issue will be discussed in later research paper.

[7] This is common practice in reality as government will wait until the completion of a project to announce a labor tax rate, because at that moment it is easier to make a more accurate labor demand estimate.

beginning of first stage, private companies have to take expectations of possible policy regimes that government might have in the second stage to decide their first stage allocation A_1.[8] Now the choice function will operate as $F^2(\pi) = \left(A_1^E,\ A_2\right) = \left(\left(e_1(\pi^E),\, i(\pi^E)\right),\ \left(e_2(\pi),\, l(\pi)\right)\right)$. Superscript E denotes that this policy is the expectation of private company, which may or may not coincide with the revealed policy in the second stage.

So we can illustrate the timeline of two types of government in Figure (4):

Fig. 4: Timeline of Different Governments' Policy Decisions



4.1.1 Proactive Government Problem

Now let's consider first-type government problem. To solve this problem we need to satisfy:

- Private Company Utility Maximization

  Under a specified government tax policy π, the company's decision $A = (A_1,\, A_2)$ solve its problem (9).

- Government Budget Requirement

  At private company's allocation $A = (A_1,\, A_2)$, the tax policy π satisfies the budget constraint.

Proposition 10 (Optimal Investment Tax Rate and First Stage Allocation)**.** *In equilibrium, first-type government will set the tax rate on investment return as* $\theta = \frac{R-1}{R}$ *so that the first stage allocation* $A_1\,(e_1,\, i)$ *will be* $e_1 = 0$*, and* $i = C$*.*

Proof. We still assume the discount factor $\delta = 1$, so perfect substitutability holds for e_1 and e_2. In this case, the second stage after-tax investment return will decide how much the private company will invest in the first stage, so if $i > (1-\theta)\, iR$ holds, then the private company will not invest in the first stage because there is no incremental benefit from the investment. However, since the

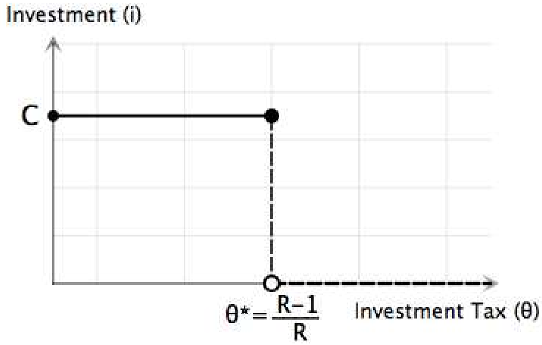
[8] Here, in most cases, the expectation can be based on the oral promise or unofficial news/rumors released by public agencies.

utility function is strictly increasing in e_1 and e_2, private company will choose to invest its entire capital funding if $i \leq (1-\theta)\, iR$ holds, which means

$$\theta \leq \frac{R-1}{R}$$

. From now on, we assume the private company will still invest all the money when equality holds, as it will provide the society with positive externalities with newly built up transit service. The following graph illustrates the ideas discussed in above proposition.

Fig. 5: Investment Decision vs. Investment Tax



For the government, since its tax revenue function is increasing in θ, it will continue to increase the investment tax rate till the point when private company holds back from investing. Moreover, government won't choose a lower investment tax rate with a hope of sufficient revenue because our previous "Labor Tax Necessity" assumption ($G > (R-1)C$) makes it impossible to fulfill the government's needs simply by charging investment tax on private company [9].

To conclude, the goverment will raise the investment tax to be $\theta = \frac{R-1}{R}$, and faced with this tax rate, private company in the first stage will choose to invest its entire capital funding and allocate zero in its first-stage expenditure, then we have $e_1 = 0,\ i = C$. □

From above proposition, we use following graph to show the relationship:

The maximum tax revenue from investment return is $(R-1)C$, which is obtained when private company decides to invest all of its capital when government tax rate is set at $\theta = \frac{R-1}{R}$; after this point, there will be no tax gain extracted from private company because it will simply save all of its capital to use for expenditure in the first stage.

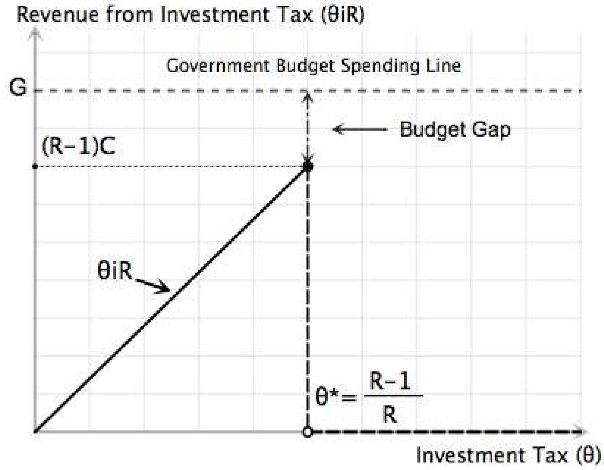
Proposition 11 (Optimal Labor Tax Rate and Second Stage Allocation)**.** *In equilibrium, second stage allocation action l will have a relationship with labor tax as*

$$l = (1-\tau)\, w \tag{13}$$

, and labor tax rate chosen by the government satisfies $\tau \leq \frac{1}{2}$.

