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Political Economy of City Sizes and Formation*

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There are two paradigms of city formation and size—the competitive model of large-scale land developers operating in national land markets and the self-organization model of agglomeration. This paper examines the effects of local politics, urban classes, and restrictions in national land markets on city size and formation. It starts by introducing local politics into the two paradigms. Then it turns to a growth situation, where land developers initiate new settlements, but existing cities are either self-organized or governed locally. The paper also examines the politics of local no-growth movements and of governance of specially favored mega-cities.
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Social scientists and social commentators have struggled with the question of whether cities are too big or too small.[1] The question is also very much in the public policy area. International agencies take the position that the urban agglomeration benefits heralded by Marshall a century ago do not justify the sizes of today's major metropolitan areas, or mega-cities. In noting that in 1950 there were only 2 metro areas in the world with over 10 million people, but today there are 14 with that number projected to double within 20 years, the United Nations [35] asks how bad "the negative factors associated with very large cities" need to get "before [it is in the]

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[1] For an overview of the debate, see "A Survey of Cities," *The Economist*, 7/29/95.

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self-interest of those in control to encourage development of alternative centers." The same report warns of "unbalanced urban hierarchies," the crime, congestion, and social inequality in mega-cities, and the social upheavals involved in draining hinterland villages and cities to populate metro areas. Similarly, these issues have been part of the World Bank's agenda since Renaud's [30] book, which examined national policies and institutional structures that lead to over-concentration in the urban sector, and they are a subject of the World Development Report for 1999/00.

On a more everyday scale, there is a very different debate in some developed countries about whether, in essence, certain communities are too small and should be forced to grow (see Scott [32] and Fischel [10]). A variety of "no-growth" instruments exist so communities may restrict population size and composition, including large lot zoning, moratoria on site services (e.g., sewer and water connections), restrictions on the number of building permits issued, and open space zoning and provision for greenbelts. There is a corresponding urban economics literature on growth controls (Helsley and Strange [16]). A basic question is Why do such situations arise where people are attempting to enter particular communities from which they are excluded?

In this paper we will specify a common framework to analyze the political economy of situations in which the international agency and no-growth controls perspectives are relevant. To do so, and more generally, to evaluate and answer the question about when cities are too big, we need to understand the fundamentals of city formation and local politics. What are the key market and institutional mechanisms? What are the political conflicts and the roles of land developers, local governments, national land markets, property rights specifications, instruments such as local zoning and subsidies to local businesses, and the like? We will develop limit cases, where in free national land markets, the fundamentals of city formation lead to efficient outcomes. However, we will suggest that restrictions in national land markets on city formation and autonomy in local governance in many countries lead to situations where cities tend to be oversized, as suggested by international agencies. In such contexts there is also an incentive for citizens of pro-active cities to attempt to limit their sizes, but conflicts among groups within cities about the limits to impose.

Sections 1–3 of this paper develop the relevant limit cases. Section 1 presents the standard general equilibrium model (from the urban and local public finance literature of city formation and size), in an economy where agents such as land developers operate freely in competitive national land markets (e.g., Henderson [18], Hamilton [15]). The model is restricted to the symmetric case with one type of city, to focus on the issues of city formation. Results generalize directly to an economy with many types of cities (Henderson [18]). While Section 1 synthesizes known results, it contains a new critical result on coalition-proofness of equilibrium. Also, as a new feature, the model contains two types of urban residents who own local businesses and workers who labor for them. Having two classes of people enriches the context, setting the stage to study the political economy for resolving the conflict between classes of people in the determination of city size and allocation of local property rights and tax burdens, as discussed in later sections of the paper.

Section 2 turns to the other extreme case in the literature. This is city formation through "self-organization" (e.g., Henderson [18], Krugman [24, 25], and Krugman and Venables [26]). Under self-organization no agents act in national land markets to form cities because either such agents do not exist or political institutions prohibit their proper functioning. Cities form through unorganized clustering of workers and firms, which can generate enormously oversized cities. Section 2 explains a limiting case to self-organization, where once clusters form they become governed by autonomous local governments, raising issues of how such governments operate. In whose interests (workers or entrepreneurs) do they act and what are their inducements to tax local property and subsidize local businesses?

Section 3 characterizes how we think cities actually form and achieve equilibrium sizes in freely functioning national land markets. Our context is a growing economy, where land developers may set up new cities but do not control existing cities. Existing cities are self-organized through migration of workers and firms and may be governed by more or less pro-active local governments. A fundamental result will be that unconstrained developer formation of new cities can be sufficient to force existing self-organized cities to efficient sizes.

In Section 4, we turn to typical situations in many countries, both developed (e.g., the United States and UK) and undeveloped (e.g., Indonesia), where institutional restrictions in national land markets inhibit city formation and inefficiently limit the number of cities. This context will bring the paper full circle to the mega-city size and no-growth control debates and link the two. In institutionally restricted situations, pro-active local governments have incentives to act to limit size and composition—i.e., to exclude people or impose "no-growth" controls. This extends to the mega-city context. As we will explain, the context of mega-cities typically involves a city favored by the national government with special amenities (e.g., capital cities such as Paris, Bangkok, and Jakarta). While such cities grow to relatively large sizes, residents still have strong incentives to limit growth and alter composition. Outcomes depend critically on whether such cities are ruled by democratic local governments or ruled by local oligarchies. They also explain the reasons for the battles in local communities, in courts, or among national planners in developing countries over city sizes, composition, and land tenure and ownership rights.

1. COMPETITIVE MODEL OF CITY FORMATION

In this section we present the traditional model of city formation in the literature, integrating a variety of existing results and presenting new results on uniqueness and coalition-proofness. This section serves as a *benchmark* and platform from which to proceed to subsequent sections. This section is broken into three parts: (i) the internal structure of cities, (ii) the economy-wide equilibrium with agents such as land developers who "own" and operate cities in competitive national labor and land development markets, and (iii) the required local instruments of control to achieve the specified equilibrium. Throughout the paper specific functional forms are used. While the qualitative results hold for a variety of specifications, use of particular functional forms allows us to be specific about existence conditions.

The Internal Structure of Cities

To have multiple, noninfinitesimal size cities in an economy requires each city to experience centripetal forces of "attraction" so as to have agglomeration and centrifugal forces of "repulsion" to limit each city's size. Forces of attraction are based on the technology of production and those of repulsion on the internal spatial structure of cities.

Technology. The two types of atomistic agents in an economy, workers and entrepreneurs, both live in cities and are perfectly mobile nationally. Each entrepreneur owns and operates one firm and workers labor for the entrepreneur. For simplicity, we model agglomeration benefits as involving information spillovers, where entrepreneurs in the city communicate information to each other about production and market conditions. For each firm, this is a positive externality (Marshall [27]), involving information spillovers, where "mysteries of the trade" are learned "unconsciously" and each idea becomes "the source of yet more ideas." Kim [22] building on Fujita and Ogawa [12] shows the problem can be modeled also as endogenous information exchange based on firms' decisions to purchase/exchange costly information. In our particular formulation, firm output is

$$y = E m^{\epsilon} \tilde{n}^{\delta}, \quad 0 < \delta < 1, 0 < \epsilon, \tag{1}$$

where $\tilde{n}$ is firm employment of labor and m is total entrepreneurs in the city, m^{ϵ} represents the external spillover benefits to the firm of having more firms locally, ϵ is the elasticity of firm output with respect to the number of local firms, and $\delta < 1$ ensures limited firm sizes.

Given identical technologies in (1) total city output $Y = my$ and total city employment/population $n = m \cdot \tilde{n}$. The city production function is

$$Y = Em^{\gamma}n^{\delta}$$
$$0 < \gamma \equiv 1 + \epsilon - \delta < 1. \tag{2}$$

Note that, given $\gamma + \delta > 1$, there are joint economies of scale to city population. $\gamma < 1$ ensures regularity conditions (in particular stability and second-order conditions). Later (Proposition 1), we will require $\epsilon < 1/2$ in order to have multiple cities in the economy. Entrepreneurs, in maximizing profits, hire labor according to the value of its marginal product (MP_n) and earn a residual return (RR). From (2), the social marginal product (SMP_m) of entrepreneurs exceeds their private residual return, given that entrepreneurs generate an information spillover externality. These relationships are

$$\begin{aligned} MP_n &= \delta y/\tilde{n} = \delta Y/n \\ SMP_m &= \gamma Y/m \\ RR &= (1 - \delta)y = (1 - \delta)Y/m. \end{aligned} \tag{3}$$

Urban Structure. The internal spatial structure of cities is the simplest standard version (Mohring [28]), demonstrating that costs of living rise with city size, as average commuting costs rise. All production in a city occurs at a point, defined as the Central Business District, or CBD. Surrounding the CBD in a circle are residences, where each resident, whether an entrepreneur or worker, lives on a lot of fixed size, 1, and commutes to the CBD (and back) at cost per unit distance of t (paid in units of city output). Equilibrium in the land market is characterized by a rent gradient, extending from the CBD at zero to the city edge at u_1. Rents at the city edge (in the best alternative use) are normalized to zero, and rent at distance u from the city center can be shown to be $R(u) = t(u_1 - u)$.[2] From this, we calculate total rents in the city to be $\int_0^{u_1} 2\pi u R(u)\, du = \frac{1}{3}\pi t u_1^3$ (given lot sizes of 1, the population at any distance is $2\pi u\, du$). Commuting costs are $\int_0^{u_1} 2\pi u(tu)\, du = \frac{2}{3}\pi t u_1^3$.

