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The Welfare and Competitive Effects of Public Investment in Tourism Infrastructure and Tourism Resources

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観光インフラおよび観光資源における公的投資による効用効果および競争的効果

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Abstract

We develop a tractable general equilibrium model to analyze the role of public investment in both tourism infrastructure and tourism resources on competition and welfare. Labor is the only factor of production and there are two final goods: one final good produced under perfect competition using linear technology and one tourism good produced under monopolistic competition a la Dixit-Stiglitz (1977). The government employs labor to provide varying levels of tourism infrastructure (which affects the marginal productivity of firms in the tourism sector) and tourism resources (which affect the fixed costs of firms). We find that an increase in investment in tourism infrastructure enhances market concentration and creates an ambiguous effect on individual utility. An increase in investment in tourism resources has an ambiguous effect on both the number of firms and utility. There are optimal levels of investment for tourism infrastructure and tourism resources, and they depend entirely on the elasticity of substitution and the individual consumer preference towards tourism.

Keywords: monopolistic competition, tourism infrastructure, tourism resource, public investment

要　旨

観光インフラおよび観光資源に対する公的投資の役割を分析するために扱いやすい一般均衡モデルを構築する。労働が唯一の生産要素であり、二つの最終財の内一つは完全競争の下で生産され、もう一つは Dixit-Stiglitz（1977）型の独占的競争の下で生産される観光財である。政府は労働を投入し、観光財を生産する企業の限界生産性に影響する観光インフラ財、そして固定費用に影響する観光資源財を生産する。結論として、観光インフラの増加は市場の集中度を上げ、効用に対する影響が不確定である。さらに、観光資源の増加はバラエティ数および効用に対する影響も不確定である。しかし、効用上の観光インフラおよび観光資源の最適水準が存在し、代替の弾力性および観光財に対する消費者の嗜好のみに依存するものである。

キーワード：独占的競争、観光インフラ、観光資源、公的投資

1. Introduction

Despite the unprecedented turmoil caused by the worldwide COVID pandemic in 2020, tourism is and will continue to be one of the most dynamic industries around the world. International tourism receipts grew from around US$562 billion in 2000 and to US$1.65 trillion in 2018 making it one of the fastest growing industries (World Bank, 2020). Tourism is also one of the most important sources of trade in services, only behind distribution, financial, telecommunications and computer, and transport services (World Trade Organization, 2019, p. 25). Another important aspect of tourism is that the majority of the tourism business is still domestic (71.3%) as opposed to international (28.7%) and consisted of leisure (78.6%) as compared to business (21.4%) according to the World Travel & Tourism Council (2020, p. 3). In order to sustain growth in such a dynamic industry,[1] investment in tourism infrastructure and tourism resources are essential.

Large investments are necessary in the creation and updating of tourism infrastructure, especially when infrastructure is defined in the following three types. The first type is the basic lifeline infrastructure such as water and electricity supply, sewage system, waste collection, telecommunication system, and public safety. The second type is the interconnected transportation infrastructure such as roads, railways, seaways, seaports, and airports. And lastly is the various tourism-related public services such as education and training in hospitality, specific tourism-related legislation and policy, public coordination within the community and the industry, and public structure for outward promotion.[2] Although private investment also happens in these areas, tourism infrastructure tends to be provided by both local and national governments due to the scale and scope of the investments, the legal issues involved, and the nature of the investment itself. The level of tourism infrastructure provided directly affects the productivity level of private businesses and the resulting prices of tourism good, as well as the local community.

Another crucial element for the success of the tourism sector is the existence of abundant tourism resources such as World Heritages and cultural elements. Not only they are the object of tourism consumption, that is, the main reason for the traveling, but they also induce the consumption of tourism goods that make the exploitation of these resources possible. Some examples of those resources, which are very diverse in their nature, include geographic and climatic attractions, architecture, historic attractions, entertainment and events, shopping environments,

1) The tourism sector comprehends all businesses providing a wide range of tourism products and services such as touristic attractions, resorts, entertainment, travel agency services, events, accommodation, transportation, dining, souvenirs, tours and courses, and other travelling services.