[9] Here we refer to the fact that government spending can't be financed from tax revenue from investment, even the tax rate is optimal. And it is supposed that there will be no revenue once the investment tax is set beyond optimal level, as the private party will choose not to invest in the first place.

Fig. 6: How tax influence revenue in investment side



Proof. Let's derive this by using backward induction, we first find optimal labor input conditional on any given labor tax rate, then we go ahead to solve the optimal labor tax.

As we know from proposition (10) above, we have $e_1(\theta, \tau) = 0$, and due to the strictly increasing feature of utility function, second-stage expenditure e_2 will continue to grow until it reaches the limit of its resource constraint. Now we have $e_2(\theta, \tau) = (1-\theta)\, iR + (1-\tau)\, wl = C + (1-\tau)\, wl$.

Plug e_1, e_2 into utility function of private company to solve a problem of

$$\underset{e_1, i, e_2, l}{max}\, e_1 + e_2 - \frac{1}{2}l^2 = \underset{l}{max}\, C + (1-\tau)\, wl - \frac{1}{2}l^2$$

. Take first order condition and we have $l = (1-\tau)\, w$.

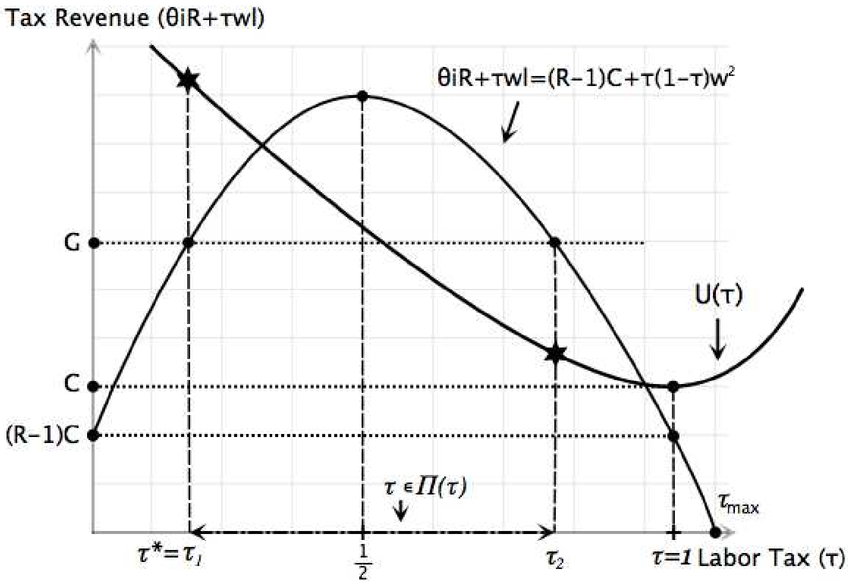
Then $e_2 = C + (1-\tau)^2 w^2$. Now we proceed to find out the optimal tax rate for goverment. With the allocation (e_1, i, e_2, l) available, the maximization problem becomes

$$\begin{aligned} & \underset{e_1, i, e_2, l}{max} && e_1 + e_2 - \frac{1}{2}l^2 \\ = & \underset{\tau}{max} && C + \frac{1}{2}(1-\tau)^2 w^2 \sim \underset{\tau}{max}\, U(\tau) \end{aligned}$$

Here we can see that once investment tax is optimized, government actually maximize utility by changing τ, and the lowest possible utility is obtained at $\tau = 1$, which means a 100% labor tax will encroach on all benefits that private party would potentially gain in the second stage.

From the following graph we show how government chooses its labor tax.

Fig. 7: First-type Government Choice of Labor Tax (τ*)



For practical reason, $\tau \leq 1$. From graph we can see that government wants to reduce labor tax as much as possible to the left side (close to zero) to maximize the utility. However, due to its budget constraint ($\theta iR + \tau wl = (R-1)C + \tau(1-\tau)w^2 \geq G$), only the interval between τ_1 and τ_2 belongs to valid policy set $\Pi(\tau) = \{\tau : \ \tau \in [\tau_1, \tau_2]\}$. Now the government's tax revenue(TR) becomes $TR = \theta iR + \tau wl = (R-1)C + \tau(1-\tau)w^2$, with the maximum value achieved at $\tau = \frac{1}{2}$. The tax revenue value when $\tau = 0$ is $(R-1)C$; while it reaches zero when τ increases to $\tau_{max} = \frac{1}{2} + \frac{1}{2}\sqrt{1 + \frac{4(R-1)C}{w^2}} > \frac{1}{2} + \frac{1}{2} = 1$, which is the lowest tax revenue that government can achieve. Therefore, τ_1 and τ_2 are both located at the left side, if we use $\tau = 1$ as a boundary. To optimize utility, government will prefer to choose tax rates that close to the left end of the policy set rather than to the right part of it. Ultimately, τ_1 will be the optimal labor tax rate. From the graph, we can see that τ_1 will be at least as large as $\frac{1}{2}$.[10] □