[2] An equilibrium in residential markets requires all residents (living on equal size lots) to spend the same amount on rent plus commuting costs; so for each consumer group, any member then has the same amount left over to spend on all other goods, so as to equalize utility levels of group members. At the city edge, rent plus commuting costs are tu_1 since $R(u_1) = 0$; and elsewhere they are $R(u) + tu$. Equating total rent plus commuting cost expenditures at the city edge with those amounts elsewhere yields the rent gradient $R(u) = t(u_1 - u)$.

City population is

$$\text{pop} = n + m, \tag{4}$$

consisting of all workers and entrepreneurs. Given a circular city with lot sizes of 1, $n + m = \pi u_1^2$ or $u_1 = \pi^{-1/2}(n + m)^{1/2}$. We may then write

$$\text{total commuting costs} = B(n + m)^{3/2} \tag{5}$$

$$\text{total land rents} = \frac{1}{2}B(n + m)^{3/2} \tag{6}$$

$$B \equiv \frac{2}{3}\pi^{-1/2}t.$$

Note that average commuting costs and rents rise with city size $(n + m)$, representing scale diseconomies to the city, or the centrifugal forces. The elasticity of *per person* commuting resource costs with respect to population is $1/2$. Equation (6) gives rental income, for distribution.

City Formation

In the benchmark case, land development companies ("developers") compete in national land markets to "own" and operate cities. Cities form on identical sites, in an unspecified national geography, where there is an unexhausted supply of potential sites, each operated by a different developer. Each development company is owned by Arrow–Debreu shareholders and seeks to maximize land rents net of any costs in its city. Each developer offers a "contract" to local workers and entrepreneurs who enter its city. The contract is $\{n, m, T_n, T_m\}$, where n and m are the workers and entrepreneurs in the city, and T_n and T_m are per person subsidies (which may be zero) to workers and entrepreneurs who locate there. The reasons the contract is specified to contain quantity and price items are analyzed in the next section. Within the city, the company allows free labor and residential land markets. From Eq. (3), entrepreneurs pay workers their MP_n, and entrepreneurs collect residual firm profits. Workers and entrepreneurs pay their own commuting costs and rents, and as Arrow–Debreu shareholders, collect dividends, if any, from development companies in which they hold shares. Workers and entrepreneurs are freely mobile across cities.

The developer's problem in any city is to maximize profits subject to constraints that workers and entrepreneurs earn their going returns in national markets. Thus we have

$$\max_{n, m, T_n, T_m} \Pi = \frac{1}{2} B(n+m)^{3/2} - T_n n - T_m m \tag{7a}$$

$$\text{s.t.} \qquad T_n + E\delta n^{\delta-1} m^{\gamma} - \frac{3}{2} B(n+m)^{1/2} - \overline{V} = 0 \tag{7b}$$

$$T_m + E(1-\delta) n^{\delta} m^{\gamma-1} - \frac{3}{2} B(n+m)^{1/2} - \overline{R} = 0 \tag{7c}$$

In the objective function, the company collects total local land rents (Eq. (6)) and pays workers (n) and entrepreneurs (m) any subsidies (T_n or T_m). In the constraints, subsidies are set so local factor compensation (Eqs. (3)), less per person rents plus commuting costs (Eqs. (5) and (6)), equals the going compensation rate, respectively $\overline{V}$ or $\overline{R}$, in national markets (including any perceptually fixed dividend payments). Solving (7) we get

$$\overline{R} = E\gamma m^{\gamma-1} n^{\delta} - \frac{3}{2} B(n+m)^{1/2} \tag{8a}$$

$$\overline{V} = E\delta m^{\gamma} n^{\delta-1} - \frac{3}{2} B(n+m)^{1/2}. \tag{8b}$$

Substituting (8a) and (8b) back into (7a) we solve

$$\begin{aligned} T_n &= 0 \\ T_m &= E\epsilon m^{\gamma-1} n^{\delta}, \end{aligned} \tag{9}$$

where $\epsilon = (\gamma + \delta - 1)$. Land development companies allow market compensation for workers in Eq. (8b), but intervene to subsidize entrepreneurs in (8a) according to the externality they generate in (1). The residual market return of $(1-\delta)y$ is augmented by ϵy to raise the total to γy, which is an entrepreneur's social marginal product (Eq. (3)).

In national markets, land developers compete for residents. Given a large enough number of cities, we utilize standard folk theorem entry solutions from the industrial organization literature, with their attendant problems discussed below. Developers enter the city formation business until profits in (7) are driven to zero. Substituting in (7) for T_m from (9), $\Pi = 0$ implies

$$E\epsilon m^{\gamma} n^{\delta} = \frac{1}{2} B(m+n)^{3/2}. \tag{10}$$

To determine city sizes and numbers nationally, we impose full employment, presuming that cities are identical in equilibrium (see Proposition 2).

The national factor ratio is

$$m/n = A, \tag{11}$$

assuming people types are immutable. Substituting (11) into (10), we get worker population in the representative city $\overset{*}{n}$, where

$$\overset{*}{n} = \left\{\epsilon 2B^{-1}E(1+A)^{-3/2}A^{\gamma}\right\}^{1/(1/2-\epsilon)}. \tag{12}$$

We loosely call this $\overset{*}{n}$, city size. Obviously, true city size is $\overset{*}{n} + \overset{*}{m}$ ($= \overset{*}{n}(1+A)$). In (12), the expression in brackets is a parameter collection. $1/2 - \epsilon > 0$ is required to have multiple cities in an economy (see Proposition 1). City size increases as the degree of scale economies, the forces of attraction, ϵ, rises toward the degree of scale diseconomies, $1/2$, in commuting costs.

The nature of the equilibrium nationally is characterized by the following proposition.

PROPOSITION 1. *Given $E, B, A > 0$ and $0 < \gamma, \delta < 1$, necessary and sufficient conditions for the existence of a unique competitive equilibrium with multiple cities of noninfinitesimal sizes are*

$$\gamma\frac{(1+A)}{A}, \delta(1+A) > 3\epsilon$$

$$0 < \epsilon < \frac{1}{2}$$

Such an equilibrium has the following characteristics:

(a) *All local land rents are transferred to entrepreneurs/firms.*

(b) *Equilibrium city size is given by*

$$\overset{*}{n} = \left[2\epsilon B^{-1}E(1+A)^{-3/2}A^{\gamma}\right]^{1/(1/2-\epsilon)}$$

and is increasing in the degree of scale economies, ϵ, and with advances in technology such as increases in E or declines in unit commuting costs, t, reflected in lower values of B.

(c) *The number of cities in the economy is $\overset{*}{S}$, where $\overset{*}{S} = N/\overset{*}{n}$ for $N \gg \overset{*}{n}$, where N is national worker population.*

(d) *The equilibrium is a free mobility one, where in the contract $[\overset{*}{n}, \overset{*}{m}, \overset{*}{T}_n, \overset{*}{T}_m]$ offered by each developer $\overset{*}{n}$ and $\overset{*}{m}$ are self-enforcing.*

Proposition 1 summarizes the standard results in the literature. Item (a) follows given free entry of developers in national land markets drives profits to zero. Note, from (9), that the LHS of (10) is mT_m and, from (6), that the RHS of (10) is total local rents. This is the "golden rule" in Flatters et al. [11], aptly renamed the Henry George theorem by Stiglitz [33]. Local urban land rents fill the gap between the social and the private marginal product of entrepreneurs. Later in the paper these notions will provide an economic basis for assigning ownership of urban lands to entrepreneurs in a growth context.

Item (b) in Proposition 1 follows by inspection of Eq. (12) and suggests that city sizes increase with technological change, whether exogenous or in an endogenous growth context as in Black and Henderson [4]. Item (c) is obvious, as a folk theorem result, ignoring integer problems (in defining $\overset{*}{S} = N/\overset{*}{n}$ or in defining $\overset{*}{n}$ and $\overset{*}{m}$).[3] However, folk theorems are potentially problematic. When we divide the national population into an intended $\overset{*}{S}$ integer number of cities, city sizes will be $\overset{*}{n}$ plus a fraction of $\overset{*}{n}$, where the fraction only goes to zero as national scale becomes infinitely large (Henderson [18]). These fractions can present problems in finding equilibria in the core of an economy, as discussed momentarily. For item (d), once $\overset{*}{n}$ and $\overset{*}{m}$ are achieved, the developer does not need to enforce them. No resident worker or entrepreneur acting on his or her own would want to move and deviate from this equilibrium. From (8), $\partial \overset{*}{R}/\partial m|_{\overset{*}{n}} < 0$ and $\partial \overset{*}{V}/\partial n|_{\overset{*}{m}} < 0$,[4] so if, say, a worker leaves one city (lowering its n) and goes to another (raising its n), the worker will be worse off.