2) For more discussions of tourism infrastructure, see for example Lim, Zhu, and Koo (2019), Giannoni and Maupertuis (2007), and Jovanovic and Ilic (2016).

business and industrial clusters, cultural and educational institutions, religious attractions, health care, and many others. Very often these resources are public goods that create large positive externalities, and governments need to participate actively in their creation, maintenance, or management, as it is the case for World Heritages, museums, national parks, urban and natural landscapes, and traditional festivals.[3)]

How does public investment in tourism infrastructure and tourism resources affect competition in the industry and overall welfare level? In a simple and sufficiently general setting, this paper incorporates the two crucial elements of the industry mentioned—tourism infrastructure and tourism resources—into a general equilibrium model featuring monopolistic competition as in Dixit and Stiglitz (1977). Love-of-variety is an adequate assumption for consumer preference in this sector because consumers tend to value tourism resources and products in their variety, not to mention that these products tend to show a high degree of differentiation. We limit the analysis to a domestic market only, where labor is the only factor of production and is used throughout the economy. The government employs labor to provide tourism infrastructure and tourism resources. There are two final goods: one numeraire good produced using labor under perfect competition, and the tourism good produced under monopolistic competition using labor as variable and fixed costs. There are two central assumptions we make: first, the larger the amount of tourism infrastructure, the lower is the input of labor as variable cost by the tourism firm; second, the larger the amount of tourism resources, the lower is the fixed cost input of the tourism firm. This captures the effects of positive externalities that arise from the public provision of resources we mentioned.

The analysis is divided in two parts. In the first part, we introduce public investment in tourism infrastructure that affects the marginal productivity of firms. We find that the larger the scale of the tourism infrastructure, the smaller is the number of firms in the tourism sector because increased productivity hinders the entry of new firms in the market. Public investment in tourism infrastructure also draws labor resources from the economy, which reduces the disposable income of workers and the overall size of the sector. In the second part, we add public investment in tourism resources that affects the necessary input of labor as fixed cost. We find that investment in tourism resources has an ambiguous effect on the number of firms because lower fixed costs increase the number of entries, but draw resources from the economy and reduces the disposable income of workers. In both cases, the effect on individual utility is ambiguous, but there are optimal levels of both labor input on tourism infrastructure and tourism resources that maximize utility.

The model developed in this paper is tractable and can be extended into different directions. One natural extension is to include international tourism in a trade model as in Krugman (1979) while exploring the idiosyncrasies of tourism policy. Another way is to include negative

3) For an example of the impact of World Heritages in China, see Yang and Lin (2014).

externalities that arise from the consumption of tourism products such as pollution, congestion, and gentrification. Also, more robust empirical evidence is still lacking in this particular setting and we will leave this for future work.

The paper is organized as follows. Part 2 introduces the basic model with tourism infrastructure only, Part 3 analyzes the domestic equilibrium, Part 4 adds public investment in tourism resources, and Part 5 concludes this work.

2. The Basic model

In this section, we build a basic model to analyze the equilibrium with domestic tourism in which the government invests in tourism infrastructure, so that the marginal costs of firms is affected. Labor is the only factor of production in the economy and each worker is identical and possesses one unit of labor. The total population and total amount of labor available is denoted by L, and the wage rate is denoted by w.

There are two final goods. One good is the numeraire good Y, which is produced in a competitive market and which price is denoted by P_Y. One unit of good Y is produced using only one unit of labor, thus $P_Y = w$. The other final good, X, represents tourism goods in the economy and features monopolistic competition as in Dixit and Stiglitz (1977). Products and services provided in the tourism industry tend to be differentiated, and, rather than opting for the cheaper product, consumer preferences show love-of-variety, that is, consumers prefer to consume a larger number of varieties than concentrating consumption in one product only. There is a large number of firms, each producing one variety of a tourism good.