Definition 12 (Ramsey Policy)**.** Ramsey policy is the optimal equilibrium government policy that deals with private sector and yields the best win-win outcome, where neither side will want to deviate in the current stage to grasp potential future gains; specifically in this context, a full scheme of Ramsey policy is defined as

- For government (Ramsey Policy): $\theta^* = \frac{R-1}{R}$, $\tau^* = \tau_1$.[11]
- For private company (Ramsey Policy Response):

$$e_1^* = 0,\ i^* = C;\ e_2^* = C + (1-\tau)^2 w^2,\ l^* = (1-\tau)\, w$$

[10] When G is set equal to $(R-1)C + \frac{W^2}{4}$, optimal τ is equal to $\frac{1}{2}$.

[11] Here we denote τ in an abstract way, where can be calculated also in algebra.

4.1.2 Reactive Government Problem

Now we continue to investigate second-type government, which delays the announcement of policies until the second stage.

We would argue here that this type government will not successfully induce a private company to participate in investing in transit projects because private company has a high tendency to believe that the government will deviate from its expected action, assuming it is a welfare maximizer.

Proposition 13 (Ineffectiveness of Reactive Government)**.** *Second-type (Reactive) government will not be effective enough to motivate private party to get involved in investing public transit projects, thus prior-commitment in investment tax is a necessity to achieve a successful partnership, as what first-type government does.*

Proof. We only need to show that the second-type government will deviate in the outcome that is achieved by the first-type government here, as the deviation can make the second-type government better off in this cooperative regime.

Assume $\pi^2 = \left(\theta^E, \tau^E\right) = (\theta^*, \tau^*) = \left(\frac{R-1}{R}, \tau_1\right) = \pi^1$, where the superscript denotes the type of government. Then the story becomes that the private company follows its expectation of best possible achieved result and goes ahead to invest in the first stage. Let's now check the behavior of the government.

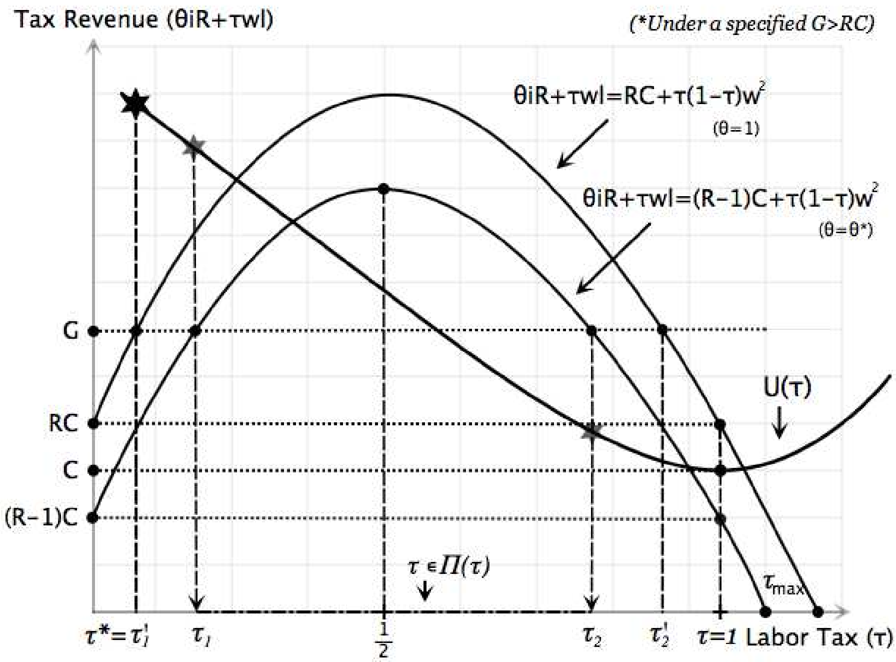
From Figure (4), we can see that now government doesn't have to worry about its policy of investment tax setting, because the investment decision has already been made before the government officially announces its tax policy. At the same time, we can see that, from proactive government problem, government's utility function only relates with τ in the second stage. In this situation, the government will abandon its expected investment tax rate θ^* and tend to fully tax on the investment return, which will result in a reduction of the portion of tax revenue from labor in its budget constraint G.

In following graphs, we can see how deviation from Ramsey policy can improve government's utility.[12]

- When $G > RC$, by deviating in θ from θ^* to 1, government can achieve a lower, positive labor tax (τ_1') with a higher utility level $U(\tau_1')$.

