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ABSTRACT

Targeted Transfers, Investment Spillovers, and the Tax Environment

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We examine the informational role of targeted tax transfers used by local governments to attract corporate investment projects. The transfer may potentially be used to solve an information externality in which subsequent investments that follow the initial project may fail to occur even though they are profitable. The targeted transfer may be used to signal the profitability of such ancillary investments and thereby attract them. We show that this signaling role implies that an environment of either generally high corporate tax rates or low gains from secondary investments paradoxically yields an equilibrium in which the necessary government subsidy is lower.

Keywords: taxes, transfers, externalities

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Targeted Transfers, Investment Spillovers, and the Tax Environment

1. *Introduction*

Both local and national governments compete vigorously to attract business investment. Fourteen years ago, government authorities in Alabama shocked numerous commentators when they offered Mercedes Benz over $250 million in site improvements, infrastructure, tax incentives and training to entice the automaker to locate its first American plant in the Alabama town of Vance. The amount offered was almost equal to the total cost of building the plant. Seven years ago, the city of Chicago made headlines when its offer of $63 million of tax and other incentives successfully wooed Boeing to choose the city for the new location of its corporate headquarters. Such stories have become a common feature of the American scene, perhaps most obviously in the case of efforts of local governments to attract sports franchises. The scenario also plays out in the international stage as technological changes and increased capital mobility increasingly broaden the geographic areas over which firms may choose to locate. For example, Germany offered sizable transfers to induce Dow Chemical to invest in plants in the former East Germany as part of an overall development plan.

There are two closely related economic justifications for government subsidization of private capital projects within their jurisdictions. One reason suggested in Pepall (1990) and recently given emphasis by Rodrik (2004) is based on key information externalities associated with the investment location choices of firms. In an uncertain world, the profit opportunities associated with a specific region may be learned either by direct experience or by observing the experience of others. When a high profile firm initiates a major capital project in a particular underdeveloped area that investment decision reveals information regarding the profitability of that location choice to other firms and this information is akin to a public good. The firm making the initial investment cannot extract payment for provision of this service. Unless transfers are made the standard under-provision result for public goods will hold, and will result in too few major investment projects in underdeveloped regions.

A second and closely related reason for targeted transfers or tax breaks is offered by Garcia-Mia and McGuire (2002), among others. The argument is again based on an externality, but one that in this case stems from agglomeration effects. There are external economies so that while capital is subject to diminishing

returns at the individual firm level, there are positive scale effects from having capital concentrated within a region. Here again, attracting investment projects is welfare enhancing because it creates a more favorable business climate and so leads to capital expansion by other firms. Such externalities have been empirically documented by Rauch (1993) and Henderson (2001) among others.

These arguments both share the common feature that a part of the gain to the local government from a major corporate investment project stems from the spillover investments that the initial project induces. As an empirical matter though, the extent of the gains from such follow-on investments remains unclear. In addition to the studies mentioned above, Keller and Yeaple (2004) find strong evidence of sizeable spillovers to US manufacturing firms from foreign direct investment in the US between the years 1987 and 1996. Similarly, Greenstone and Moretti (2004) find that winning a "million dollar plant", while costly, increases local property values without creating fiscal ruin. However these results stand in contrast to other empirical studies, such as Hanson (2001) and Gorg and Greenaway (2002) who find that FDI spillovers can be relatively small or non-existent. Indeed, the spillover effects could even be negative if they lead to important congestion problems as critics of these development projects frequently claim.

The spillovers associated with ancillary or subsequent investments will be realized only when the initial investment does in fact lead to these investments taking place. This in turn will depend on how ancillary firms interpret the first firm's decision to invest in the area and the government's decision regarding the size of a targeted subsidy paid to that first firm. This paper explores how the information conveyed by the first or target firm's investment decision and the government's targeted subsidy affects the investment decisions of later investors. Specifically we are interested how the general corporate tax environment affects the information or signaling role of the targeted subsidy. Our results show how the signaling role of transfers is affected by the overall tax environment. We show in fact that a lower tax environment, somewhat paradoxically, makes it more costly for a local government to use targeted transfers successfully to induce both primary and secondary investments in their communities. Our results also help account for the mixed empirical evidence on the spillovers created by the initial investment. Similarly sized transfers may be associated with either suboptimally low investment or suboptimally high investment depending on the tax and investment spillover environment.

2. The Model

Suppose that a multiregional or highly visible firm is seeking a location for a major new investment project. The value of the firm's project will depend upon both the nature of the project and where the project is located. Location affects both the operating costs and conditions of the new facility. Certain operating costs, such as labor, shipping, construction and energy costs, as well as taxes may or may not vary much across the possible location sites. However, other costs of doing business depend upon the quality of public services or the local public infrastructure in the area. These are typically difficult to measure and can vary across locations especially in regards to their cost implications for the specific project.

Location decisions are a matching problem—both for the firm making the investment and for the government interested in attracting investment. A good match occurs when the initial investment is a good quality project and the area's infrastructure is well suited to such an opportunity. A bad match occurs when the investment is a poor quality project and/or the area cannot adequately support the project. When the match is a good one and the first firm invests in the area, then we assume that the region offers attractive investment opportunities for other firms. The converse holds if the match is a bad one. The actual quality of a match is, however, private information revealed to firm and the government when they enter into negotiations. Such information cannot be easily and credibly communicated to other investors. So, if the first firm does invest in the region, follower firms must make a conjecture about whether the match is a good one and whether to follow and make their own investments in the region.[1]

We formalize this problem as follows. The surplus, denoted by S, generated by the initial firm's investment depends on the quality of the match, which in turn depends upon the nature of the project π and the strength of the local infrastructure i. We assume that both π and i are independent random variables with each drawn from a uniform distribution between 0 and 1, and $S = \pi i$. The probability density function of the surplus is $f(S) = -\ln S$. and the mean or average surplus $E(S) = 1/4$. The firm is likely to know the project's quality—

[1] Our model is related to that of Bond and Samuelson (1986). Their analysis does not address the complementary investments issue but instead focuses on a case in which the government has complete information and in which the principle concern is the time-inconsistency of government policy.

the value of π, but not the value of the local infrastructure *i*. Similarly the government is likely to know the value of the local infrastructure *i*—but not the quality of the firm's investment project π.

The firm and the government can learn the value of investment project or *S* if they enter into negotiations with each other. If they do and they learn the value of the match then at this point the government can decide to offer a transfer *T* to attract the firm's investment project to the area. When the infrastructure in the region is relatively poor and $i < ½$, then the firm would not locate in the region unless it receives a transfer from the government. The government has potentially two reasons to offer such an incentive. First, the firm's investment could generate additional tax revenues that the government can use to finance the transfer. Specifically, if the corporate tax rate is τ, then the government will earn τS when the firm locates its project in the area. We assume that τ has a common value across all the regions under consideration by the firm, and so the value of τ reflects the general tax environment.

A second reason to offer a transfer is that the government may enjoy gains if ancillary investments follow the initial firm's investment lead. The degree of spillovers to the government from subsequent investments is measured by a parameter α, and spillovers to the government from subsequent investments are equal to αS. We assume that in any location the parameter α is a random draw from a uniform distribution [-a, a], where $0 < a < 1$, and that the value of α is local information, known to the local government and the potential ancillary investors in the region. However, similar to of the local infrastructure, the parameter α is learned by the initial investing firm upon negotiations with the local government. We also assume that in all cases to be considered the corporate tax rate and the degree of spillovers are such that $\tau + \alpha \leq 1$.

The parameter α measures the various ways in which the follow-on ancillary investments can confer advantages or disadvantages to the government or region. For example, $\alpha > 0$ could imply complementarities that make it less expensive to provide government services. It may become less expensive to provide schooling or sanitation services in a prosperous economic environment, or further development made by the follow on firms may lead to the private provision of some services, e.g., health care, parks, and education, that

again frees up local government resources. On the other hand α could also be negative if ancillary investments generate congestion or other negative externalities.