2.1 Preferences

Consumer preference follows a Cobb-Douglas specification and the level of individual utility U is given by the following function.

$$U = X^{\alpha} Y^{1-\alpha} \qquad (0 < \alpha < 1) \tag{1}$$

where X is the quantity index of the tourism good and Y the amount consumed of the numeraire good. Consumers maximize utility in two stages: in the first stage they choose the amount of X and Y subject to the total individual disposable income I. This results in the individual demand for the numeraire good as follows.

$$Y = \frac{(1-\alpha) I}{P_Y}. \tag{2}$$

Since consumers are identical, aggregate demand for the numeraire good in this country becomes

$$LY = \frac{(1-\alpha) IL}{P_Y}, \tag{3}$$

and individual demand for the tourism good is given by

$$X = \frac{\alpha I}{P_X}, \tag{4}$$

where P_X is the price index of the tourism good X.

In the second stage, consumers maximize utility by choosing the amount consumed of each variety in the tourism sector under a CES utility function denoting the quantity index X as follows

$$X = \left(\sum_{i=1}^{n} x_i^{\theta} \right)^{\frac{1}{\theta}}, \qquad (0 < \theta < 1) \tag{5}$$

where x_i is the individual consumption of variety i, and θ is the elasticity of substitution between two varieties. All consumers consume all varieties available in the sector, and utility is subject to the following budget constraint:

$$\sum_{i=1}^{n} p_i x_i = P_X X = \alpha I. \tag{6}$$

We also define the price index P_X as follows.

$$P_X = \left(\sum_{i=1}^{n} p_i^{\theta/(\theta-1)} \right)^{\frac{\theta-1}{\theta}}. \tag{7}$$

Given the above specification, the optimal individual demand of variety i becomes

$$x_i = p_i^{\frac{1}{(\theta-1)}} P_X^{\frac{\theta}{(1-\theta)}} X, \tag{8}$$

and the total demand c_i for variety i can be denoted as

$$Lx_i = p_i^{\frac{1}{(\theta-1)}} P_X^{\frac{\theta}{(1-\theta)}} \alpha IL. \tag{9}$$

2.2 The Public Sector

In the tourism sector, the efficiency of firms is determined by the level of public tourism infrastructure. In the context of this paper, public tourism infrastructure are the public instruments and policies that allow tourists to consume tourism products (products directly associated with touristic attractions). Thus public tourism infrastructure can be widely understood as public transportation systems such as airports, roads, and railways, hospitality-related educational institutions, information centers, public promotional campaigns, subsidies to tourism-related projects, resources spent in tourism-related legislation, and others. For the sake of simplicity, we assume that the total amount of tourism infrastructure is represented by K, and to maintain that level, the government needs to input a fraction μ ($0 < \mu < 1$) of the total amount of labor L in the economy ($K = \mu L$). Tourism infrastructure is a source of positive externality that directly affects the productivity of firms in the tourism sector. Note that the government drains μL amount of labor from the economy, so individual disposable income of consumers become

$$I = (1-\mu) w. \tag{10}$$

2.3 Profit Maximization in the Tourism Sector

A firm producing differentiated variety i under monopolistic competition uses $1/\mu$ amount of labor as variable cost for each unit produced of the final good and an amount F of labor as fixed cost. Thus, the larger the scale of the tourism infrastructure provided, the more efficient the firm is. We also assume that differentiation is costless and that there is a large number of firms. The profit level π_i of a firm providing variety i, then, becomes

$$\pi_i = p_i c_i - w\frac{c_i}{\mu} - wF. \tag{11}$$

Given the above assumptions, the pricing rule becomes

$$p_i = \frac{w}{\mu\theta}, \tag{12}$$

and assuming that the entry of new firms stops at zero profits, the production level c_i of an individual variety i is

$$c_i = \frac{\mu\theta F}{(1-\theta)} = Lx_i. \tag{13}$$

Note that the total amount supplied by one firm is equal to the total individual demand of variety i. As we can see, the amount supplied by each firm is completely defined by the elasticity of substitution, fraction of labor used in the provision of tourism infrastructure, and the fixed cost coefficient. In particular, the larger the fraction of total labor spent in tourism infrastructure, the larger the amount supplied by each firm.