Continuing with Proposition 1, given the inherent nonconvexities in agglomeration models, well-behaved solutions are confined to particular regions of parameter space. First, factor consumptions must be positive, or $V, R > 0$ (otherwise, economic agents will choose to "consume their endowments," yielding a normalized utility of zero.) The net returns to entrepreneurs and workers, by substitution into (8), are

$$\overset{*}{R} = Z\{\gamma(A + 1) - 3A\epsilon\} > 0 \tag{13a}$$

$$\overset{*}{V} = ZA\{\delta(A + 1) - 3\epsilon\} > 0, \tag{13b}$$

[3] More formally, $\overset{*}{S}$ could be realized in a sequential game (see Helsley and Strange [16]) where there are $\tilde{S}(\gg \overset{*}{S})$ potential developers. In a staged game, each city-developer enters in a (arbitrary) predetermined sequence. Given the one-time option to enter, developers enter as long as potential profits are positive. Entry stops at $\overset{*}{S}$, which then defines the number of cities. In the penultimate stage of the game, workers and entrepreneurs each choose a contract $\{n, m, T_n, T_m\}$ offered by a city. In the final stage, internal local and land markets clear.

[4] Even at the equilibrium $\overset{*}{T}_m$ in the second city, with entry both the residual return to an entrepreneur falls and rents plus commuting costs rise.

where $Z \equiv \overset{*}{n}^{1/2}(1/2)B\epsilon^{-1}A^{-1}(1+A)^{1/2}$. As indicated in the proposition, positive factor returns require $\gamma(A+1)/A$, $\delta(A+1) > 3\epsilon$.[5] In terms of other restrictions, $\epsilon > 0$ is required for urban agglomeration, or $\overset{*}{n} > 0$ in (12). Additionally $\epsilon < 1/2$ is required. Total city compensation, $\overset{*}{n}\overset{*}{V} - \overset{*}{m}\overset{*}{R}$, is positive only if $\epsilon < 1/2$ and $\epsilon \geq 1/2$ violates a social planner's second-order conditions in this context (see Proposition 2). Why? If $\epsilon \geq 1/2$, $\overset{*}{n}$ is not defined because we want only one city in the economy. Scale effects are so large as to always outweigh the disadvantages of increased commuting costs as city size increases. Finally in Proposition 1, there remains uniqueness. Uniqueness can be proved by showing that, in a competitive equilibrium, cities which are of efficient size for their A cannot operate with different A's and pay the same utility levels.[6]

Comment 1. If entrepreneurs can choose to be workers instead of entrepreneurs (but not vice versa), then (13) requires A such that $\overset{*}{R} \geq \overset{*}{V}$, or

$$\gamma \geq \delta A.$$

For competitive equilibria, this would place an upper bound on A ($A \leq \gamma/\delta$). If A starts at a higher value, entrepreneurs would convert to workers until $A(\equiv m/n)$ falls to γ/δ.

The equilibrium characterized in Proposition 1 has two desirable properties, which are summarized in the next proposition. The second property forms the conceptual foundation for later results.

PROPOSITION 2. (*a*) *The only allocation of factors which is efficient requires all cities to be size* $\overset{*}{n}$. (*b*) *Cities of size* $\overset{*}{n}$ *constitute the only coalition-proof equilibrium.*

From (7) $\overset{*}{n}$ is a Pareto efficient equilibrium for $m/n = A$, since it maximizes developer profits, for V and R fixed. However, $m/n = A$ imposes symmetry. That asymmetric allocations are inefficient can be determined by showing that the national isoquants for this one good

[5] If the restrictions in (13) are met, the complete second-order conditions to the maximization problem in (8) are also satisfied.

[6] Consider, say, m_i and n_i for a particular city type (A_i). At that m_i and n_i, with optimizing behavior and entry so $\Pi_i = 0$, we have an equilibrium city size in (12) $\overset{*}{n}(A_i)$. Equilibrium in national factor markets still requires that factor returns be equalized for different cities, i and j, when $A_i \neq A_j$. However $\overset{*}{V}$ is a monotonic increasing function of A so $\overset{*}{V}(A_i) = \overset{*}{V}(A_j)$ iff $A_i = A_j$. (Evaluating $\partial\overset{*}{V}/\partial A$ reduces to signing $(1/2)\gamma[\delta(1+A) - 3\epsilon] + (1/2)\delta A[\gamma(1+A) - 3\epsilon A]$, which is positive if $V, R > 0$ from Eq. (13).)

economy are convex in N, M space.[7] With convexity, efficiency requires that all cities operate at the full employment A, the national endowment ratio. Thus part (a) tells us that having cities of size $\overset{*}{n}$ is the only candidate for the core of the economy. Part (b) states that the equilibrium $\overset{*}{n}$ is in the core. We can show that there is no deviating "coalition" with a city of a different size, which can attract factors away from cities of size $\overset{*}{n}$.[8] However, this is where our folk theorem and integer issues for $\overset{*}{S}$ present a problem. In a finite-sized economy, as noted above, if we think of $\overset{*}{S}$ as an integer, then equilibrium city size will be $\overset{*}{n}$ plus a fraction of $\overset{*}{n}$. Scotchmer and Wooders [31] point out that these fractions present problems in finding equilibria in the core of an economy. However, Henderson [20] and Conley and Konishi [5] suggest that we may want to redefine coalition-proofness, given that equilibrium coalitions should be subject to free mobility (cannot restrict their membership). That is, the assumption of the mobility in urban economics is at odds with usual coalition proofness requirements that permit exclusionary objecting coalitions in defining whether equilibria are in the core.

Coalition-proofness is fundamental to the paper. $\overset{*}{n}$ is the only allocation that is impervious to "large (or small) deviations" by coalitions of any type,

[7] Consider an isoquant for an arbitrary large national output $\overline{Y}_0$. Along any factor ray in national N and M space, where $A = M/N, \overline{Y}_0$ is produced in $S(A)$ cities where $S(A) = \overline{Y}_0/Y(A)$. $Y(A)$ is the net output $(Y - B(n+m)^{3/2} = E\overset{*}{n}^{\gamma+\delta}A^{\gamma} - B\overset{*}{n}^{3/2}(1+A)^{3/2})$ produced in a city of efficient size, $\overset{*}{n}(A)$, from (12). Then nationally to produce $\overline{Y}_0$, for any A, we need $N(A)$ workers where $N(A) = S(A) \cdot \overset{*}{n}(A) = \overline{Y}_0 \overset{*}{n}(A)/Y(A)$. Substituting in for $Y(A)$ and $\overset{*}{n}(A)$ we get $N(A) = C_1 A^{-(1/2)\gamma/(1/2-\epsilon)}(1+A)^{(3/2)\epsilon/(1/2-\epsilon)}$. Rewriting this, substituting in $A = M/N$, we get

$$N^{\delta}M^{\gamma}(N+M)^{-3\epsilon} = C_2^{(1/2-\epsilon)/(1/2)}, \tag{a}$$

where C_1 and C_2 are collections of parameters. This equation defines N, M combinations nationally needed to produce $\overline{Y}_0$ in cities of efficient sizes. Differentiating this and then evaluating for $A = M/N$ we get $\frac{dN}{dM} = -A^{-1}\left(\frac{\gamma(1+A) - 3\epsilon A}{\delta(1+A) - 3\epsilon}\right)$ and $\frac{d^2N}{dM^2} > 0$ if $\frac{dN}{dM} < 0$. As long as isoquants are downward sloping (and it is never efficient to operate where they are positively sloped), they are strictly convex. Based on (a), if we define the isoquant function $N_i = N(M_i, \overline{Y}_0)$ in N, M space, strict convexity means $N(\lambda M_1 + (1-\lambda)M_2; \overline{Y}_0) < \lambda N(M_1; \overline{Y}_0) + (1-\lambda)N(M_2; \overline{Y}_0) = \overline{N}$, for any λ where $\lambda M_1 + (1-\lambda)M_2 = \overline{M}$. If $\overline{N}$ and $\overline{M}$ are national endowments of labor and entrepreneurs, the inequality means that, relative to having cities with different A_i, the same output can be produced with less labor, if cities operate at the same A.

[8] In particular, $m(A_i)R(A_i) + n(A_i)V(A_i) < m(A_i)R(A) + n(A_i)V(A)$ for all $A \neq A_i$. $R(A)$ and $V(A)$ are the returns in Eq. (13). $m(A_i)$, $n(A_i)$, $R(A_i)$ and $V(A_i)$ are employments and returns (for $\Pi_i = 0$) in a city of efficient size for factor ratio A_i. To see this, we maximize $[m(A_i)R(A_i) + n(A_i)V(A_i)]/[m(A_i)R(A) + n(A_i)V(A)]$ with respect to A_i and show that the unique maximum occurs where $A = A_i$.

whether land developers exist or not. Land developers can be viewed as constructs, or agents, facilitating the formation of efficient size coalitions.