It is clear that when $\tau+\alpha > 0$ the government has an incentive to attract the first firm to invest in the area. However, it is profitable for subsequent investors to invest only if the match is a good one, or only if the surplus $S \geq 1/4$. These follow-on investor firms do not directly observe the value of *S*. These firms do know the local conditions summarized by α, and the distribution of *S*. They also observe whether the first firm invests in the region and the size of any transfer *T* the firm received from the government. Let $I \in \{0,1\}$ denote whether the first firm makes the investment in the area. The information set upon which an ancillary investing firm bases its belief on the likelihood of a good match is therefore $\theta = [I, T]$. We denote the belief of a follower investor on the likelihood of a good match by $\mu\left(S \geq \frac{1}{4} | \theta\right)$ and when $\mu\left(S \geq \frac{1}{4} | \theta\right) \geq \frac{1}{2}$ then an ancillary firm will invest in the area.

We begin with the case in which there is no corporate tax, or $\tau = 0$. Because the total surplus $S = \pi i$ goes entirely to the firm and because the expected quality of infrastructure in another region is $i = ½$, the firm will choose this region if the firm learns that the local infrastructure has $i \geq ½$.[2] The government will not offer a transfer and the ancillary firms observe $I = 1$ and $T = 0$. In this case the ancillary firms are able to deduce that the infrastructure must be such that $i \geq ½$. The belief of an ancillary firm that the match is a good one when $i \geq ½$ is $\mu\left(S \geq \frac{1}{4} | I = 1, T = 0\right) \approx .65$. The expected profit of an ancillary firm is positive and the ancillary firm will also invest in the area.

Our interest, however, is when the infrastructure in the region is underdeveloped or poor and $i < ½$, and the first firm would not invest in the area without a targeted transfer. For the benchmark case in which $\tau = 0$, the local government gains from the initial investment project only if $\alpha > 0$, and the government is able to attract ancillary investors and earn αS. When $\alpha > 0$ the local government may have an incentive to offer the

[2]We simplify the analysis by not extensively modeling the firm's search process. It simply invests if $S = i\pi > E(S) = 1/4$.

first firm a transfer T where $T < \alpha S$. We characterize the equilibrium for this benchmark case with the following proposition.

Proposition 1: When $\tau = 0$, $i < ½$ and $\alpha > 0$ there exists a separating perfect Bayesian equilibrium such that: when $S \geq ¼$, and $½ \geq i \geq 1/2(1+\alpha)$ the government offers a transfer $T \geq \alpha/4$ and the firm invests in the area and ancillary investors follow and invest in the area as well. When either $S < ¼$, or when $S \geq ¼$ but $i < 1/2(1+\alpha)$, then the government offers no transfer, and there is no investment by the first firm, and the ancillary investors do not follow. The beliefs of the ancillary investors are:

$$\mu\left(S \geq \frac{1}{4} \middle| I = 1, T \geq \frac{\alpha}{4}\right) = 1 \ , \mu\left(S \geq \frac{1}{4} \middle| I = 1, T < \frac{\alpha}{4}\right) = 0 \text{, and } \mu\left(S \geq \frac{1}{4} \middle| I = 0, T\right) = 0 .$$

Proof: (See Appendix)

The benchmark equilibrium outcome is described in Figure 1.[3] Region I shows the area of efficient matches where investment occurs because of transfers. The government offers a transfer $T \geq \alpha/4$ and both the first and secondary investments occur. Region II describes the area in which matches are inefficient and the investment does not occur. In this region the government is not able to offer a transfer $T \geq \alpha/4$ large enough to induce any follow-on investments. Region III describes an area of potential inefficiency. Here, the match is a good one and the environment is a good for ancillary investments, but neither the first nor the secondary investments occur. This reason is that the initial investment project has a relatively high value with $\pi \geq (1+\alpha)/2$ but the local infrastructure is so low, $i < 1/2(1+\alpha)$, that the government cannot afford to offer a transfer large enough to attract the initial firm's investment. In other words, in this case we have $\alpha S + S < \pi/2$ when $i < 1/2(1+\alpha)$. The firm does better to locate elsewhere. Yet it is possible that the overall surplus generated by the ancillary investments, had they occurred, would have generated gains for all parties. This outcome is potentially inefficient. It reflects the usual under-provision effects when there are positive externalities.

There is another feature worth noting about the benchmark equilibrium described by Proposition 1. When transfers do occur (Region 1), they are such that the government transfers much of its gains to the first investor. That is, since $i < ½$ and $\pi \leq 1$, the maximum $S < 1/2$, the government's potential surplus of $\alpha S < \alpha/2$.

[3] In this and all other figures, we omit the region for which $i > ½$, as no transfer is needed in this region.

Since the necessary transfer is $T \geq \alpha/4$, the government must give more than half of its gains away. Furthermore, the share that the government gets to keep falls as the quality of its infrastructure *i* declines. Governments with poor public infrastructures (for this specific project) will either be unable to afford a transfer (Regions II and III) or, make a transfer that attracts the initial investment but that leaves them with little net gain.

Consider now the case in which there is a positive corporate tax rate $\tau > 0$, levied independently but identical across all regions that the first firm is considering for its investment. We assume, not unreasonably, that $1/2 > \tau > 0$. The presence of a corporate profit tax means that government can gain from the initial investment even when no ancillary investments occur. Specifically, the government can collect τS in additional revenue if the initial investment project is undertaken. The corporate tax rate gives both an added incentive for the government to attract the project and a greater pool of resources from which to finance any targeted transfer. Matches that are not attractive to ancillary investors could in this case be attractive to the local government. And because $i < ½$ these poorer matches must be associated with a transfer $T > 0$ for the initial investment to occur. An important consequence of the corporate income tax is that the signaling potential of the transfer *T* becomes obscured.

To work out the equilibrium when the corporate tax $\tau > 0$, observe first that when $i < ½$ and $½ > \tau > 0$ the first firm will locate in the area only if it receives a transfer *T* such that $(1-\tau)S + T \geq (1-\tau)\frac{\pi}{2}$. That is, the firm will invest only if the transfer $T \geq (1-\tau)\pi(\frac{1}{2} - i)$. We define by T_L the minimum transfer that the government must offer the first firm to attract its investment, or $T_L(\pi, i) = (1-\tau)\pi(\frac{1}{2} - i)$. If the first firm receives $T \geq T_L(\pi, i)$ the firm has an incentive to locate in the area. For the government to finance $T \geq T_L(\pi, i)$ when ancillary firms do not invest in the area follows that $\tau S - T_L(\pi, i) \geq 0$, or $i \geq \frac{(1-\tau)}{2}$.

However, when ancillary investors do follow and also invest in the region and when the spillovers are positive, the government has a potentially larger surplus equal to $(\tau + \alpha)S$ from which to finance a transfer *T*. We define T_H to be the transfer that makes the government indifferent between offering a high transfer T_H to attract the first firm as well as ancillary investors and offering the lower transfer T_L and attracting only the first firm to the area. That is, $(\tau + \alpha)S - T_H(\pi, i) = \tau S - T_L(\pi, i)$ and so $T_H(\pi, i) = \alpha\pi i + T_L(\pi, i)$. When the infrastructure is such that $i \geq \frac{(1-\tau)}{2}$ and $\alpha > 0$ the government is indifferent between offering the transfer T_H and attracting subsequent investors, or a lower transfer T_L that does not attract them. For the government to be indifferent it must transfer some of its gain from ancillary investments to the targeted first firm.