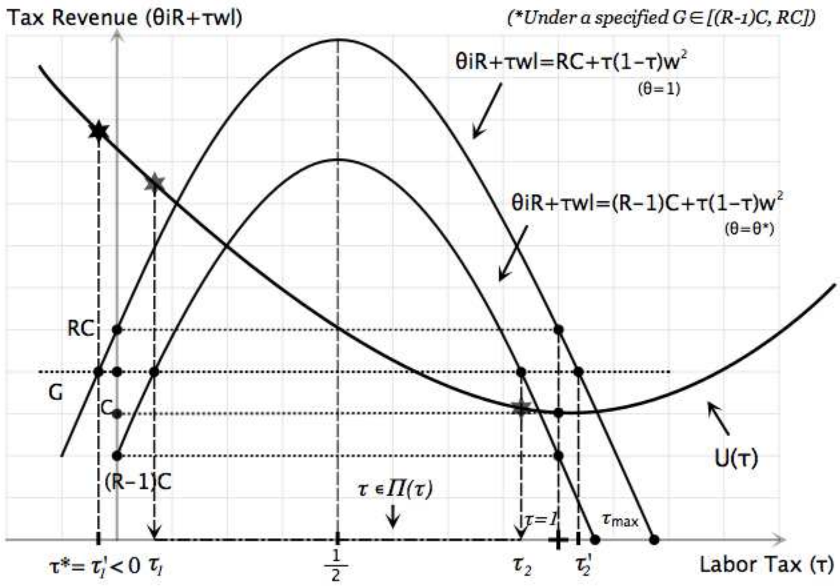
[12] The following graphs assume a return rate $R < 2$, which is along the line with historical data of return.

Fig. 8: Second-type Government Choice of Labor Tax (τ^*) ($G > RC$)



- When $G \in [(R-1)\,C,\, RC]$, by deviating in θ, government can achieve a lower, even negative labor tax (τ_1') with a higher utility level $U(\tau_1')$.

Fig. 9: Second-type Government Choice of Labor Tax (τ^*) ($(R-1)\,C < G < RC$)



Clearly, by making up the gap in budget with an increased investment tax rate, government can now levy less tax rate on labor to achieve a higher utility level, which is noted by the star mark in the above graph. Here a negative τ indicates a tax refund to labor party.[13]

Being aware of this potential deviation, private party will choose to spend all of its capital on expenditure side in the first stage, as the return of the investment now is highly possible to be less than 1. In this sense, we conclude that second-type government is much less effective in motivating private parties to invest in public transit projects, thus a prior-commitment in invsetment tax is a necessity to maintain a successful partnership. And this commitment is critical to launch the project, as it can relieve the private party of doubts and suspicions of potential deviations from government that could happen once it would have participated in this game. □

4.2 Effects in Fractionizing in Private Sector

In this section, we are going to discuss the effects when formally dividing private party into two sectors: private investors (capitalists)[14] and labor providers (workers). The model has been introduced at the beginning of this paper.

The reason to differentiate these two sectors is to further illustrate the nuances within this investment game. On one hand, private company may mainly focus on its investment return, instead of the associated labor output. On the other hand, the actual beneficiaries from this investment are the workers who get employed through the project, and this is one of the main reasons of Obama's Stimulus Package – to create more job opportunities for Americans.

Assumption 14 (No-work-to-do Assumption)**.** *If investors choose not to invest, the project will be suspended, so that labor party will be impaired because the people who are going to be employed during the construction or upon the completion of the project will now have no jobs to do. Formally, we assume if* $i = 0$*,* $U^W = \underline{U}^W = 0$*.*[15]

In this regime, we are going to argue that a social welfare maximizing government is not effective in inducing investment if it is unable to make commitment of labor tax rate τ also in the first stage. Formally, we have

Proposition 15 (Full Prior-commitment in Tax Policies required in 3-Party Game)**.** *A social welfare maximizing government has to make commitment to both tax rates* (θ, τ) *at the beginning of the first stage to effectively induce initial investment from investors when labor sector is separated from private party.*

Proof. Let's look at investors problem first, taking the equality of their resource constraints, their utility is given by

$$U^C(e_1, e_2^C) = e_1 + e_2^C = C - i + (1 - \theta)iR, \; i \in [0, C]$$

[13] In reality, it is unrealistic to levy a 100% tax on investment return, however, the model here is just to illustrate the underlying desire of a government to deviate to a higher investment tax rate, which is larger that $\frac{R-1}{R}$, to obtain a higher utility level. Specifically, when $G > RC$, it is possible to achieve a lower $\tau \in (\tau_1', \tau_1)$; when $G \in [(R-1)C, RC]$, it is possible to achieve a negative $\tau \in (\tau_1', 0)$.

[14] Here the private investors generally refers to the board members or key stake holders of a company who have the influence to make investment decisions with company's capital.

[15] To simplify the analysis, we drop other potential alternative choices for workers and consider an extreme case to assume that they have no other work options besides this project.