3. The Equilibrium with Public Tourism Infrastructure

Now we turn to the equilibrium of the economy with publicly provided tourism infrastructure. We assume that varieties in the tourism sector are symmetric and the total number is n. In equilibrium, both the numeraire good and the tourism goods are produced, and all the varieties are consumed by all workers. Since the numeraire good is produced, $P_Y = w = 1$.

Using (3), (10) and (11), we set the market clearing condition as shown below in (14). We compute the total amount of labor used as variable costs and fixed costs by firms in the tourism sector, the total amount of labor used in the production of the numeraire good, and the amount of labor used by the public sector used in public tourism infrastructure:

$$n\frac{c_i}{\mu} + nF + \frac{(1-\alpha)(1-\mu)wL}{P_Y} + \mu L = L. \tag{14}$$

We rearrange (14) and find the total number of varieties in equilibrium:

$$n = \frac{(1-\theta)(1-\mu)\alpha L}{F}. \tag{15}$$

Thus the number of varieties is proportional to the amount of labor available in the economy and inversely proportional to the amount of the fixed cost coefficient F. One unintuitive conclusion is

that, if countries have the same size, countries with larger public investment in tourism infrastructure will have a smaller number of varieties in the tourism sector. This happens because the provision of tourism infrastructure makes each firm more efficient and this, in turn, creates market concentration.

Now we turn to the Price Index P_X and the Quantity Index X. From (7) and (12), we obtain

$$P_X = \left(\frac{(1-\theta)(1-\mu)\alpha L}{F} \right)^{\frac{(\theta-1)}{\theta}} \frac{1}{\mu\theta}, \tag{16}$$

and from (5) and (12) we obtain

$$X = \mu\theta\alpha^{\frac{1}{\theta}}(1-\mu)^{\frac{1}{\theta}} \left(\frac{(1-\theta)L}{F} \right)^{\frac{1-\theta}{\theta}}. \tag{17}$$

Now we are able to calculate the equilibrium level of utility of individual consumers. From (1), (16) and (17) we obtain the equilibrium utility level

$$U = \alpha^{\frac{\alpha}{\theta}}(1-\alpha)^{1-\alpha}\theta^{\alpha}\mu^{\alpha}(1-\mu)^{\frac{\alpha}{\theta}+1-\alpha} \left(\frac{(1-\theta)L}{F} \right)^{\frac{(1-\theta)\alpha}{\theta}}. \tag{18}$$

Utility is higher the larger the population and the lower the fixed cost coefficient. Note that the level of utility is ambiguous in relation to public tourism infrastructure, so utility may increase or decrease with μ.

We can calculate the level of μ that maximizes utility. Differentiating (18) by μ, we obtain the first order condition

$$\frac{\partial U}{\partial \mu} = A\left[\alpha\mu^{\alpha-1}(1-\mu)^{\frac{\alpha}{\theta}+1-\alpha} - \left(\frac{\alpha}{\theta} + 1 - \alpha \right) \mu^{\alpha}(1-\mu)^{\frac{\alpha}{\theta}-\alpha} \right] = 0, \tag{19}$$

where $A = \alpha^{\alpha/\theta}(1-\alpha)^{1-\alpha}\theta^{\alpha}((1-\theta)L/F)^{(1-\theta)\alpha/\theta}$. The above condition is satisfied when

$$\mu^* = \frac{\alpha\theta}{\alpha+\theta}. \tag{20}$$

Thus when $\mu^* = \alpha\theta/(\alpha+\theta)$, individual utility is maximized.[4] Note that the optimal level μ^* of tourism investment depends on α, which represents the consumer preference towards tourism goods in relation to the numeraire good. Since $\partial\mu^*/\partial\alpha > 0$ always holds, we can conclude that the larger the preference towards tourism goods, the larger the optimal level of interment in tourism infrastructure.

From our basic model, we can reach a few conclusions.