When $i < \frac{(1-\tau)}{2}$ the government is able to finance a transfer sufficiently large to attract the first firm only when spillovers are positive and it can tap into the surplus αS generated from the ancillary investments. Specifically, when $\frac{(1-\tau)}{2} > i > \frac{(1-\tau)}{2(1+\alpha)}$ the government can offer a transfer *T* where $(\tau+\alpha)S \geq T > T_L(\pi,i)$ to attract the first firm. However when the region's infrastructure is poorer and $i < \frac{(1-\tau)}{2(1+\alpha)}$, then even in the case of positive spillovers, the government is unable to finance a transfer sufficiently large to attract the first firm to the area.

Consider first the outcome when there is a relatively low tax environment with positive spillovers or when $\tau \leq \alpha$ and as before $1/2 > \tau > 0$, and $\tau + \alpha \leq 1$.[4] Proposition 2 below describes this case.

Proposition 2: When $0 < \tau \leq \alpha$ and $\frac{1}{2} > \tau > 0$, and $\tau + \alpha \leq 1$, then there exists the following hybrid perfect Bayesian equilibrium:

I(i) When $\frac{1}{2} > i > \frac{(1-\tau)}{2}$ and $S \geq \frac{1}{4}$, and $T_H \geq \frac{\alpha+\tau}{4}$ then the government will offer $T \geq \frac{\alpha+\tau}{4}$ and the firm will invest in the area.

[4] If we assume that the government gains from the ancillary investments are also due to taxes, then $\alpha \geq \tau$ is equivalent to assuming that the secondary surplus is greater than or equal to the surplus generated by the first project.

I(ii) When $\frac{(1-\tau)}{2} > i > \frac{(1-\tau)}{2(1+\alpha)}$ and $S \geq$ ¼, then the government will offer the firm a transfer T such that $T \geq \frac{\alpha+\tau}{4}$ and $T > T_L$, and the firm will invest in the area.

II(i) When $\frac{1}{2} > i > \frac{(1-\tau)}{2}$ and $S \geq$ ¼, and when $T_H < \frac{\alpha+\tau}{4}$, then the government will offer the firm the transfer $T_L < \frac{\alpha+\tau}{4}$ and the firm will invest in the area..

II(ii) When $\frac{1}{2} > i > \frac{(1-\tau)}{2}$ and $S \leq$ ¼, then the government will offer the firm the transfer $T_L < \frac{\alpha+\tau}{4}$ and the firm will invest in the area.

III(i) When $\frac{(1-\tau)}{2} > i$ and $S <$ ¼, or *III(ii)* when $\frac{(1-\tau)}{2(1+\alpha)} > i$ and, $S \geq$ ¼, then the government will not offer the firm a transfer or $T = 0$, and the firm will not invest in the area.

The equilibrium beliefs of ancillary investors are:

$\mu\left(S \geq \frac{1}{4} \middle| I = 1, T \geq \frac{\alpha+\tau}{4}\right) = 1$, $\mu\left(S \geq \frac{1}{4} \middle| I = 1, 0 < T < \frac{\alpha+\tau}{4}\right) < \frac{1}{2}$ and $\mu\left(S \geq \frac{1}{4} \middle| I = 0, T = 0\right) < \frac{1}{2}$.

When $\mu\left(S \geq \frac{1}{4} \middle| I, T\right) < \frac{1}{2}$ ancillary investors do not invest, whereas when $\mu\left(S \geq \frac{1}{4} \middle| I, T\right) \geq \frac{1}{2}$ they do.[5]

Proof: (see Appendix).

The possible equilibrium outcomes described in ***Proposition 2*** are illustrated by Figures 2(a), 2(b), and 3, which are drawn for a tax rate $\tau = 0.3$.[6] The regions labeled *I*, *II*, and *III*, (corresponding to the various parts of Proposition 2), describe the matches for which the government has an incentive to offer transfers T_H higher than the minimum T_L, to offer the transfer T_L, or to offer no transfer, respectively. The incentives of the government affect the beliefs of the ancillary investors about the relationship between the transfer observed

[5] To complete the beliefs held by ancillary investors recall that if these investors observe an investment and no transfer they believe $\mu\left(S \geq \frac{1}{4} \middle| I = 1, T = 0\right) \approx .65$. If these investors observe no investment and a transfer they believe $\mu\left(S \geq \frac{1}{4} \middle| I = 0, T\right) < \frac{1}{2}$.

[6] For these figures, we take the illustrative case of $\tau = 0.3$ and α either equal to 0.3 (Figure 2a) or greater than 0.3 (Figure 2b). As stated in the text, these figures are specific examples of the general case of $\alpha \geq \tau$.

and the likelihood of a good match. When the transfer is higher than T_L, the ancillary firms can deduce a good match. To see how, observe that when $i = \frac{(1-\tau)}{2}$ and S= 1/4, or alternatively when $\pi = \frac{1}{2(1-\tau)}$, then the high transfer associated with this particular match is $T_H(\pi, i) = \frac{(\alpha+\tau)}{4}$.[7] The government in this case is just indifferent between offering $T_H(\pi, i) = \frac{(\alpha+\tau)}{4}$ and attracting the ancillary investors and offering the lower transfer $T_L(\pi, i) < \frac{(\alpha+\tau)}{4}$ that attracts only the first firm but no the ancillary investors. Of course, there are a number of other matches for which this is also the case. The dark red curve separating regions *I (i)* and *II(i)* identifies the set of matches for which this is true. The set of matches for which $T_H(\pi, i) = \frac{(\alpha+\tau)}{4}$ intersects i = 1/2 at π = 1 in Figure 2(a). As shown in the Appendix, this is always the case when the value of $\alpha = \tau$. When $\alpha > \tau$, the $T_H(\pi, i) = \frac{(\alpha+\tau)}{4}$ curve rotates leftward as shown in Figure 2(b). Observe as well that increases in α lead to α > (1-2τ) and so unlike Figure 2(a), there is no region *III(ii)* in Figure 2(b).

To understand why ancillary firms hold the belief $\mu\left(S \geq \frac{1}{4} \middle| I = 1, 0 < T < \frac{\alpha+\tau}{4}\right) < \frac{1}{2}$ consider Figure 3. It is the same as Figure 2(a) with $\alpha = \tau = 0.3$, except that some additional contours have been added. Each contour reflects the various combinations of i and π that yield the same value of the minimum transfer T_L. Each contour is described by the equation: $i = \frac{1}{2} - \frac{T_L}{(1-\tau)\pi}$. Higher values of T_L correspond to lower contours. The relevant portion of each contours starts from the $i = (1-\tau)/2$, (intersection point one) and continues northeastward to cross the S = ¼ (intersection point two) and then crosses the curve describing the set of matches corresponding to $T_H = (\alpha+\tau)/4$ (intersection point three). Denote the π value associated with each of these three points as π_1, π_2, and π_3, respectively. The curvature of the contour, as defined by the ratio of the

[7] As shown in the Appendix, the set of matches for which $T_H(\pi, i) = \frac{(\alpha+\tau)}{4}$ always begins at the intersection of $i = (1-\tau)/2$ and the $S = \pi i = 1/4$.

absolute value of the second derivative to the first derivative, is $2/\pi$ and, therefore, decreasing in π. The contour thus flattens out as one moves from left to right. As shown in the Appendix, when $\alpha = \tau$, π_2 is horizontally equidistant from both π_1 and π_3. From the decreasing curvature of these contours it therefore follows that the arc length of the contour is greater over its leftward portion in which π rises from π_1 to π_2 than it is over its rightward portion in which π rises from π_2 to π_3. Of course, this same relative arc length comparison will also hold when $\alpha > \tau$, as this relationship implies that the curve $T_H = (\alpha + \tau)/4$, is rotated leftward and so reduces the value of π_3 while leaving π_1 and π_2 unchanged.