Instruments of Control

For future reference in analyzing the political economy of more realistic situations, it is helpful to understand the actual instruments of control and extent of ownership agents need in order to achieve the equilibrium just presented. What instruments do developers need to specify contracts of the form $\langle \overset{*}{n}, \overset{*}{m}, \overset{*}{T}_n, \overset{*}{T}_m \rangle$? We start by stating why $\overset{*}{n}$ and $\overset{*}{m}$ need to be specified at all, since equilibria are self-enforcing in $\overset{*}{n}$ and $\overset{*}{m}$. Suppose just $\overset{*}{T}_n, \overset{*}{T}_m$ are announced, and workers and entrepreneurs mill around choosing potential cities. The problem is that $\overset{*}{S}$ cities may not be filled. In particular, suppose residents choose to flow into $\hat{S}$ cities, where $\hat{S} < \overset{*}{S}$ and $\hat{n} > \overset{*}{n}$. Generally, as the next section on self-organization shows, there will be no incentive for residents to go to announced but unoccupied sites (where there is no scale of operation), given $\overset{*}{T}_n = 0$ and $\overset{*}{T}_m > 0$ in those unoccupied sites. Specifying $\overset{*}{n}$ and $\overset{*}{m}$ ensures that an efficient number of cities will form.[9] In a large, mixed-use commercial development (e.g., a new edge city), the developer can specify the number of businesses $\overset{*}{m}$ and the density of employment (giving $\overset{*}{n}$). More traditionally, the developer specifies the total residential population and number of businesses through a land use plan, indicating the number of lots for residential and commercial development and their density (e.g., the number of dwelling units per lot). Reichman [29], Ellickson [9], and Fischel [10] argue persuasively that land use plans, which are submitted to higher level governmental boards, are effectively binding in the community formation stage.

The other portion of the developers' contracts concerns factor rewards. Developers need to offer a lump-sum subsidy of $\overset{*}{T}_m$ to entrepreneurs. Local subsidies to new business are almost universal and include underpriced land, holidays from local taxes and fees, and subsidized loans. A general analysis of choice of fiscal instruments is beyond the scope of this paper. There remains a potential issue concerning the developer's access to the income specified in Eqs. (7), in order to pay subsidies. It might appear as if the developer must own all local lands in order to collect the specified land rent income, which can raise questions of a developer's ability to assemble such large pieces of land (Helsley and Strange [17]). However, the objective function does *not* require developer ownership of residential land, per se. To see this, by substituting constraints (b) and (c) into the objective function (a) in Eq. (7), we can rewrite the problem as a

[9] Of course, if only $\hat{S}$ cities were filled, that would not be a coalition-proof equilibrium. But for new developers to move residents into more cities would still require specification of a contract such as $\langle \overset{*}{n}, \overset{*}{m}, \overset{*}{T}_n, \overset{*}{T}_m \rangle$.

command one where the developer's objective function is $Y - \bar{V}n - \bar{R}m - B(n+m)^{3/2}$. Here if the developer owns and controls the commercial district of the city, to optimize, he needs "access" to local residential land rents so he may pay entrepreneurs a lump-sum transfer. If workers own their residential local lands, in theory, the developer can access implicit rents by taxing workers in the commercial district and remitting proceeds to entrepreneurs. If entrepreneurs already own the local land, no transfers are necessary.

2. SELF-ORGANIZATION

If there are no developers operating in national land markets, city formation occurs by workers and entrepreneurs milling around on the urban landscape, self-organizing, and forming "natural" clusters, or cities, given the joint scale economies from agglomerating together. In Krugman [25] and Krugman and Venables [26], this problem is given more structure by imposing a national geography and, in growth contexts, a specific history (initial allocation). However, those analyses do not examine efficiency or comparisons with city formation when there are developers. Here the self-organization context is simpler, but suggests an important problem in city formation.

Before we proceed to examine equilibria under self-organization, there is an issue of who gets urban land rents. In general, following the Arrow–Debreu tradition, land rents could go out of each city to national shareholders, where each person in the economy would own an equal share of rents in every city. We will note the key feature of this case in this section because it is arguably the most general: under self-organization, land rent income for an individual is then independent of location decisions. However, the urban literature often assumes land rent income of a city is redistributed within a city, and we adopt a specific version as our base case. We assume that only the local entrepreneurs in a city share in the land rental income in that city. This assumption allows us to isolate the key source of market failure under self-organization—absence of a market for city formation—from the issue of the effect on city size of marginal pricing of entrepreneurs' entry to cities. Because local entrepreneurs get all local land rents, at an efficient city size from the previous section, they will receive the social marginal product of their entry to the city. Under any other rent distribution scheme they would get less than their social marginal product, introducing a distortion in micro-location decisions. Consistent with this logic, a mechanism by which entrepreneurs would be assigned these rents is the existence of a local government which taxes land rents to redistribute to entrepreneurs, in order to subsidize their location given the positive externalities they generate. Such a local government does not otherwise participate in self-organization solutions. In particular, it does not act to restrict populations, unlike what we will allow pro-active governments to do later in the paper.

The assumption has two other advantages. First, it simplifies the number of cases to be considered without affecting qualitative results, by having bounds on city sizes correspond to previously calculated expressions. Second, in the next section, we will provide a basis for the assumption that local entrepreneurs claim local land rents, in an enhanced self-organization context.

To solve for equilibria under self-organization we start by looking at returns to our two types of factors in any natural cluster, or city, which happens to exist. Then we determine the set of possible equilibrium cluster configurations nationally. In any city, workers are paid their MP from Eq. (3) and pay rent plus commuting costs. Each entrepreneur gets residual firm income, pays commuting plus rent costs, and receives a share of total local land rents. In a representative city, worker utility, V, and entrepreneur utility, R are

$$V = E\delta n^{\delta-1}m^{\gamma} - \frac{3}{2}B(n+m)^{1/2} \tag{14a}$$

$$R = E(1-\delta)n^{\delta}m^{\gamma-1} - \frac{3}{2}B(n+m)^{1/2} + \frac{1}{2}B(n+m)^{3/2}m^{-1}. \tag{14b}$$

In this section, for the benchmark case, we consider only symmetrical self-organization equilibria, in which all cities end up being identical in size. Asymmetrical Nash equilibria may also exist and, in some regions of parameter space, they may be "stable."[10] The analysis in subsequent sections will hold for asymmetric equilibria as well, and asymmetry is not the focus of this paper. Symmetrical self-organization equilibria provide a sufficient benchmark.

There are three parts to characterizing self-organization equilibria. First, as in Section 1, real incomes of factors must exceed the alternative of "consuming endowments," as before, normalized to yield zero. Given $m = An$, $V > 0$ and $R > 0$ define two different maximal, n's, $n^V_{\max}$ and $n^R_{\max}$, which the representative city must be less than.[11] Maximum city size

[10] This is particularly the case when national $A < 1/2$. In relevant regions for A constant, V is decreasing in city size while R is increasing.

[11] These are

$$n^V_{\max} = \left[\frac{2}{3}B^{-1}A^{\gamma}(1+A)^{-1/2}E\delta\right]^{1/(1/2-\epsilon)}$$

$$n^R_{\max} = \left[2B^{-1}A^{\gamma}(1+A)^{-1/2}E(1-\delta)(2A-1)^{-1}\right]^{1/(1/2-\epsilon)} \text{ for } A > 0.5.$$

$n^R_{\max}$ is defined only for $A > 0.5$, because for $A \leq 0.5$, R rises indefinitely as n rises.

is therefore less than

$$n_{\max} = \min\left[n^V_{\max}, n^R_{\max}\right]. \quad (15)$$

At $n_{\max}$ the agglomeration benefits to at least one factor are totally dissipated. The second part in determining equilibrium is to specify Nash allocations. Any city smaller than $n_{\max}$ is a Nash equilibrium because in (14) $\partial V/\partial n|_m < 0$ and $\partial R/\partial m|_n < 0$ (given $0 < \gamma, \delta < 1$). Nash requirements do not narrow the scope of potential equilibria. In order to narrow the scope of potential equilibria, the final part imposes robustness to pairwise deviations or other perturbations to equilibria. This is traditional local "dynamic" stability.[12] Robustness holds only if

$$n \geq \left\{\epsilon 2B^{-1}E(1+A)^{-3/2}A^{\gamma}\right\}^{1/(1/2-\epsilon)} = \overset{*}{n}, \quad (16)$$

where $\overset{*}{n}$ is efficient city size in Eq. (12).

Equations (15) and (16) define upper and lower bounds on equilibrium city sizes. From (16) robust city sizes are at least as large as $\overset{*}{n}$, and from (15) sizes must be less than $n_{\max}$. For existence of equilibrium, $n_{\max} > \overset{*}{n}$, which reduces to the parametric restrictions of Proposition 1. In summary:

PROPOSITION 3. *In a self-organizing economy, equilibrium city size lies between the efficient size,* $\overset{*}{n}$ *and* $n_{\max}$. *Existence requires the same parametric restrictions as in Proposition* 1.