1. The larger the scale of the tourism infrastructure, the smaller is the number of firms in the tourism sector. Since public tourism infrastructure directly decreases the marginal cost of firms, the stronger is market concentration.
2. The larger the scale of the tourism infrastructure, the larger is the quantity supplied by each firm. This is also a direct consequence of the decreased marginal cost of firms.

4) For second-order condition, please check the Appendix.

3. Individual utility level is ambiguous in relation to the scale of public tourism infrastructure. This happens because, in one hand, a larger investment in tourism infrastructure increases the amount supplied of each variety, but it also decreases the number of varieties. In addition, tourism infrastructure draws resources from the economy, which decreases disposable income.
4. There is an optimal level of investment in tourism infrastructure and that depends on the preference of consumers towards the tourism good. Confirming intuition, the more inclined are consumer preferences towards tourism goods, the larger is the optimal level of investment in public tourism infrastructure.

4. Adding Public Investment in Tourism Resources

Now we examine the effects of investments in the formation of tourism resources, or touristic attractions, which directly affect the production of tourism goods. Besides the infrastructure mentioned in the previous section, a tourism economy thrives when there are abundant tourism resources that can directly generate touristic products. In the real world, we find these as some examples of tourism resources.

1. Natural environment and geographical resources: landscapes, mountains, parks, beaches and marine facilities, natural wonders, wild animals, forests, rivers and lakes
2. Entertainment resources: media and show business, gambling, nightlife, theme parks, gaming and entertainment, concerts and events
3. Shopping resources: shopping complexes, shopping districts, and commerce clusters of specific products and services
4. Historical resources: museums, buildings and facilities, ruins and excavation sites, and old city districts
5. Cultural resources: art, rituals and festivals, traditional and modern craft and practices, traditional buildings and facilities, local culinary
6. Business and Industrial resources: specific business and industrial clusters such as finance and apparel, agricultural businesses such as wineries and ranches, MICE
7. Religious resources: religious sites, religious organizations, religious events

These are some examples of tourism resources that become the primary interest of the consumer in the tourism sector. In order to function as tourism resources, however, most of these resources depend at a certain level on the intervention of the public sector in terms of access, maintenance, legislation, coordination and management, etc. For example, mountains and natural parks need maintenance and management as well legal permission for access and business utilization; large entertainment resorts need complex legal and urbanistic management and public

physical investment; historical resources need public subsidies for research and maintenance; cultural resources need subsidies in education and the arts; and so on. This section incorporates the idea of public investment in tourism resources in the model developed in the previous section and examine the implications to the general level of utility.

The extension is very similar to basic model, but now there is also public investment in tourism resources that affect the fixed cost of firms in the tourism sector. We assume that larger investment in public tourism resources alleviate the fixed cost of firms that is used to develop their touristic product or service. Specifically, the government inputs σL ($0 < \sigma < 1$) amount of labor in the creation, maintenance, and management of tourism resources, which decreases the amount of labor used as fixed costs by firms, so the profit level π_i of variety i is now

$$\pi_i = p_i c_i - w\frac{c_i}{\mu} - w\frac{F}{\sigma}. \tag{21}$$

As a result, the amount c_i supplied by a firm changes to

$$c_i = \frac{\mu\theta F}{(1-\theta)\sigma} = Lx_i. \tag{22}$$

Thus, with a larger investment in tourism resources, the production level of each variety decreases because the zero-profit condition allows for a larger number of firms entering the sector due to the lower fixed costs.

Since labor is now also used in tourism resources, disposable income becomes

$$I = (1-\mu-\sigma)w. \qquad (\mu+\sigma<1) \tag{23}$$

Now we compute the market clearing condition taking into consideration labor used as variable and fixed cost in the tourism good sector, labor used in the production of the numeraire good, labor used in the production of tourism infrastructure, and labor used in tourism resources:

$$n\frac{c_i}{\mu} + \frac{nF}{\sigma} + \frac{(1-\alpha)(1-\mu-\sigma)wL}{P_Y} + \mu L + \sigma L = L. \tag{24}$$

The number of firms in equilibrium is now given by

$$n = \frac{\alpha(1-\theta)\sigma(1-\mu-\sigma)L}{F}. \tag{25}$$

Comparing (15) to (25), we notice that σ affects the number of varieties in two opposite directions. It tends to increase the number of varieties by decreasing the labor input as fixed cost by each firm, but it tends to decrease the number of varieties because it drains labor from the market and decreases disposable income.