The regions of interest in Figure 3 are II(i), and II(ii). In II(i) the match is a good one ($S \geq 1/4$) but the government prefers to offer the lower transfer T_L rather than a higher transfer $T \geq (\alpha+\tau)/4$. The government also prefers to offer the lower transfer T_L in Region II(ii) where the match is not a good one ($S < 1/4$). From the viewpoint of the ancillary firms the matches in Regions II(i) and II(ii) are indistinguishable. All that these firms observe in these cases is the payment of a transfer T_L and the entry of the first firm. However, since there are many i and π combinations with the same observed T_L, and since for any $\alpha \geq \tau$, more than half of these lie in Region II(ii) where $S < 1/4$, the ancillary firms reasonably conjecture that the entry of the first firm does not imply a good environment for their investment.

The remaining regions in Figure 3 are III(i) and III(ii). In these regions, no transfer is offered and no entry occurs. This is not surprising as the local infrastructure i is a particularly bad match for the project. However, as in the no-tax case of Figure 1, there is a small region in which the lack of entry reflects a welfare loss, namely, Region III(ii).

Observe that for a given $\alpha > 0$, ***Proposition 2*** converges to ***Proposition 1*** as the corporate tax rate τ converges to zero. It is equally important to note that, once again, for the government to induce the first firm to make the initial investment requires that it give in transfer half or more of its realized gains as measured either by τS, or $(\alpha+\tau)S$. In regions *I(i)* and *I(ii)*, in which the ancillary firms also invest, this result is simply an extension of the same finding in *Proposition 1*. However, in regions *II(i)* and *II(ii)*, in which only the target first

firm invests, this finding follows from observing that the transfer $T_L = (1-\tau)\pi(\frac{1}{2} - i) > \frac{\tau(i\pi)}{2}$, where the latter is exactly half of the government's tax gains in the case of no ancillary investment.

For a given $\alpha > 0$, increases in the corporate tax rate τ increase the region identified by II(i) where the match is a good one but no secondary investments occur. At some point, a further increase in the tax rate τ will lead to $\tau > \alpha$. Alternatively, decreases in the extent of spillovers α, holding the tax rate constant, will also yield this outcome. In either case, the environment becomes one low spillovers relative to the tax rate. The equilibrium outcome for this case is described by ***Proposition 3***.

Proposition 3: When $\tau > \alpha$ and $\frac{1}{2} > \tau > 0$, and $\tau + \alpha \leq 1$, then there exists the following hybrid perfect Bayesian equilibrium:

I. When $\frac{1}{2} > i > \frac{(1-\tau)}{2}$ there is a critical $T_L = T_1(\alpha, \tau) \leq T < \frac{\alpha + \tau}{4}$ such that for all i and π combinations for which $T_L \geq T_1$, the government offers a transfer $T \geq T_1$ and the target first firm enters the area.

II. When $\frac{1}{2} > i > \frac{(1-\tau)}{2}$, then for all i and π combinations for which $T_L < T_1$, the government will offer a transfer T such that $T_L \leq T < T_1$ and the target first firm will enter the area.

III(i) When $\frac{(1-\tau)}{2} > i$ and $S < \frac{1}{4}$, or *III(ii)* when $\frac{(1-\tau)}{2(1+\alpha)} > i$ and $S \geq \frac{1}{4}$, then the government will not offer the first firm a transfer, or $T = 0$, and the firm will not invest in the area.

The equilibrium beliefs of ancillary investors are:

$$\mu\left(S \geq \frac{1}{4} \middle| I = 1, T; T \geq T_1(\alpha, \tau) \right) \geq \frac{1}{2}, \mu\left(S \geq \frac{1}{4} \middle| I = 1, T; 0 < T < T_1(\alpha, \tau) \right) < \frac{1}{2}, \mu\left(S \geq \frac{1}{4} \middle| I = 0, T = 0 \right) < \frac{1}{2}.$$

Again when $\mu\left(S \geq \frac{1}{4} \middle| I, T \right) < \frac{1}{2}$ ancillary investors do not invest, whereas when $\mu\left(S \geq \frac{1}{4} \middle| I, T \right) \geq \frac{1}{2}$ they do.[8]

[8] Again when the ancillary investors observe an investment and no transfer they believe that $\mu\left(S \geq \frac{1}{4} \middle| I = 1, T = 0 \right) \approx .65$.

Proof: (see Appendix)

Proposition 3 is described in Figure 4. Recall that as α falls below τ, the $T_H = (\alpha + \tau)/4$ curve rotates rightward of the point $\pi = 1$, $i = 1/2$. This is shown Figure 4 for the case $\alpha = 0.15 < \tau = 0.4$. Now there are a set of matches to the immediate north of $T_H = (\alpha+\tau)/4$, such that the government does not have an incentive to offer a high transfer $T \geq (\alpha+\tau)/4$, although the match is a good one. Moreover, it is also the case that a T_L contour with a sufficiently high value of T_L can now have a longer arc length to the right of the $S = 1/4$, than to the left. Both of these observations make clear that it is no longer rational for ancillary firms to believe that only transfers for which $T \geq (\alpha+\tau)/4$ indicate good matches and profitable opportunities. Instead, there is a critical transfer $T_L = T_1$, such that for an observed transfer $T \geq T_1$ the ancillary firms work out that the conditional probability that the match is a good one is greater than 50% and follow the target firm's investment. In Figure 4, where $\alpha = 0.3 < \tau = 0.4$ the critical value of $T_1 = 0.0201$. When $i \geq (1 - \tau)/2$, then for any transfer $T \geq 0.0201$, the target first firm will make the initial investment and ancillary firms will follow with subsequent investments, but for any transfer $T < 0.0201$, the target firm will make the initial investment but the ancillary firms will not follow and invest in the area.

In a high tax (or low spillover) environment, the local government can pay a relatively low subsidy and yet still successfully attract both the initial investment of the target firm and the subsequent investment of the ancillary firms. The reason for this is straightforward. In a high tax (low spillover) environment, the government reaps substantial tax benefits from the initial investment itself. As these gains become large relative to the spillover gains from ancillary investments, it becomes less worthwhile for the government to pursue those ancillary gains by offering a large tax break or subsidy to the initial firm. When the ancillary firms understand this, however, the informational value of the transfer T declines. T will no longer vary across regimes of varying investment quality. If T is large enough to induce the first firm to invest it is a decent bet that secondary investments will be profitable. This leads to considerably more secondary investment at a considerably lower transfer cost to the government. One might think that a high tax environment would be one in which a large subsidy would be necessary to attract both the initial and ancillary investments. Yet, as just shown, once the signaling role of the transfer is considered, this is not necessarily the case.

The differences between Proposition 2 and Proposition 3 also have implications for empirical analysis. In the low tax (high spillover) world of Proposition 2, the government grants a low transfer T_L yet, even then, there will be occasions[Region II(i)] there will instances of (suboptimally) no ancillary investment. In the high tax (low spillover) world of Proposition 3, however, the government again grants a low transfer T_L yet now there will be a good deal of ancillary investment that, with positive probability, will be inefficiently excessive. Econometric analysis will have difficulty identifying the marginal impact and benefit of transfers unless they control for the signaling environment in which the transfers are offered.

3. *Concluding Remarks*

Targeted investment transfers are a frequently used policy tool of local and national governments to attract new capital projects to their regions. A common justification for these transfers is that successful attraction of the initial investment will generate further gains because of subsequent investments from ancillary firms. We investigate in this paper the way in which a transfer to attract the first major investment in an underdeveloped region acts as a signal and leads to other investments in the region. We find that the informational content of the signal sent by the initial investment and the transfer depends upon both the overall tax environment and the extent of spillover gains created by the ancillary investments. In a low-tax-relative-to-spillover environment, the government enjoys particularly large gains if the ancillary investments take place. Hence, the government will be willing to "pay" a lot for those gains by means of a transfer to the first firm. As a result, ancillary firms will make those subsequent investments only when the government signals that willingness to pay with a large transfer to the target firm—so large, in fact, that the government gives away more than half of any potential surplus.