The administrator knows that in stage two, choice of labor will maximize worker's utility

$$U^W(e_2^W, l) = (1-\tau)wl - \frac{1}{2}l^2$$

as a function of the chosen labor tax. This will result in labor choice $l = (1-\tau)\,w$. Given this, the administrator's optimization problem can be rewritten as

$$\begin{aligned} \underset{\theta,\,\tau}{max} \quad & U^G = U^C + U^W \\ subject\ to \quad U^C + U^W & = C + (R(1-\theta)-1)i + \frac{1}{2}(1-\tau)^2w^2 \\ G & \le \tau(1-\tau)w^2 + \theta iR \end{aligned}$$

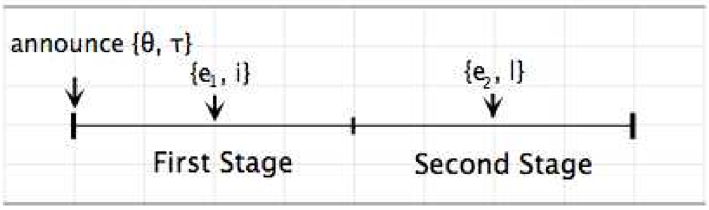
Substitution of the binding constraint implies equivalence to

$$\max_{\tau}\ C + (R-1)i - G + \tau(1-\tau)w^2 + \frac{1}{2}(1-\tau)^2w^2 \Rightarrow \qquad \tau^* = 0$$

which gives us $G = \theta' iR$, where $\theta' > \theta^*$. This means that no matter how much investment is made in the first stage, government tends to deviate from its policy of investment tax to maximize social utility. This can be understood as a way that government would take to please labor union before the labor supply starts in the second stage. □

Thus it is necessary to make commitment of a full tax policy at the beginning of the game to successfully attract private investment. Following graph shows the timeline of government move.

Fig. 10: Policy Timeline in Fractionized Case



The difference here is, when facing more parties in this game, government need to take more initiatives to appease the indefinite psychology from private investors, i.e., to clearly announce a full policy scheme to ensure private investors' confidence in future policy. The lesson learned here is when private investors are suffered more uncertainty, they need to know that their expectation of the future policy is realizable.

Now let's see if there are other potentials to reframe the game and achieve a satisfactory result. From now on we still assume that the government policy timeline follows the case of a proactive government.

Definition 16 (Nonbenevolent Government)**.** Nonbenevolent government means that the government is partial towards investors, formally, when maximizing overall welfare, the utility form is

$$U\left(U^C, U^W, \lambda\right) = \lambda U^C + U^W,\ where\ \lambda > 1$$

By introducing the concept of nonbenevolent government here, we can see that, when government is in favor of investors, it will put more weights on investors' utility so that the benefits for investors will be enlarged by any action taken by the government. Similar idea can be found from Baron and Myerson (1982), however, the difference is that they put a weight α ($0 \leq \alpha \leq 1$) on the private company side. The result from their paper has shown that there will be welfare omission due to smaller weight assigned to the firm, and the regulated price is deviated from marginal cost of production, which leads to welfare loss. Since here the private company is the key to realize the transit investment, the only possible way is to use a weight parameter greater than 1 to allow private company to gain enlarged benefits.

Now we want to explore if a nonbenevolent government will actually achieve benevolent outcomes under its administration.

Proposition 17 (Existence of a Trustworthy Benevolent Government)**.** *There exists a $\lambda > 1$, such that a nonbenevolent government with this intrinsic value of λ would spontaneously choose, during its administration period, not to deviate from the Ramsey policies.*

Proof. As what we discussed in Proposition (15), an administrator with these preferences would solve

$$\max_{\tau} \ \lambda \left[C + (R-1)i - G + \tau(1-\tau)w^2\right] + \frac{1}{2}(1-\tau)^2 w^2$$

implying first order condition

$$\lambda(1-2\tau) = 1-\tau \qquad \Rightarrow \qquad \tau = \frac{1-\lambda}{1-2\lambda} \tag{14}$$

Whichever τ supports the Ramsey policies, it must be less than $\frac{1}{2}$, as that maximizes labor tax income and the social welfare function is decreasing in τ (as shown in previous graphs). Accordingly, the relationship between τ and λ in (14) indicates that, for each Ramsey labor tax τ that lies in the domain of $(0, 1/2)$, there exists a $\lambda \in (1, \infty)$ supporting it such that the administrator would not have incentive to deviate. □

Now we want to know what impact a nonbenevolent government will present to this game, and how a nonbenevolent government will influence the result.

Proposition 18 (Success of a Nonbenevolent Government)**.** *If the timeline of government's policies follows the original plan (i.e., the proactive government case), labor party will potentially prefer a nonbenevolent government as it actually has more chance to maintain the expected optimal equilibrium by observing Ramsey policies, with certain conditions satisfied, which will open the door for the private investment, thus lay down the cornerstone for the public transit projects.*

Proof. Assuming government will still announce the labor tax rate upon the completion of the project (i.e., in the second stage), but now the government is nonbenevolent, with a $\lambda > 1$ assigned to investors.

We need to differentiate two cases to compare the results:

1. If government is impartial, the result as discussed before would be $\theta = \theta' > \theta^*$, thus in this case $i = 0$. Following assumption (14), labor party will experience the lowest utility level $\underline{U}^W$ ultimately.