We can now calculate the Price Index P_X and the Quantity Index X.

$$P_X = \left(\frac{\alpha(1-\theta)\sigma(1-\mu-\sigma)L}{F}\right)^{\frac{\theta-1}{\theta}} \frac{w}{\mu\theta}, \tag{26}$$

$$X = \mu\theta[\alpha(1-\mu-\sigma)]^{\frac{1}{\theta}}\left(\frac{(1-\theta)\sigma L}{F}\right)^{\frac{1-\theta}{\theta}}. \tag{27}$$

Notice that both indices present an ambiguous change in relation to σ. We now calculate the level of individual welfare as follows:

$$U = \alpha^{\frac{\alpha}{\theta}}(1-\alpha)^{1-\alpha}\theta^{\alpha}\mu^{\alpha}(1-\mu-\sigma)^{\frac{\alpha}{\theta}+1-\alpha}\left(\frac{(1-\theta)\sigma L}{F}\right)^{\frac{(1-\theta)\alpha}{\theta}}. \tag{28}$$

The change in utility level is ambiguous in relation to the change in σ. This happens because, on one hand, σ increase the number of firms in the tourism sector, which benefits the consumer. On the other hand, public investment consumes labor and decreases the disposable income of workers, which reduces utility.

If the amount of tourism resources is held fixed at a certain value σ, from (28) we can calculate the level of tourism infrastructure μ^* that maximizes utility:

$$\mu^* = \frac{\alpha\theta(1-\sigma)}{(\alpha+\theta)}. \tag{29}$$

Notice that μ^* is linearly decreasing in σ, denoting the substitutability between tourism resources and tourism infrastructure. In the same way, if the amount of tourism infrastructure is held fixed at a certain value μ, again from (28) we can calculate the level of tourism resources σ^* that maximizes utility:

$$\sigma^* = \frac{\alpha(1-\mu)(1-\theta)}{(2\alpha-2\alpha\theta+\theta)}. \tag{30}$$

Notice that σ^* is similarly linearly decreasing in μ, denoting the substitutability between tourism resources and tourism infrastructure. We are also able to calculate the optimal σ^{**} and μ^{**} that maximizes utility when both are optimally chosen. Maximizing (28) on σ and μ, we obtain[5)]

$$\sigma^{**} = \frac{\alpha(1-\theta)}{(2\alpha-\theta\alpha+\theta)}, \tag{31}$$

$$\mu^{**} = \frac{\alpha\theta}{(2\alpha-\theta\alpha+\theta)}. \tag{32}$$

Notice that the fractions σ and μ of labor that maximize utility only depend on the preference towards the tourism good and the elasticity of substitution. We also see that the relative magnitude between the optimal fractions of labor employed $\sigma^*/\mu^* = (1-\theta)/\theta$ is fixed by the elasticity of substitution.

From the extension of the model, we can summarize a few of the conclusions.

1. Different from investment in tourism infrastructure, investment in tourism resources has an ambiguous effect on the number of firms in the sector. At the same time the input of a larger fraction of labor in tourism resources increases the number of firms by diminishing

5) See Appendix for calculations.

the necessary labor input of fixed cost, it decreases the number of firms by deviating labor from other sectors and reducing the disposable income of consumers.

2. In the same token, the effect of an investment in tourism resources has an ambiguous effect on individual utility levels. Not only the ambiguous effect on the number firms is directly transferred to individual utility, but there is also a negative effect on utility because of the decrease in disposable income.
3. Tourism infrastructure and tourism resources are complementary intermediate inputs, but since both compete for labor (and other resources) in the economy, they enter as substitutes when it comes to utility maximization.
4. There are optimal levels of investment in tourism infrastructure and tourism resources, and they depend on the elasticity of substitution of varieties and on the consumer preference towards tourism goods.