By contrast, when the tax rate is high relative to the spillover gains, the relative importance of the ancillary investments to the government falls. In this setting, the transfer becomes a less precise signal with the result that even a low transfer to the target firm is able to attract both the first and the secondary investments. Of course, in all environments the under-provision of information results in some probability that no investment will take place, despite the fact that the project quality and government infrastructure are a good match for both the initial and subsequent investments.

Our results shed light on the mixed empirical findings regarding targeted transfers as a means of attracting large, visible investment projects in the hopes that these will lead to ancillary investments. When the transfer plays a signaling role, its ability to induce both primary and secondary investments reflects factors that may not have been captured in econometric studies. Since we also find that the government must typically give away more than half of its gains in the targeted transfer, our findings also suggest that evidence of large net gains for the community as a result of attracting the initial investment may be difficult to find. Finally, our analysis gives an additional rationale for communities fearing a "race to the bottom" in tax rates. Beyond the direct, revenue-reducing effect of a general fall in tax rates across communities, our model suggests that such a move to a lower tax environment will, somewhat paradoxically, makes it more costly for any one local government to use targeted transfers successfully to induce both primary and secondary investments in their communities.

4. Appendix

A1. Proof of Proposition 1: Because $i < ½$ a transfer T must be paid to attract the firm's project to the area. Since $\tau = 0$ the transfer T that the local government can pay is financed from the positive spillovers surplus of subsequent investments and so $T \leq \alpha S$. However, αS must be sufficient to compensate the firm to invest in an area with a relatively weak infrastructure, or $\alpha S \geq \pi(1/2 - i)$. This implies that the government can potentially attract the initial investment only if $i \geq 1/2(1+\alpha)$. When a transfer T is paid, it must be sufficiently large so that the ancillary investors understand the match is a good one and will invest in the area and finance the transfer. Transfers $T \geq \alpha/4$ can be offered by good matches only and so the beliefs of the ancillary firms are rational

A2. Proof that $T_H(\pi, i) = \frac{(\alpha+\tau)}{4}$ intersects i = 1/2 at $\pi = 1$ when $\alpha = \tau$.

$$T_H(\pi,i) = \alpha\pi i + T_L(\pi,i) = \alpha\pi i + (1-\tau)\pi\left(\frac{1}{2} - i\right) = \frac{(\alpha+\tau)}{4}.$$

Imposing the restriction that $\alpha = \tau$, and $i = 1/2$, then this equation becomes:

$$\frac{\alpha\pi}{2} = \frac{2\alpha}{4} \Rightarrow \pi = 1.$$

A3. Proof that the distance between π_1 and π_2 equals the distance between π_2 and π_3 when $\alpha = \tau$.

π_1 is the value of π at the intersection of $T_L(\pi,i) = (1-\tau)\pi(\frac{1}{2} - i)$ and $i = (1-\tau)/2$. By substitution then $\pi_1 = \frac{2T_L}{(1-\tau)\tau}$. π_2 is the value of π at the intersection of $T_L(\pi,i) = (1-\tau)\pi(\frac{1}{2} - i)$ and the curve defined by $S = i\pi = 1/4$. It is easy to verify by substitution that $\pi_2 = \frac{1}{2}\left[1 + \frac{4T_L}{(1-\tau)}\right]$. Finally, π_3 is the value of π at the intersection of $T_L(\pi,i) = (1-\tau)\pi(\frac{1}{2} - i)$ and the curve defined by $T_H(\pi,i) = \alpha\pi i + T_L(\pi,i) = (\alpha + \tau)/4$. Substitution in this case yields $\pi_3 = 2T_L\left[\frac{1}{(1-\tau)} - \frac{1}{\alpha}\right] + \frac{\alpha+\tau}{2\alpha}$. The distance D_1 between π_2 and π_1 is:

$$D_1 = \frac{1}{2}\left[1 + \frac{4T_L}{(1-\tau)}\right] - \left[\frac{2T_L}{(1-\tau)\tau}\right] = \frac{1}{2} + \frac{2T_L\tau}{(1-\tau)\tau} - \frac{2T_L}{(1-\tau)\tau} = \frac{1}{2} - \frac{2T_L(1-\tau)}{(1-\tau)\tau} = \frac{1}{2} - \frac{2T_L}{\tau}.$$

Note that as the distance must be nonnegative, the value for D_1 implies that $\tau \geq 4T_L$.

The distance D_2 between π_2 and π_3 is:

$$D_2 = 2T_L\left[\frac{1}{(1-\tau)} - \frac{1}{\alpha}\right] + \frac{(\alpha+\tau)}{2\alpha} - \frac{1}{2}\left[1 + \frac{4T_L}{(1-\tau)}\right]$$

When $\alpha = \tau$, it is straightforward to show that:

$$D_2 = \frac{1}{2} - \frac{2T_L}{\tau} = D_1$$

As D_1 is independent of α, and as D_2 is decreasing in α, it is equally ready to see that D_2 becomes larger (smaller) than D_1 as α rises (falls).

A4. Rotation of the $T_H = (\alpha + \tau)/4$ curve.

Note that π_1, π_2, and D_1 are all independent of α, while

$\frac{d\pi_3}{d\alpha} = \frac{dD}{d\alpha} = \frac{2T_L}{\alpha^2} - \frac{2\tau}{4\alpha^2} = \frac{8T_L - 2\tau}{4\alpha^2} \leq 0$ by the earlier condition for D_1 to be nonnegative.

A5. Proof of Proposition 2

Because $i < ½$ a transfer T must be offered to attract the first mover's investment to the area. Consider first the regions *I(i), II(i)* and *II(ii)* where $\frac{1}{2} > i > \frac{(1-\tau)}{2}$. In the region defined by *I(i)* the value of the match $S=\pi i$ is such that the government can offer a transfer $T > \frac{\alpha+\tau}{4}$ where $T_H(\pi, i) \geq T > T_L(\pi, i)$. In the region *II(i)* and *II(ii)* the value of the match $S=\pi i$ is such that the government offers the transfer $T_L(\pi, i)$ to attract only the first mover firm to the area. The government does not have an incentive to raise the transfer to $T > \frac{\alpha+\tau}{4}$ and attract ancillary investors because $\frac{\alpha+\tau}{4} > T_H(\pi, i)$ and so doing so would make the government worse off. Observe that for values of matches S such that the corresponding $T_H(\pi, i) = \frac{(\alpha+\tau)}{4}$ the government is indifferent between offering T_H and attracting ancillary investors and offering T_L and attracting only the firm. Now consider $\frac{(1-\tau)}{2} > i > 0$. In region *III* where the match is a bad one, $S < ¼$, the government is worse off trying to finance a transfer sufficiently large either to attract the first mover firm to the area or to attract that firm and ancillary investors. However, in *I(ii)* where $\frac{(1-\tau)}{2} > i > \frac{(1-\tau)}{2(1+\alpha)}$ and the match is good, $S \geq ¼$, the government, because of positive spillovers, can finance a transfer $T \geq \frac{\alpha+\tau}{4}$ and since $T > T_L$ both the

government and firm are better off.. However when $\frac{(1-\tau)}{2(1+\alpha)} > i$ and the match is a good one, $S \geq ¼$, the government is better off not attracting the firm or offering $T = 0$. The potential surplus even accounting for spillovers is insufficient to compensate the firm for investing in the area. Given the strategies of the government and first mover firm, the ancillary investors enter and invest in the area only when they observe a transfer $T \geq \frac{\alpha+\tau}{4}$. These firms understand that such transfers can be financed only in good matches or $\mu\left(S \geq \frac{1}{4} \middle| I = 1, T \geq \frac{\alpha+\tau}{4}\right) = 1$. Ancillary investors also know that the government has an incentive to offer transfers T_L where $0 < T_L < \frac{\alpha+\tau}{4}$ to attract the firm to the area and these transfers will be observed both when the match is a good one, region *II(i)* and when the match is a bad one, region *II(ii)*. The ancillary firms in this case do not enter when they observe I = 1 and a transfer T satisfying $0 < T < \frac{\alpha+\tau}{4}$ because they rationally believe that $\mu\left(S \geq \frac{1}{4} \middle| I = 1, T; 0 < T < \frac{\alpha+\tau}{4}\right) < \frac{1}{2}$. This belief is rational, because as illustrated above and shown in the Appendix, the arc length of T_L in region *II(i)* is less than the arc length of T_L in region *II(ii)*. Thus, when the ancillary firms observe I = 1 and some transfer T_L, $0 < T_L < \frac{\alpha+\tau}{4}$, its conditional belief is $\Pr ob\left(S < \frac{1}{4} \middle| I = 1, T_L\right) > \Pr ob\left(S \geq \frac{1}{4} \middle| I = 1, T_L\right)$.