2. If government is nonbenevolent, there exists a $\lambda > 1$ which makes $\tau = \frac{1-\lambda}{1-2\lambda}$ to maintain the optimal outcome as the private entirety case. As long as the government holds an appropriate λ, the labor party can obtain U^{W*}, with the government budget constraint is expressed as

$$\begin{aligned} G &= \theta i R + \left(\frac{1-\lambda}{1-2\lambda}\right) \cdot \left(1 - \frac{1-\lambda}{1-2\lambda}\right) w^2 \\ &= (R-1)C + \frac{\lambda(\lambda-1)}{1-2\lambda} w^2 \end{aligned}$$

So $U^{W*} \geq \underline{U}^W = 0$, labor party will now actually prefer to have a nonbenevolent government, to create job opportunities for them.[16]

□

One thing to point out here is that the government's goal is to carry out the project, which will generate enormous positive benefits for the society, rather than to raise revenue through this project once and for all. From another perspective, once the project serves the society well, there will be continuous tax flow that can be collected for the future.

5 Cost Structure and Tax Implications in Different Cases

The model discussed in Section 3 has shown a big picture of the decision-making process, and indicated that the investment tax is critical in creating a successful partnership with private party. Now we are going to put this part under a microscope to explore more features from taxation side by relate investment with cost structure under different scenarios. From Assumption (1), when private company makes an investment, its amount equals to the total cost needed for the project minus the a portion in fixed cost sector that is patronized by government subsidy.[17] If we involve the concept of cost structure, we then differentiate the cost for private party $C^{private} = C(Z)$ into two categories: fixed cost and variable cost. Generally, we use F to denote fixed cost and k is the marginal cost of project-associated capacity expansion. Here the capacity Z refers to the normalized capacity index, and to make things as simple as possible, we assume the cost function is linear. This approach is used by Borger et al. (2009) in a paper which investigated the impact that different cost structures would have on recovering cost.

[16] Actually, in this case, labor party will prefer any nonbenevolent government that can induce a positive private investment, as it will generate a non-negative utility for labor party which is at least as good as the utility generated in an impartial government case ($\underline{U}^W$).

[17] In a partnership regime, the investment generally depends on the contract negotiated with the government. The focus here is that the investment is used to cover whatever the cost assigned to private company.

5.1 Scenario 1 - Investment with sufficient funding

In our highspeed light rail project, the cost of land construction and infrastructure setup can be viewed as a fixed cost, while each addtional rolling stock and associated tools, equipment can be viewed as one unit of capacity. The cost of this capacity will include, besides the purchase of things mentioned above, the gas, electricity, operation, maintenance, parking facilities, and whatever necessary for providing the service. Formally, we have

$$i = C(Z) = F + kZ \tag{15}$$

Once the fixed-cost part investment is invoked, it will generally stay there and lays the foundation for the project. Thus we are going to assume the government will only tax the investment on variable costs.

Assumption 19 (Exclusive Variable Cost Taxation)**.** *The government will tax the investment return based its spending on its variable cost related use.*

So now there is another constraint to satisfy before company is willing to make investment.

$$i \leq FR + kZR(1 - \theta) \tag{16}$$

From the discussion before, we know if above constraint (22) is satisfied, private company will choose to invest all of its capital C in the optimal equilibrium under Ramsey policy, and now let's see what tax rate government should set.

From (22), we have equality at the equalibrium, so

$$\theta = 1 - \frac{\left(\frac{i}{R} - F\right)}{kZ} \tag{17}$$

Plugging in (15), we have an investment tax as

$$\theta = \frac{R-1}{R}\frac{F+kZ}{kZ} \tag{18}$$

Definition 20 (Returns to Scale)**.** Returns to Scale (RTS, denoted as ϕ) refers to the percentage quantity change of output influenced by the percentage quantity change of input.[18]

From the definition (20), the input here is cost and output is capacity, so

$$RTS(\phi) = \frac{\frac{\partial Z}{Z}}{\frac{\partial C}{C}} = \frac{1}{\epsilon_{CZ}} = \frac{F+kZ}{kZ} \tag{19}$$

, where $\epsilon_{CZ} = \frac{\partial C}{\partial Z}\frac{Z}{C}$ is the cost elasticity with respect to capacity.

From (19) we can see a constant returns to scale implies zero fixed cost in the investment plan, and with the incremental portion of fixed cost in the total cost, we could have higher level of increasing returns to scale.

Combining (19) and (18) together, we can relate cost structure with investment tax rate, shown as

$$\theta = \frac{R-1}{R}\phi \tag{20}$$

[18] In this sense, increasing returns to scale refers to a proportionate increase in all input quantities resulting in a greater than proportionate increase in output, and similar analogy applies to decreasing returns to scale.

Proposition 21 (Fixed Cost V.S Var. Cost)**.** *A higher fixed cost portion in a project cost structure will achieve higher level of increasing returns to scale, however, it will also potentially increase the investment tax rate which may decourage the investment in the first place. The upper limit of a fixed cost is decided by the ratio of variable cost and the "actual" return of project, i.e.*

$$F = \frac{1}{R-1} kZ \tag{21}$$

Proof. Since $\frac{R-1}{R} < 1$ and $\phi \geq 1$ with a nonnegative F, it is likely to lead to an "overflow" of the tax rate $\to \theta \geq 1$, which makes it undesirable. Rearrange (18), we have $F(\theta) = \frac{1-(1-\theta)R}{R-1} kZ$, with $F'(\theta) = \frac{R}{R-1} kZ > 0$. This implies that as tax increases, the potential fixed cost allocated in the investment plan will also increase.