[12] The simplest criterion examines the "partial equilibrium" for any one city. Consider an equilibrium $\bar{V}$ and $\bar{R}$ in national labor markets, where each city has $\bar{n}$ entrepreneurs. Perturb the equilibrium populations in one city, where internal markets adjust instantanteously to yield new values of V and R for that city, for national $\bar{V}$ and $\bar{R}$ unchanged (the partial equilibrium assumption). Given the adjusting V and R there must be further factor movements to or from the city so as to return the city to the original equilibrium. The dynamic adjustment equations are $dn/ds \equiv \dot{n} = d_n(V - \bar{V})$ and $dm/ds \equiv \dot{m} = d_m(R - \bar{R})$, where s is time and d_n and d_m are speeds of migration flows to the city from national markets. Doing a first-order Taylor series expansion about $\bar{n}$ and $\bar{m}$ yields

$$\begin{bmatrix} \dot{n} \\ \dot{m} \end{bmatrix} = \begin{bmatrix} d_n\, \partial V(\bar{n},\bar{m})/\partial n & d_n\, \partial V(\bar{n},\bar{m})/\partial m \\ d_m\, \partial R(\bar{n},\bar{m})/\partial n & d_m\, \partial R(\bar{n},\bar{m})/\partial m \end{bmatrix} \begin{bmatrix} n - \bar{n} \\ m - \bar{m} \end{bmatrix}.$$

A necessary and sufficient condition for convergence is that the matrix be "stable" or have negative characteristic roots. This requires its trace to be negative (which it is) and its determinant to be positive. Evaluating the determinant at $m = An$ results in Eq. (16). This condition for stability is the same for a two-city national labor market with workers and entrepreneurs. In this case, the factor adjustment equations are $\dot{n}_1 = d_n(V_1 - V_2)$ and $\dot{m}_1 = d_m(R_1 - R_2)$. Doing a Taylor series expansion about, say, V_2 and R_2, results in equations such as $\dot{n}_1 = d_n(\frac{\partial V}{\partial n} \cdot (\mathrm{n}_1 - \mathrm{n}_2) + \frac{\partial V}{\partial m} \cdot (m_1 - m_2))$. Proceeding as above, again, yields (16).

To help motivate this result, consider a model with just one factor of production. $\overset{*}{n}$ would be at the maximum of the inverted U-shaped curve defining utility for that factor as a function of city size. Stability would require that city size not lie to the left of that maximum. Similarly the upper bound size in a one-factor model would be at an enormous city size so far to the right of the peak of the utility curve that a person would be off in autarky—living in no city. Here, with two factors of production, as elaborated in Becker and Henderson [3] in a different but related model, the peak of the utility curve for workers (as it varies with city size, for A fixed) may lie to the left ($A > 0.5$, $\delta(1 + A) < 3/2$) or to right ($A > 0.5$, $\delta(1 + A) > 3/2$) of that for entrepreneurs (with $\overset{*}{n}$ in between the two peaks), or the curve for entrepreneurs may rise indefinitely ($A \leq 0.5$).

Given existence, any city size in the interval $(\overset{*}{n}, n_{\max})$ constitutes a robust equilibrium. To determine the size of the interval, we form the ratio $n_{\max}/\overset{*}{n}$.

$$\frac{n_{\max}}{\overset{*}{n}} = \left[\frac{1}{3}\delta\frac{(1 + A)}{\epsilon}\right]^{1/(1/2 - \epsilon)} \quad \text{for } A \leq 0.5$$

$$= \min\left[\left(\frac{1}{3}\delta\frac{(1 + A)}{\epsilon}\right)^{1/(1/2 - \epsilon)}, \left(\frac{(1 - \delta)(1 + A)}{\epsilon(2A - 1)}\right)^{1/(1/2 - \epsilon)}\right] \quad \text{for } A > 0.5.$$

Consider "typical" parameter values from the scale externality literature (Henderson [19]) and national proportions of workers to extrepreneurs and their compensations. We use $\delta = 0.80$, $A = 0.30$, and $\gamma = 0.25\text{–}0.35$ (so $\epsilon = 0.05\text{–}0.15$). Then $n_{\max}$ is 10–75 times $\overset{*}{n}$.[13] In general self-organizing city sizes are not efficient. Here they are oversized, potentially enormously so.

If, instead of local land rents going just to local entrepreneurs, they are more widely distributed, the lower bound on city size will be less than $\overset{*}{n}$, but the potential to be enormously oversized remains. For example, with Arrow–Debreu ownership, the lower bound will be $\overset{*}{n}(2/3)^{1/(1/2 - \epsilon)}$ which is less than $\overset{*}{n}$. As noted earlier, if local entrepreneurs do not collect local rents, their entry to the city is priced at less than social marginal product, which is a force reducing city sizes. Here, by assigning local rents to local entrepreneurs, we have isolated the key problem with self-organization, that being the lack of a national market for city formation which leads cities to be too big.

[13] Note $(n_{\max}/\overset{*}{n}) \to 1$ as $\gamma + \delta \equiv 1 + \epsilon$ gets "large." For $\epsilon \geq 1/2$, only one city in the economy is desired and $n_{\max}$ and $\overset{*}{n}$ coincide. Second $(n_{\max}/\overset{*}{n})$ gets arbitrarily large as $\epsilon \to 0$ and hence, $\overset{*}{n} \to 0$ (i.e., no cities are desired).

Narrowing the set of equilibria: *Growth*. The literature sometimes puts self-organization in the context of an economy experiencing population growth (only), as a way of trying to specify what equilibria are likely to emerge over time (Henderson [18]; Fujita et al. [13]). Suppose we grow population N and M such that A remains constant. Starting with an arbitrary given number of cities, population will grow in each city until the $n_{\max}$ limit is hit, causing "bifurcation," where some workers or entrepreneurs deviate and form new cities. The number of new cities may not be deterministic with bifurcation. Population growth then continues in the new set of cities until the $n_{\max}$ bound is again reached, and then more cities form. This depressing "growth" process of repeatedly hitting a Malthusian upper-bound on city sizes (where worker or entrepreneur utility approaches zero), continues indefinitely. As a solace, in the United States, there is little evidence of a bifurcation process, which implies large drops and cycles in individual city populations. In Dobkins and Ioannides [6], virtually all cities increase in size every decade. Population losses, when they occur, are small.

Local Governments in Self-Organized Cities

Suppose to the self-organization model we add a national constitution which requires that each natural cluster, or self-organized city, have a local government. While, unlike developers, local governments cannot form cities, the assumption is that, once a natural cluster forms, a local government evolves. Further, let us assume that *all* such governments are pro-active in maximizing the welfare of either local workers or entrepreneurs. Both assumptions are extreme, and certainly introduce mischief into simple self-organized worlds. But they tell us about self-organization with local politics, and they provide a useful framework and benchmark for thinking about the "real world" scenarios presented in Sections 3 and 4 to follow.

Under these assumptions, self-organization can be consistent with efficient outcomes. First, we state and prove the proposition and then comment on our exercise.

PROPOSITION 4. *If every self-organized city is governed by an autonomous local government acting to maximize the welfare of the representative member of the majority population and if such governments can operate unconstrained by free mobility* (*i.e.*, *can exclude residents*), *all self-organized cities will be of identical*, *efficient size*.

To prove this, we examine the behavior of the local government in any city. Assume for now that workers are the majority ($A < 1$) and that local lands are owned locally by entrepreneurs. Both assumptions are noncritical. The government then seeks to maximize the return to workers, subject to the city's ability to attract entrepreneurs, or

$$\max_{n, m, T_m} E\delta n^{\delta-1} m^{\gamma} - \frac{3}{2}B(n+m)^{1/2} - T_m m/n \tag{17}$$

$$\text{s.t. } T_m + E(1-\delta)n^{\delta} m^{\gamma-1} - \frac{3}{2}B(n+m)^{1/2} + \frac{1}{2}B(n+m)^{3/2} m^{-1} - \bar{R} = 0.$$

In the objective function, the first two terms are wages net of per-worker rents plus commuting costs. $T_m \gtrless 0$ is a transfer payment, where each entrepreneur gets T_m and each worker $-T_m m/n$. In the constraint, besides collecting T_m, firm profits, and paying rents plus commuting costs ($\frac{3}{2}B(n+m)^{1/2}$), each entrepreneur collects a dividend—his or her share of land rents ($\frac{1}{2}B(n+m)^{3/2}/m$) which the local government recognizes as endogenous. The local government sees a fixed return to entrepreneurs, $\bar{R}$, which we will show in equilibrium will equal the R in Eq. (13a) above. By substituting the constraint into the objective function for T_m, it is apparent that the optimization problem (in n, m) is unchanged if workers, rather than developers, own local lands. Thus the initial ownership assignment is not relevant. Optimizing in (17) yields Eq. (10) for the Henry George theorem. Because entrepreneurs own local lands, $T_m = 0$; but the existence of T_m functions as a mechanism for potential entrepreneur–worker transfers, so workers choose to satisfy Eq. (10). Optimization also yields Eq. (8a) (or (14b)) which defines a relationship among R, m, and n in the city. How do we know that, with pro-active governments, the equilibrium R ($= \bar{R}$ perceived by any city government) and city size are the same as those in Section 1?