A6. ***Proof of Proposition 3***

Because $i < ½$ a transfer T must be paid to attract the first mover firm's investment project to the area. Consider Region I where $\frac{1}{2} > i > \frac{(1-\tau)}{2}$. In this region, the value of $S=\pi i$ is such that the government can offer a transfer $T \geq T_L \geq T_1$ sufficient to attract the target firm's initial investment. Lowering the transfer below T_L would lose the firm's investment, and when $T \geq T_L \geq T_1$ the target first firm has no incentive to invest elsewhere. When ancillary firms observe a transfer $T \geq T_1$, and the target firm investing, they believe that $\mu\left(S \geq \frac{1}{4} \middle| I = 1, T; T \geq T_1(\alpha, \tau)\right) \geq \frac{1}{2}$ and make the follow-on investments. In contrast, in Region II, the value of $S=\pi i$ is such that the government can only offer a transfer $T_L \leq T < T_1$. This is sufficient to attract the target firm's initial investment. However, when ancillary firms observe $T < T_1$ and the first firm's investment, their belief is $\mu\left(S \geq \frac{1}{4} \middle| I = 1, T; T < T_1(\alpha, \tau)\right) < \frac{1}{2}$. This belief is again rational, as illustrated above and shown formally

in the Appendix. Finally, in Region III in which $\frac{(1-\tau)}{2} > i$ and either $S < ¼$, or the match is a good one $S > ¼$ but $\frac{(1-\tau)}{2(1+\alpha)} > i$, then the government cannot offer the first firm a positive transfer or $T = 0$. In this case, it is rational for the target first firm not to invest in the area. Likewise, when ancillary investors do not observe an investment and do not observe a transfer their belief is $\mu\left(S \geq \frac{1}{4} | I = 0, T = 0 \right) < \frac{1}{2}$, which too is rational.