5. Concluding Remarks

Tourism infrastructure and tourism resources are fundamental elements that enable a tourism industry to exist. In many cases, the government plays a key role in providing these since they directly affect both private businesses in their costs when providing tourism products and services and the communities involved. This paper aims at analyzing the effects of government provision of tourism infrastructure and tourism resources on firms' competitiveness and overall social welfare.

In the first half, where public investment in tourism infrastructure affects the marginal productivity of firms, we find that the larger the scale of the tourism infrastructure, the lower is the competition because the smaller is the number of firms. In addition, investment in infrastructure draws labor resources from the economy reducing disposable income of consumers, decreasing the size of the tourism industry.

In the second half, where public investment in tourism resources affects the fixed cost of firms, we find that investment in tourism resources has an ambiguous effect on the number of firms because lower fixed costs increase the number of entries, but draw resources from the economy and reduces the disposable income of workers. In both cases, the effect on individual utility is ambiguous, but there are optimal levels of both labor input on tourism infrastructure and tourism resources that maximize utility.

We provide a very tractable model of tourism that can be extended into various directions to include tourism policy, externalities, and international trade.

6. Appendix

A. In order to check the second-order condition, we differentiate (19) by μ, and the following inequality should hold

$$\frac{\partial^2 U}{\partial \mu^2} < 0.$$

From (19) we obtain

$$\frac{\partial^2 U}{\partial \mu^2} = (\alpha-1)A\alpha\mu^{\alpha-2}(1-\mu)^{\frac{\alpha}{\theta}+1-\alpha} - \left(\frac{\alpha}{\theta}+1-\alpha\right)A\alpha\mu^{\alpha-1}(1-\mu)^{\frac{\alpha}{\theta}-\alpha}$$

$$-\alpha A\left(\frac{\alpha}{\theta}+1-\alpha\right)\mu^{\alpha-1}(1-\mu)^{\frac{\alpha}{\theta}-\alpha} + \left(\frac{\alpha}{\theta}-\alpha\right)A\left(\frac{\alpha}{\theta}+1-\alpha\right)\mu^{\alpha}(1-\mu)^{\frac{\alpha}{\theta}-\alpha-1} < 0.$$

Solving the inequality, we obtain

$$\mu^2(1-\theta)(\alpha(1-\theta)+\theta) < \theta(1+\alpha)(1-\mu)^2 + 2\mu(1-\mu)(\alpha(1-\theta)+\theta).$$

Thus, if $\mu < 2/(3-\theta)$, there is a solution to the maximization problem. We see that a sufficiently large θ is a sufficient condition.

B. Since U can be maximized in both μ and σ, we substitute (30) into (28), obtaining

$$U = \frac{\alpha^{\frac{\alpha(2-\theta)}{\theta}}(1-\alpha)^{1-\alpha}\theta^{\alpha}(1-\theta)^{\frac{2\alpha(1-\theta)}{\theta}}(\alpha-\alpha\theta+\theta)^{\frac{\alpha(1-\theta)}{\theta}+1}}{(2\alpha-2\alpha\theta+\theta)^{\frac{2\alpha(1-\theta)}{\theta}+1}}\left(\frac{L}{F}\right)^{\frac{\alpha(1-\theta)}{\theta}}$$

$$\mu^{\alpha}(1-\mu)^{\frac{2\alpha(1-\theta)}{\theta}+1}.$$

Differentiating the above equation by μ and equating to zero, we obtain the utility maximizing value μ^{**}

$$\mu^{**} = \frac{\alpha\theta}{(2\alpha-\alpha\theta+\theta)}.$$

Now we can calculate the utility maximizing level σ^{**}

$$\sigma^{**} = \frac{\alpha(1-\theta)}{(2\alpha-\alpha\theta+\theta)}.$$

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