If all self-organized agglomerations are governed by pro-active local governments, then all cities satisfy Eq. (10), and Eq. (8a) (or (14b)) defines R as a function of the national A, given that with symmetry m/n in each city equals A. We then get Eqs. (12) and (13) for, respectively, efficient city size and corresponding factor returns.[14] That is, the imposition of symmetry across cities means each $m/n = A$ and optimizing with respect to size forces $\overset{*}{n}$. That leaves us with R as defined in Eq. (13a). Proposition 1 established uniqueness, where if Eq. (10) is satisfied in every city and factor returns are equalized across cities, all cities must operate at the

[14] Equation (13b) for V is satisfied, given that, into the objective, or welfare function of workers in (16), Eqs. (10) and (8b) are substituted for R (given T_m) and land rent income terms.)

same composition, A, the national factor ratio and Proposition 2 gave us efficiency. This establishes Proposition 4.

How did we get this slight-of-hand outcome—self-organization with efficient outcomes? We did it by imposing the requirement that as people mill around on the nation's surface, every time they coalesce, a local government forms. Then we assumed that every such government is pro-active and limits city size toward $\overset{*}{n}$, "excluding" residents from the oversize self-organization cities of Proposition 3. This exclusion forces "new" agglomerations to form which also "by definition" have local governments that optimize with respect to size and composition, forcing all city sizes toward $\overset{*}{n}$ (where sizes below $\overset{*}{n}$ are not robust). Moreover, in this context of all pro-active governments, control issues in local politics are irrelevant. Whether governments maximize the welfare of workers or entrepreneurs and which group nominally owns land rents have no effect on the final outcome.

This is a nice benchmark. But it is not the reality of national land markets and constitutional institutions. Not all agglomerations have single local pro-active autonomous local governments. Local autonomy may not be part of the national constitution; many local governments may not or cannot be pro-active; and not all agglomerations are governed by a single local government or by a set of township governments that coordinate well. In the next two sections, we try to model aspects of more complex situations.

3. THE ROLE OF DEVELOPERS AND SELF-ORGANIZATION IN AN EXPANDING ECONOMY

In considering the first two extreme cases presented—a world with competitive profit-maximizing land development companies governing each city in Section 1 and a world with no agents organizing cities in Section 2—one might react that the Section 1 world appears to apply to new cities and the Section 2 world to existing cities. Specifically, many new towns are started by large agents controlling the entire city at the time of formation. Historically, these can be cities founded by railway companies (e.g., the Canadian Pacific Railway in Vancouver, Canada), by commercial enterprises (e.g., the British East India Company in Calcutta), or by the church (e.g., Mannheim, Germany), quite apart from land developers. In the United States the role of land developers in the formation of "new towns" has been recognized (e.g., Reichman [29]). Joel Garreau's [14] book on edge cities provides an overarching survey of new city formation in the United States. Garreau identifies 130 established edge cities, all formed between the late 1960s and late 1980s, which generally are each the work of a single land development company (Henderson and Mitra [21]). However, once formed, developers relinquish control of such cities and they are taken over by a public or private governance process by the occupants (Knapp [23]). Existing cities certainly offer subsidies, but absent exclusionary zoning may do little to specify n or m. In this section, we generally consider existing cities to be self-organized—not subject to a developer or local governance process setting city size.

Coexistence of Self-Organized and Developer Cities

The basic point of this section can be made in the static model utilized in Sections 1 and 2. Then we exposit the result in the context of an economy experiencing population growth and provide a justification for the assignment of land ownership in self-organized cities.

Suppose, at any instant, the economy is composed of just self-organized cities, which are all inefficiently sized, or too large. While we will generally assume there is a symmetrical equilibrium in the self-organized sector, the basic proposition will apply directly to asymmetric starting points as well. Within self-organized cities, we assume, as in Section 2, that land rental income is assigned to local entrepreneurs. Suppose we now allow there to be free entry of developers into city formation activity. With the introduction of developers, we have the following proposition.

PROPOSITION 5. *If to an economy with just self-organized cities, free entry of competitive land developers who can set up and operate cities is introduced the only equilibrium is characterized by all cities being of identical and efficient size and composition.*

There are two instructive ways to prove this proposition. The first is to apply Proposition 2 directly. Since having cities of size $\overset{*}{n}$ at the national factor ratio A is the only point in the core, a developer can make profits (increase total output for a given factor allocation) by setting up such a city, if all other cities are not at $\overset{*}{n}(A)$ and operating at the national factor ratio A. Note that Proposition 2 explicitly considered asymmetric cities, as points outside the core.

The second method of proof looks at the nature of the final equilibrium itself. Such an equilibrium must be characterized by three conditions. First, utility levels of workers must be equalized across self-organized and developer cities so $\bar{V}$ in (8b) equals V in (14a). The same applies to entrepreneurs, so $\bar{R}$ in (8a) equals R in (14b). Finally with free entry of developers, profits for land development firms (cities) must be zero, so Eq. (10) is satisfied. If we specify (equilibrium) city size and composition in the developer sector as n_d and A_d, and in the self-organized sector as n_s and A_s (not ruling out potentially multiple A_s's under asymmetry) and manipulate the three equations to solve out n_d and n_s, we get an implicit function

$g(A_d, A_s) = 0$ which can only be satisfied at $A_s = A_d$.[15] $A_s = A_d$ requires developer and self-organization cities to have the same composition. Given that, equality of factor returns across cities requires identical sizes, which are hence efficient given developer behavior.[16]

Given this, we note

Comment 2. If self-organized cities are governed by local governments pro-active in regulating size and composition, Proposition 5 also holds.

With optimizing local governments, Eq. (10) is satisfied, which means given the objective function and constraint in (17), the welfare of workers and entrepreneurs in local government cities is described by Eqs. (14)

[15]

$$g(A_d, A_S) = A_d^{(-1/2\gamma)/(\epsilon-1/2)}\left[E\delta\left(\frac{1}{2}\epsilon^{-1}BE^{-1}(1+A_d)^{3/2}\right)^{\epsilon/(\epsilon-1/2)} - \frac{3}{2}B(1+A_d)^{(1/2(1+\epsilon))/(\epsilon-1/2)}\left(\frac{1}{2}\epsilon^{-1}BE^{-1}\right)^{(1/2)/(\epsilon-1/2)}\right]$$
$$-\left(\frac{1}{2}E^{-1}B\right)^{\epsilon/(\epsilon-1/2)} A_s^{(-1/2\gamma)/(\epsilon-1/2)}(1+A_s)^{(1/2\epsilon)/(\epsilon-1/2)}$$
$$\times\left\{\delta E\left[\frac{(1+A_d)\epsilon^{-1}F_1 + 3/2(A_s - A_d)}{F_2 + (1/2)\epsilon^{-1}(1-\delta)\delta(A_s - A_d)(1+A_d)}\right]^{\epsilon/(\epsilon-1/2)} - \frac{3}{2}B\left[\frac{(1+A_d)\epsilon^{-1}F_1 + \frac{3}{2}(A_s - A_d)}{F_2 + (1/2)\epsilon^{-1}(1-\delta)\delta(A_s - A_d)(1+A_d)}\right]^{(1/2)/(\epsilon-1/2)}\right\} = 0,$$

where

$$F_1 \equiv \frac{3}{2}(1-\delta)A_s + A_d\delta\left(\frac{1}{2} - A_s\right)$$
$$F_2 = \frac{3}{2}(1-\delta)A_d + A_2\delta\left(\frac{1}{2} - A_d\right).$$

Tedious calculations show $\frac{\partial g(\cdot)}{\partial A_s} = 0$ at $A_s = A_d$, indicating that the condition for the implicit function to define other A_s, A_d pairs in the neighborhood of $A_s = A_d$ is not satisfied. In particular, for any A_d, $g(\cdot)$ takes a maximum at $A_s = A_d$, where at that tangency $g(\cdot)$ just equals zero.

[16] We can give more structure to the problem by having a developer entry game outlined in footnote 3. Perfect foresight developers enter in an arbitrary sequence, where the last developer to enter is the one who drives profits of all developers to zero, forcing all developers to run cities of efficient size and composition and forcing all self-organized cities to the identical position in order to survive.

under self-organization. With free entry of developers setting up cities competing with local government cities, Proposition 4 can be applied directly. But, in fact, the result is stronger. Local government action generates Eqs. (8) and (10), given (14) and (10) both apply. Given that, uniqueness in Proposition 1 requires all cities operating under Eqs. (8) and (10) be identical.

Population Growth

We now turn to an explicit growth context, where an economy experiences continuous population growth. It is possible to embed the problem in an endogenous growth model, where individuals invest in human capital and there are local "knowledge" spillovers within cities.[17] While in such a model competitive city sizes are efficient for the human capital accumulated at any point in time, equilibrium human capital investments may be inefficient. That issue is beyond the scope of this paper. Here we focus on accommodating national population growth through city formation, so we specify a simple growth context without economic growth. The city formation results generalize to a richer growth context.