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Figure 1

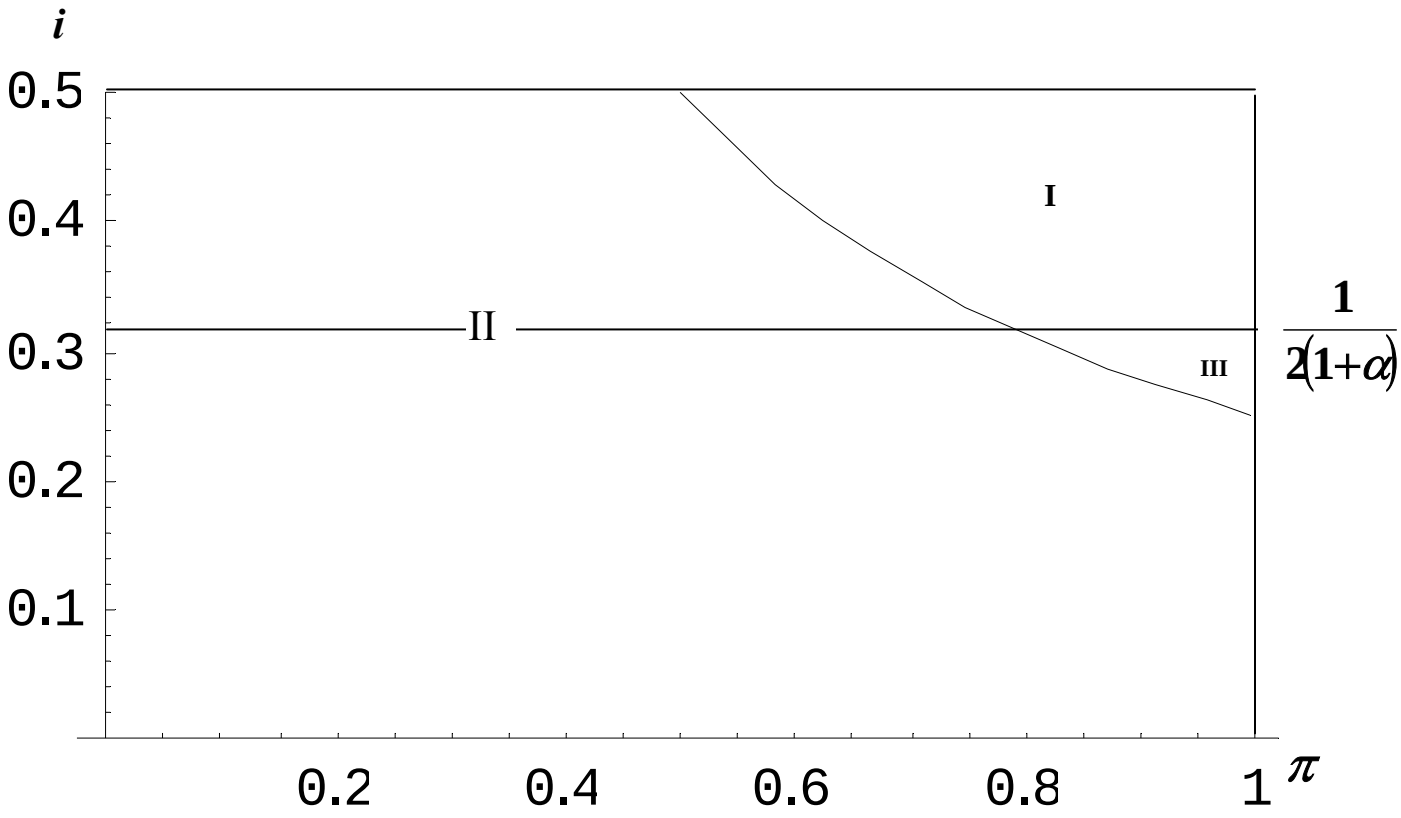

Figure 2a
$\tau = \alpha = 0.3$

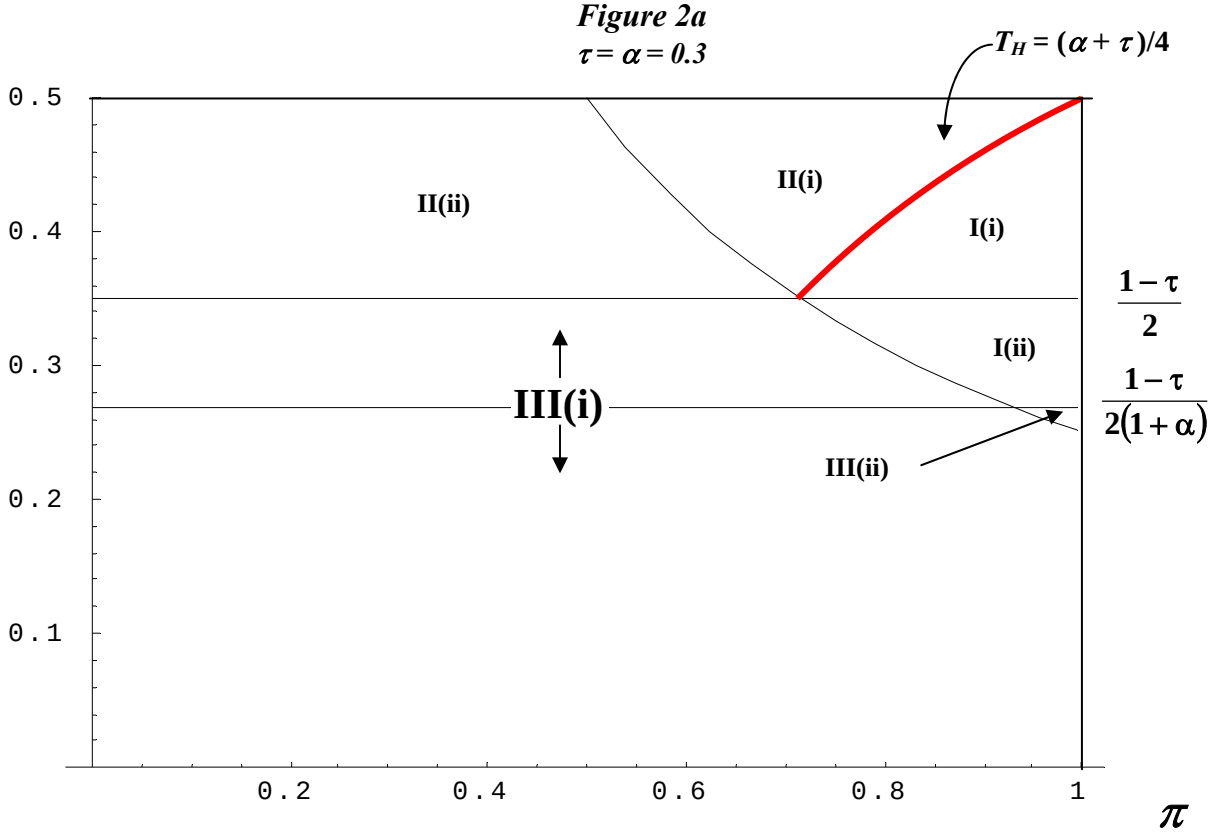

Figure 2b

$\tau = 0.3,\ \alpha = 0.6$