Contrariwise, with $\theta'(F) = \frac{R}{R-1} \frac{1}{kZ} > 0$, even though a cost strcuture with higher portion of fixed cost will achieve higher level of returns to scale, the tax policy will serve as a "rein" on the private company to limit its freedom in specifying its cost structure. Taking $\theta = 1$ as an example, we can see now $\frac{F+kZ}{kZ} = \frac{R}{R-1}$, which means $F = \frac{1}{R-1} kZ$, and this is the upper bound of F if we take $\theta = 1$ as the upper limit of investment tax rate. To give a quantitative taste of this upper bound, if we take an average return rate which we discussed in previous section, say 12.5%, then the highest fixed cost allocation is roughly 8 times of the amount of variable cost. □

5.2 Scenario 2 - Investment with insufficient funding

In the assumption(1) and previous cases, we all consider $W \leq C^{private} + C^{Gov} = i + f$. Now we want to loose this assumption and consider what would happen if $W > C^{private} + C^{Gov} = i + f$, meaning that the total cost required is more than the sum of government funding and private investment.

To be more specific, we assume the insufficient funding will lead to a portion of uncovered fixed cost by private company. We assume here a parameter ρ to represent the percentage of money covered for fixed cost portion as

$$\rho = \frac{i - kZ}{W - f - kZ} = \frac{i - kZ}{F_{required}}$$

Thus $i = \hat{C}(Z) = \rho F + kZ$, for simplicity and comparison, here $F = F_{required}$.

Still we assume the government will only tax investment on variable costs.

Assumption 22 (Deteriorated Return by Inferior Quality)**.** *As the investment in the fixed cost portion is reduced, the quality of the infrastructure becomes inferior, which leads to deteriorated return on the fixed cost investment, even if there is no government tax. The deteriorated rate of return is assumed to be equal to the percentage of covered fixed cost.*

Now there is a new constraint to satisfy before company is willing to make investment.

$$i \leq \rho F \cdot (\rho R) + kZR(1-\theta) \tag{22}$$

From the discussion before, we know if above constraint (22) is satisfied, private company will choose to invest all of its capital C in the optimal equilibrium under Ramsey policy, and now let's see what tax rate government should set.

From (22), we have equality at the equalibrium, so

$$\begin{aligned}\theta &= \frac{kZ\,(R-1)+\rho F\,(R\rho-1)}{kZR} \\ &= \frac{R-1}{R}\frac{\rho^2 F+kZ}{kZ}-\frac{\rho F(1-\rho)}{kZR} \\ &= \frac{R-1}{R}\frac{\rho\hat{F}+kZ}{kZ}-\frac{1-\rho}{R}\frac{\hat{F}}{kZ},\ where\ \hat{F}=\rho F \qquad (23) \\ &= \frac{R-1}{R}\frac{\hat{F}+kZ}{kZ}-(1-\rho)\,\frac{\hat{F}}{kZ} \qquad (24)\end{aligned}$$

In the above formula, if we consider $\hat{F}$ as the current fixed cost investment, then the difference from (18) is that there existing a second term $(1-\rho)\frac{\hat{F}}{kZ}$ which reduces the capital tax rate. This is somewhat counter intuitive as it gives the private company to undercut in its investment in fixed cost portion to receive a smaller capital tax rate. However, since our initial assumption is that the required spending is larger than what is affordable by the private company, thus it is unavoidable to have lower quality project due to insufficient funding. To attract private company to participate, the government has to lower the tax rate to "compensate" for the loss of return resulted from inferior quality. In this sense, we call $Q=(1-\rho)\frac{\hat{F}}{kZ}$ as "quality tax compensation". Taking previous example where $R=112.5\%$, $F_{max}=8kZ$, assuming $\rho=0.95$, we have $Q=0.38=38\%$, thus decreasing $\overline{\theta}=1$ to $\overline{\theta^*}=0.72$.

We can see the government tax needs to reduce in a large percentage to compensate the insufficient funding situation, thus it is critical to guarantee funding support in the very beginning if we want to involve private investors with the implementation of a satisfatory capital tax rate.

Therefore, government can adjust its investment tax rate according to the chosen cost structure by private company, to achieve a better supervision over the whole investment plan. On one hand, we can view that the government can use the tax rate to influence private party's cost structure; on the other hand, we can think this tax is a tool to obtain higher tax revenue simultaneously with private party's desire to have increasing returns to scale.[19]

A high returns to scale cost strcuture doesn't necessarily imply good news even if we don't incorporate taxation considerations here. Since this paper only focuses on the interactions between government and private parties, in reality, we still need to consider cost recovery issues for the investment. Generally speaking, higher fixed cost will generate lower cost recovery ratio with high probability. As discussed by Borger et al. (2009), compared to a benchmark infrastructure (here they focus on highway) with zero fixed costs, "toll revenues go down when fixed capacity costs become more important, due to substantially lower tolls on just slightly more demand. Cost recovery becomes therefore less favorable." To cite an example in the paper, with tolls and no through traffic, as fixed cost increases, the cost recovery ratio decreases by 70% with only a 11.5% improvement in social welfare.