Suppose an economy's population grows at a rate g, maintaining the same national composition A. Then, if S is the number of cities and n

[17] We would adapt the model in Black and Henderson [4] where there is one factor of production and two goods and types of cities (see also Eaton and Eckstein [8]). Here there is one type of city and two factors of production. To introduce growth we write the firm production function in (1) as $y_i = (E_0 h^{\psi}(t) h_i^{\theta}(t) m^{\epsilon} \tilde{n}^{\delta}$ where $h(t)$ is the average level of human capital in the city and $h_i(t)$ is the firm entrepreneur's own human capital. Human capital is the only capital in the model and only entrepreneurs gain by accumulating it. The firm optimizes as above with respect to $\tilde{n}$ to get the entrepreneur's per period residual return

$$RR_i(t) = \left(E_0 h(t)^{\psi/(1-\delta)} h_i(t)^{\theta/(1-\delta)}\right)(1-\delta)\delta^{\delta/(1-\delta)} m(t)^{\epsilon/(1-\delta)} w(t)^{\delta/(1-\delta)},$$

where $w(t)$ is worker wage. For an equilibrium solution the land developer faces a succession of static optimization problems as in (7), where for example $\overset{**}{n} = \overset{*}{n} h(t)^{(\psi+\theta)/(1/2-\epsilon)}$ in a symmetrical equilibrium (in choices of $h_i(t)$), with $\overset{*}{n}$ given in (12). Dynastic families who grow at a rate g and discount at rate $\rho(\rho > g)$ have preferences $\frac{C_i(t)^{1-\sigma} - 1}{1-\sigma}$ where $C_i(t)$ is per person consumption. They face an equation of motion where $\dot{h}_i(t) = RR_i(t) + T_m(t) - \frac{3}{2} b n(t)^{1/2} - C_i(t) - g h_i(t)$. On the RHS the first three terms are real income, $C_i(t)$ is consumption, and $g h_i(t)$ is capital allocated to new family members to maintain equal human capital per member. Growth solutions are standard. There is steady-state growth (with no transition path) if $(\psi + \theta)/(1 - 2\epsilon) = 1$ and we converge to steady-state levels of $(\psi + \theta)/(1 - 2\epsilon) < 1$. The key results are that city sizes grow at twice the rate of human capital or at $2\gamma^h$ where $\gamma^h \equiv \dot{h}/h$. With steady-state levels, where $\dot{h}/h = 0$, $\dot{n}/n = 0$ so $\dot{S}/S = g$, as in Eq. (18).

their worker population,

$$\frac{\dot{S}}{S} + \frac{\dot{n}}{n} = g.$$

Assume for now that technology is time invariant. At time zero, developers set up cities for the initial population, satisfying Eqs. (8)–(13). Assume for the moment that developers retain control of their formed cities. At the next instant the new popualtion needs to be housed in cities, but in this stationary context Eqs. (8)–(13) still describe the situation for any city. Thus city sizes remain the same and the new population is accommodated in new cities also of size $\overset{*}{n}$, so

$$\dot{S}/S = g. \tag{18}$$

At every instant Eq. (18) holds, as long as there is no technological change altering city sizes (see Proposition 1).

So far, in this context, there is no distinction between new and old cities, and, in fact, we could simply reshuffle the deck at each instant, having all cities be "new." It is simple to adjust the model to have cities once established stay in existence. A one time sunk cost, C, for setting up a city will be sufficient, so that a developer's objective function becomes

$$\int_0^{\infty} \left(\frac{1}{2} B(n(t) + m(t))^{3/2} - T_n(t)n(t) - T_m(t)m(t) \right) e^{-rt}\, dt - C,$$

where the discount factor, r, is from outside the specification.[18] In a stationary context where $\dot{n} = \dot{m} = \dot{T}_n = \dot{T}_m = 0$, given the Henry George theorem, $T_m = (1/2)B(n + m)^{3/2}/m - rC/m$. Developers reduce subsidies to entrepreneurs, to recover their initial capital costs, C.

Now for the key part. The same efficient outcome with cities being of efficient size $\overset{*}{n}$ and numbers growing at the rate g can be achieved if developers dissociate themselves from their cities once they have formed, leaving the cities as self-organized entities. In showing this, let us presume that developers turn urban lands over to local entrepreneurs, offering each an equal share in ownership of local lands, a presumption we will justify momentarily. If they were to retain control of the city, competitive developers would indefinitely turn all rents over to entrepreneurs. Now they simply turn over all local lands for free to local entrepreneurs. (If there is a sunk cost, C, to setting up a city, local entrepreneurs must reimburse the

[18] For example, r can be defined as the opportunity return on capital in the model in footnote 17, which is explicitly defined if we introduce national capital markets (see Black and Henderson [4]). Here it can also be a personal discount factor.

developer for this cost in return for ownership of lands.) With ownership of urban lands, entrepreneurs collect rents; and factor returns are given by Eqs. (14). We may then apply Proposition 5 directly. With new cities always ready to be formed by competitive developers (to accommodate not just new, but potentially existing people), existing cities must be of efficient size in order to survive.

So, if the developers dissociate themselves, why turn lands over to entrepreneurs as we presumed, rather than to workers? From Proposition 2, the only point in the core at an instant involves cities where all rents go to entrepreneurs. So a city where rents go to workers could not survive developer formation of new cities. Moreover if, when the developer dissociates himself from the city, an autonomous local public government forms (the institutional reality in the United States (Knapp [23])) and is pro-active, from Section 2 we know that who is assigned land ownership is not relevant. Efficient local tax policy will ensure all rental income ends up in the pockets of entrepreneurs, in order to internalize scale externalities.

4. POLITICAL ECONOMY OF INDIVIDUAL CITY SIZE

In this section, we examine two nonlimit cases which we characterized as the mega-city and the no-growth controls problems in the introduction. These describe common situations in national land development markets. The solutions in prior sections assume: (i) Agglomerations, whether developer inspired or self-organized, may form freely on the national landscape. (ii) Developers or local governments have autonomy to set local taxes and to restrict size and composition through zoning. (iii) All cities have identical environments, or production and consumption conditions.

Land markets in most countries differ from other markets in a fundamental way. Land markets are highly planned and regulated, with a high degree of public ownership. To undertake a development or for a development to self-organize in many countries requires building permits, environmental permits, and regulation by zoning, whether within existing cities or outside cities and hence regulation by county, state, or national agencies. Formation of new cities is restricted by regulation. Planned development also requires assemblage of relatively unencumbered land with clear title. In many Asian countries, for example, land tenure and titles are unclear, greatly inhibiting transactions and alteration of land usage from, say, agriculture to urban use (see Dowell and Leaf [7] and Struyk et al. [34]). But even if an agglomeration forms, the autonomy of developers or local governments is very limited, in terms of the ability to impose taxes and the ability to regulate composition through industrial zoning. For example, in Indonesia and Chile, the property tax is more a national than local tax. In some countries local zoning is more a national than local responsibility as well, or is unenforceable, or both. Use of these instruments also requires local officials who have some degree of sophistication, a major problem in Indonesia, for example (see Aksoro [2]).

These comments suggest that a “partial” self-organization situation may exist in many countries, where the number of cities is limited, where cities are generally oversized, and where most do not regulate their sizes. Within that context, suppose one or a few cities are sufficiently sophisticated in governance and sufficiently pro-active to optimize by restricting city size and composition through zoning and tax-subsidy policy. How does a pro-active exclusionary city then compare to the mass of self-organized and/or nonactive cities? We explore that question first in this section, analyzing what we call the exclusionary city case.

The third condition listed above requires all cities to have identical environments. In general, that condition will not be met for one of two reasons and suggests our second special case of this section. First, natural geography differs, so one city may be on a site with better port facilities, access to water, terrain for building, climate, etc., than other potential sites in the country. Second, and more critically, in many countries, especially nonfederal ones or ones with limited political freedoms, the national government may either favor one city, such as the national capital with better infrastructure and public services, or restrict other cities in their transport and communication linkages to national and international markets. Ades and Glaeser [1] suggest such conditions enhance urban primacy of national capitals in a country, which accords with earlier empirical work (e.g., Henderson [19]). The motivation is fairly straightforward. National rulers seek to enhance the quality of life in the city in which they live and with which they are familiar (and where they also own property). Earlier we noted examples such as Bangkok, Paris, and Jakarta, to which we would add Cairo, Buenos Aires, Dacca, Karachi, and even Tokyo.

Our second special case attempts to characterize this favored city situation. To isolate the impact of one city having special conditions from issues of restrictions in national land markets, we revert to assuming that national land markets function perfectly with free formation of cities. It is just that one city is favored with special production (or consumption) conditions, but all cities are pro-active in restricting size and composition. We call this the mega-city case. In the mega-city case, political economy plays a strong role in determining city composition.

We solve the two cases analytically. However, given the complexity of the model, both to get analytical results and to limit the number of situations to be considered, we impose one restriction. We assume that not only are workers the majority but that they outnumber entrepreneurs by more than two to one. That is, we assume

$$A < \frac{1}{2}.$$

Restricting $A < 0.5$ puts us in one of three general regions of parameter space in this model.[19] But it seems a reasonable assumption, given that in the United States, the average number of workers per enterprise for all private enterprises generates an A of about 0.07.

The Exclusionary City

For this case we assume that, apart from the one exclusionary city, all other cities in the economy operate as self-organized entities. Their equilibrium factor returns are described by Eqs. (14) from Section 2 on self-organization. They operate identically at, effectively, the national factor ratio A (i.e., the exclusionary city is "small" relative to the nation). Their sizes are greater than $\overset{*}{n}$ in (12) and less than $n_{\max}$ in (16), given their composition A. We label their size and composition n and A. Whatever size they attain, they pay factor returns from (14) denoted by $\bar{V}$ and $\bar{R}$.