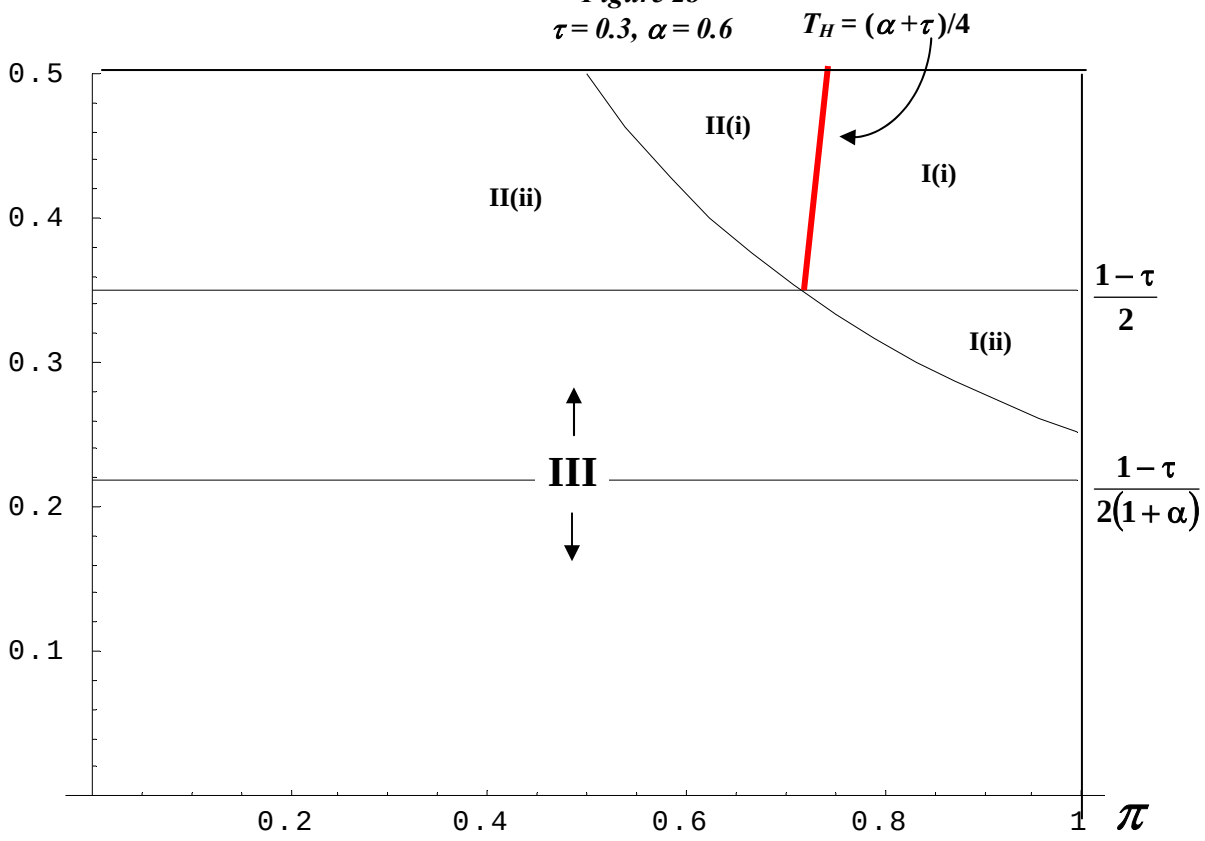

Figure 3
$\tau = \alpha = 0.3$

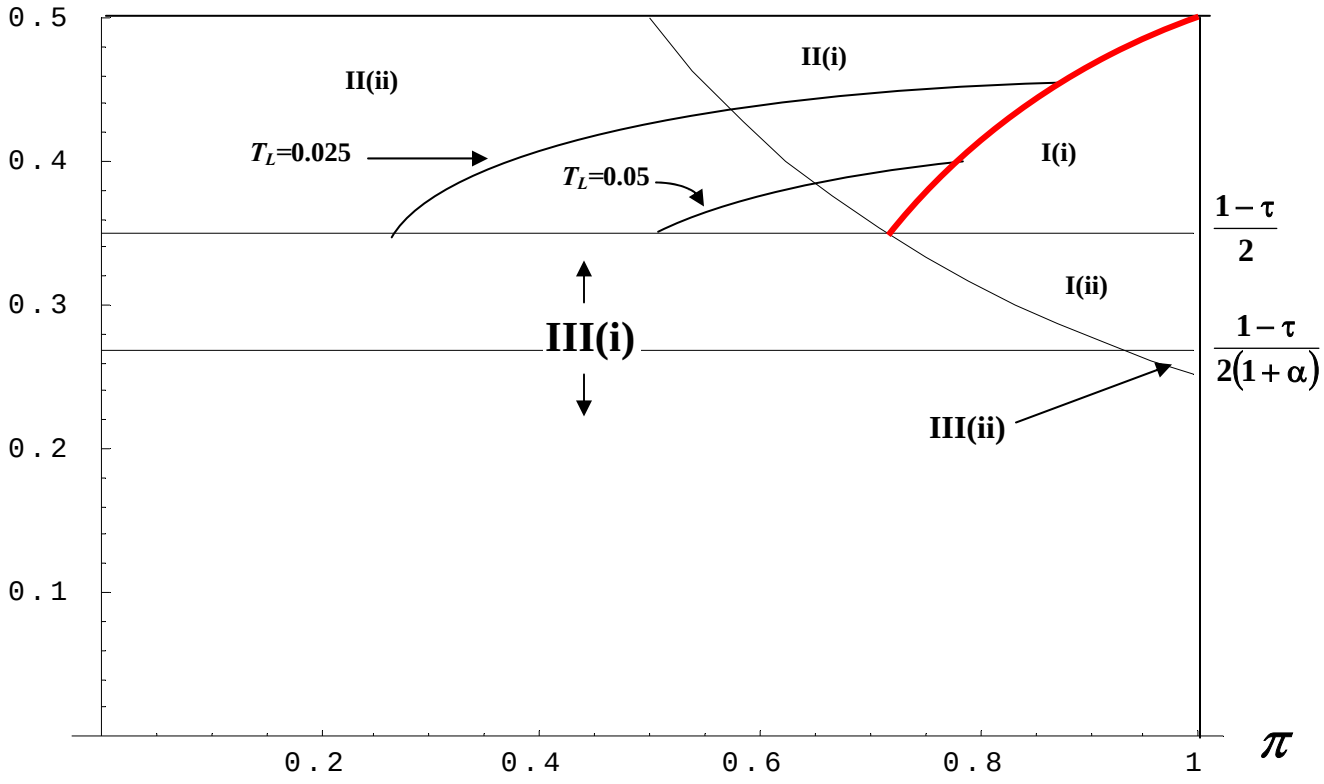

Figure 4
τ=0.4, α = 0.3

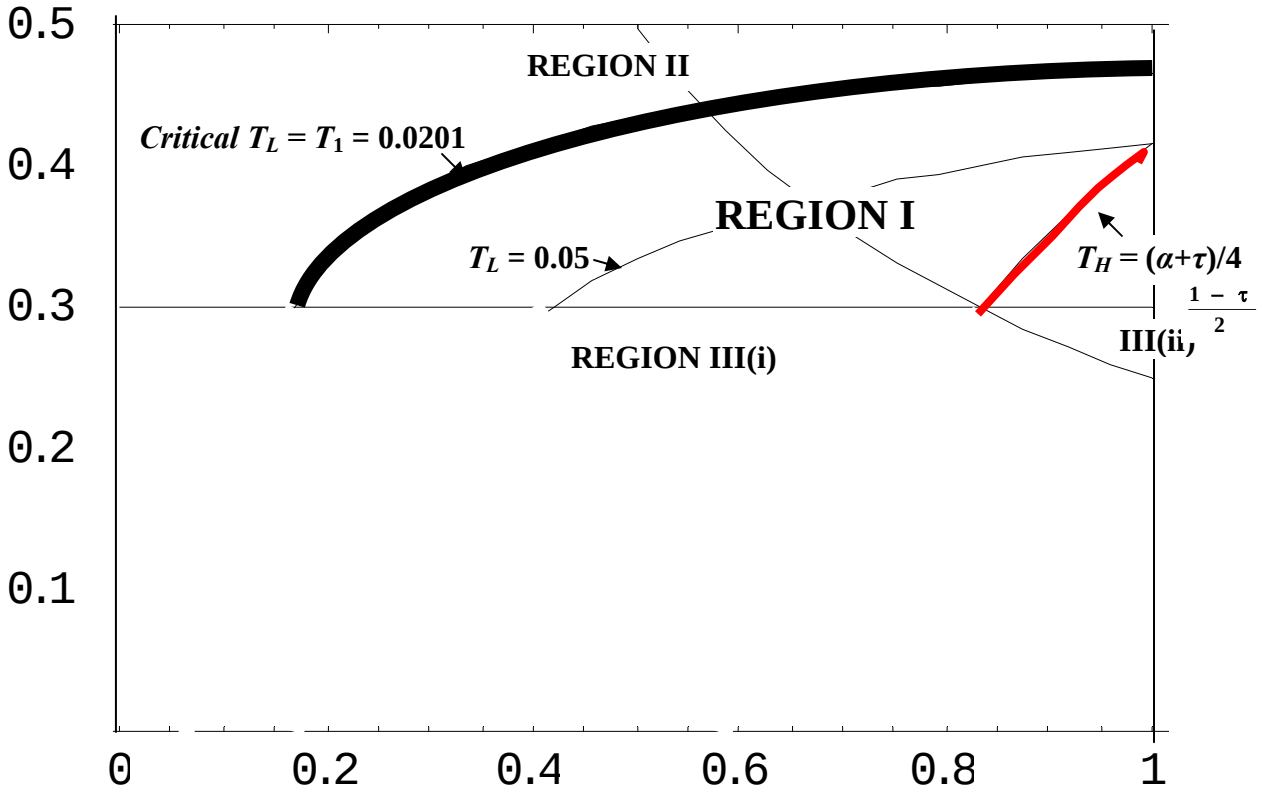
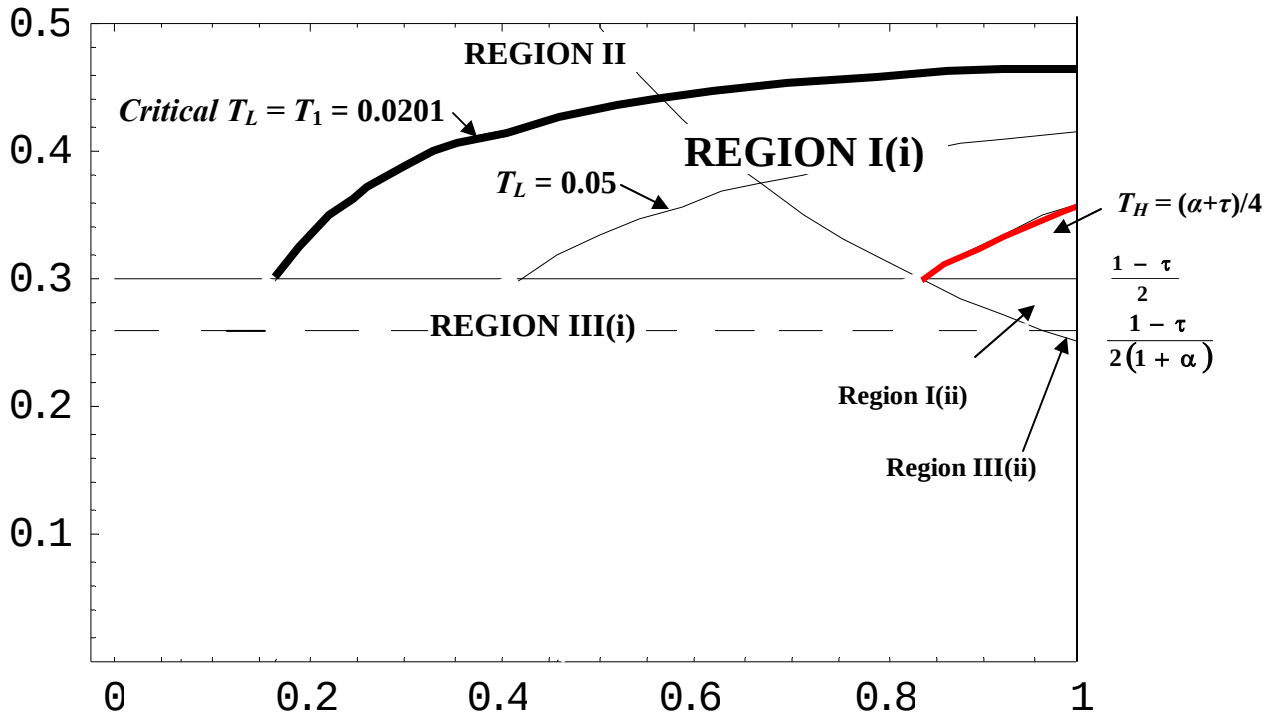
Figure 4
τ=0.4, α = 0.15