Another comment here is that above formula also implies that a project requires high fixed cost investment may have potential lower returns, and therefore

[19] One thing to point out is that government will consider not following above tax rate formula, if certain cost structure is necessary and benefical in the long run. The argument above is mainly to show how government can better manage its policy in this investment plan.

the government may take this into consideration when making its tax policies, as private investors may require more favorable terms on the taxation to be induced to participate in the investment. Examples like this may include high-speed rail, highway construction, etc. One similar argument related with this issue is that some countries set limitations on the debt-equity ratio. In a paper discussing the private investment in India, Harris and Tadimalla (2008) argued that restricting an investor's ability to choose its capital structure can increase the cost of capital and prevent companies from reaping tax advantages associated with particular types of financing. Thus government may be cautious about the level of monitoring investor's cost or capital structure.

6 Conclusion

In this paper, we focus on the actions that government should take to incorporate private parties into its public transit project investment regime. Here we would love to differentiate the concept of effectiveness and efficiency. In short, effectiveness is to do the right things, while efficiency refers to doing things right. From this paper's perspective, government's effectiveness means to successfully motivate private parties to participate in the cooperation of providing transit service, while government's efficiency refers to optimally manage private parties to serve its best productivity and strength in performing their duties.

As shown before, when private party presents itself as a whole (investors and workers together), government needs to make commitment to the investment tax in the first place to induce private party to participate in this game, because a lack of commitment in investment tax from government side will undoubtedly evoke suspicions of policy deviation from private party side. Furthermore, if we differentiate private party into two groups: investors and labor force, then government has to make a commitment not only in its investment tax policy, but also in labor tax in the first place. This complies with the idea in the theory of industrial organization, as more parties get involved, the interactions among different parties become more complicated, thus we need the government to take more initiatives in leading this game, i.e. to announce its full tax policy at the very beginning to assure other parties' (especially the first mover of the game) feeling of uncertainty.

To better address the implications of this multi-party game, we introduced the concept of nonbenevolent government, i.e. a government being partial to investors, which instead will help to maintain the equilibrium we could achieve when private party emerges as a whole. This anomalous result actually adds more flavor to our paper as it stresses the importance of private party, specifically, the group of people who possess capital. Since they (group of investors) are the people who make investment, which opens the door for all succeeding stories, government may have to give in to this crucial factor.

In the last, with the introduction of cost structure concept, we further explored the potential investment tax policies as cost structure changes. Through the discussions of two cases with sufficient and insufficient funding, we have shown that the final investment tax will have a fixed relationship with the returns to scale (RTS) chosen by private party. As the portion of fixed cost increases, the returns to scale of the project grow, which leads to an higher investment tax. In this sense, the tax sets an upper bound for the portion of fixed cost, and this upper bound may limit the freedom of private party to allocate most of its investment into fixed cost side as it will not be taxed according to our assumption. However, we do want to mention that the existence of upper bound also leaves the room for future research of its merits and drawbacks. In the case of insufficient funding, we further illustrate the potential distortion of investment tax under our assumptions. The idea we attempt to convey is that insufficient funding leads to inferior quality of infrastructure which potentially generates deterioriated return, and government has to lower the corresponding tax rate to make up for the loss of private party and to ensure its participation in the first place.

In 1998 Transportation Equity Act for the 21st Century (TEA-21), examining novel methods for contracting public transport services is proposed (TRB, 2001). The FHWA estimated that contracting transit services could produce cost savings of 25% − 30% (Bladikas et al., 1992). Teal in his 1988's paper researched around 800 transit agencies and found that around 35% of those agencies contracted their services to private companies, with cost reduced ranging from 10% to as high as 50% (Teal, 1988). Thus it is obvious more cost efficient if we can privatize some, if not the whole, of our public transportation projects in an effective way. This paper mainly serves as an incipient exploration of potential complexity among different parties before a successful project is carried out, and potential practicable stratigies that government may want to apply in certain situations. We focus on the initiatives that government should take to implement the project instead of actual operations and pricing schemes after the project is realized, by assuming a satisfactory return will be achieved later on. There are limitations here as we simply use a two-stage model and ignore the discount factor in the utility function, and we also consider a simplified utility function form which mainly serves to illustrate the ideas of this paper rather than to claim authenticity that is happening for the moment. Later research directions can be focused on either highway projects which doesn't involve much labor after its done, or the interactions that would potentially happen if there are multi-transportation modes within the same region and how the competition would re-frame the model. Alternative topics can be related with taxation differentiation, repeated investment games and how government's reputation plays a role in the public-private partnership.

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