The pro-active government in the exclusionary city chooses its size and composition, n_e and A_e, and taxes to maximize the welfare of the local representative member of the majority population, workers. The city takes as given $\bar{R}$, the cost of entrepreneurs in national markets. And any solution must satisfy $V_e \geq \bar{V}$, the going return for workers in national markets. The optimization problem for the local government is given in Section 2 in Eq. (17), except we replace n by n_e and m by m_e (for A by $A_e \equiv m_e/n_e$). Optimizing in (17), as before, yields two conditions. To optimize, we substitute the constraint into the objective function for T_m and maximize with respect to n_e and m_e. Combining the two first-order conditions yields

$$n_e = \left[E\epsilon 2B^{-1}A_e^{\gamma}(1 + A_e)^{-3/2}\right]^{1/(1/2-\epsilon)}. \tag{12'}$$

Equation (12′) is the same as for $\overset{*}{n}$, except it is defined for the exclusionary city's A_e, not the national A. Second, from the first-order condition for n_e alone, after rearrangement, we obtain an expression for R_e,

$$R_e = E(1-\delta)A_e^{\gamma-1}n_e^{\epsilon} + Bn_e^{1/2}(1 + A_e)^{1/2}A_e^{-1}\left(\frac{1}{2} - A_e\right). \tag{19}$$

Note we are just considering the case where $A < 1/2$.

[19] For $A < 1/2$, V holding A constant in (8b) as a function of individual city size rises and reaches a maximum before $\overset{*}{n}$, while R in (8a) rises indefinitely as noted earlier.

With this framework we can prove

PROPOSITION 6. *In an otherwise self-organized economy, the pro-active autonomous local government in an exclusionary city, in maximizing the welfare of a representative member of the majority worker population, will reduce city population and alter composition to reduce A, or increase the relative number of workers to entrepreneurs relative to other cities.*

The proposition is proved by showing that R_e in (19) can equal $\bar{R}$ from (14) as required in equilibrium, iff $A_e < A$ and $n_e < n$ (so $n_e + m_e < n + m$ also).[20] So an exclusionary city, which acts to maximize the welfare of workers, increases their relative numbers but decreases their absolute numbers (and hence total city population, $n_e + m_e$).

The key result here is the reduction in city population. Relative to the oversized self-organized sector, a pro-active government restricts size to

[20] In equilibrium R_e in (19) must equal $\bar{R}$, where by rearranging (14) $\bar{R} = E(1 - \delta)A^{\gamma-1}n^{\epsilon} + Bn^{1/2}(1+A)^{1/2}A^{-1}(\frac{1}{2} - A)$. If we start with $A = A_e$, then $R_e < \bar{R}$, given $n_e = \overset{*}{n}$ for $A = A_e$ from (12) and (12′) and $\overset{*}{n} < n$, by definition of the experiment, with $\partial R_e/\partial n_e > 0$ in (19). Then, to bring R_e into equality with $\bar{R}$, we can show that we must lower A_e relative to A, given in (19) $dR_e/dA_e < 0$, accounting (from (12′)) for the impact of A_e on n_e. Thus we know $A_e < A$. But by inspection of $\bar{R}$ and (19), given $R = R_e$ at $A = A_e$ and $n = n_e$, but $\partial R/\partial A$, $\partial R_e/\partial A_e < 0$ and $\partial R_e/\partial n_e$, $\partial R/\partial n > 0$, if $A_e < A$ then equality of R and R_e requires $n_e < n$. For properties of R_e by combining (12′) with (19) we get

$$R_e = \left(\frac{1}{2}B\epsilon^{-1}\right)n_e^{1/2}A_e^{-1}(1+A_e)^{1/2}\left[\gamma(1+A_e) - 3\epsilon A_e\right] \tag{a}$$

or

$$R_e = \left[E\gamma 2B^{-1}A_e^{\gamma}(1+A_e)^{-3/2}\right]^{(1/2)/(1/2-\epsilon)} \times\left(\frac{1}{2}B\epsilon^{-1}\right)A_e^{-1}(1+A_e)^{1/2}\left[\gamma(1+A_e) - 3\epsilon A_e\right]. \tag{b}$$

Then we can show

$$\operatorname{Sign}[dR_e/dA_e] = \operatorname{sign}\left[\frac{(-\gamma A(1+\epsilon-\gamma))}{2} + \epsilon\gamma - \frac{1}{2}\gamma(1-\gamma) + \frac{1}{2}A(1+\epsilon-\gamma)(-\gamma(1+A) + 3\epsilon A)\right].$$

All terms on the RHS are negative given $\delta(1+A) > 3\epsilon$ and $\gamma(1+A) > 3\epsilon A$ from Proposition 1. Note $\frac{-A(1+\epsilon-\gamma)}{2} - \frac{1}{2}(1-\gamma) + \epsilon = -\frac{-\delta(1+A)}{2} + \frac{3}{2}\epsilon$, for $\delta = \epsilon + 1 - \gamma$. Note in (a) $dR_e/dA_e = \partial R_e/\partial A_e + (\partial R_e/\partial n_e)(\partial n_e/\partial A_e)$.

benefit the majority population.[21] The alteration in composition towards more workers reflects what is needed to equilibrate factor markets. (In fact, if the city is ruled by an oligarchy of entrepreneurs, examples indicate they will set also $n_e < n$ and $A_e < A$, accentuating the drop in the latter.) The situation can be interpreted as describing a key aspect of U.S. no-growth communities. They act to restrict their sizes, benefiting their residents. In fact, no-growth controls usually apply exclusively to residential populations, not numbers of businesses, m_e. In Proposition 6, m_e is a self-enforcing outcome given $R_e = \overline{R}$. Naturally, excluded residents who are worse off ($V < V_e$) want to get in (and may sue to attempt to do so).

The Mega-City

For this case, we assume there is free formation of cities, to isolate the impact of one city having favored conditions. All but the favored city have identical production and consumption conditions. However, the favored city has special features, either natural ones or, more critically, ones endowed by the national government. Here we simply represent that favoritism as a shift factor for firms so, in production functions, $E_e > E$ (but the story works equally well with $B_e < B$ in commuting), where we continue to use subscript e to denote the special city. Besides having special features, the special city is pro-active in zoning and taxation to regulate population and composition.

We consider two cases, one where the special city is governed by a local democracy acting to maximize the welfare of the representative worker and the other where the special city is governed by an oligarchy of local entrepreneurs. Both specifications lead the special city to become a mega-city. But the implications for population composition are rather different. In particular we can show

PROPOSITION 7. *If there is a city endowed with special advantage (higher E or lower B), this city will be larger than other cities in the economy, but is still restricted in size. That is, $n_e > n$ $(= \overset{*}{n})$. If the city is governed by a local democracy, workers will act to restrict their numbers absolutely, and relative to entrepreneurs, so $A_e > A$. Conversely, an oligarchy of local entrepreneurs will seek to restrict the relative and absolute number of entrepreneurs, so $A_e < A$.*

To prove the proposition we start by noting that, for all other cities, assuming the special city is small relative to the rest, sizes and factor returns are described by Eqs. (12) and (13), given that these are all

[21] Note $V_e > \overline{V}$, given $\overline{V}$ is obtainable by duplicating self-organized cities and we optimized relative to that.

pro-active government developer run cities. For the special city, let us start with the case where it is governed by a pro-active local democracy. In that case, size and returns to entrepreneurs are described by the same equations as for the exclusionary city, or (12′) and (19). To show that for a local democracy $n_e > n (= \overset{*}{n})$ and $A_e > A$, we equate $\bar{R}$ in all other cities, given by (13a), with R_e in the special city.[22] The result in Proposition 7 that in a mega-city workers want to increase A_e relative to A but in an exclusionary city in Proposition 6 they want to decrease A_e relative to A may seem contradictory. It is not. Exclusionary cities are smaller than other cities in the economy, so to pay an equilibrium R with less scale they must lower A to increase the return to capital. Mega-cities are larger than other cities so with greater scale (and greater E or lower B) to pay an equilibrium R they raise A.

If the city is governed by a local oligarchy of entrepreneurs in the second part of the proposition, it acts to maximize the welfare of a representative entrepreneur. Local entrepreneurs collect residual returns in their firms, pay rent plus commuting costs, collect local land rents, and can tax workers. But workers must earn the going return in national markets, $\bar{V}$. The maximization problem is

$$\max_{n_e, m_e, T_n} E(1-\delta) n_e^{\delta} m_e^{\gamma-1} - \frac{3}{2} B (n_e + m_e)^{1/2} + \frac{1}{2} B (n_e + m_e)^{3/2} m_e^{-1} + T_n n_e / m_e \tag{20}$$

$$\text{s.t. } \bar{V} - E\gamma n_e^{\delta-1} m_e^{\gamma} + \frac{3}{2} B (n_e + m_e)^{1/2} + T_n = 0.$$

Optimizing in (20) yields an expression for city size given by (12′) and an expression for V_e as a function of E_e, n_e and A_e, corresponding to (13b). To prove the rest of the proposition, we show that equating this V_e to an

[22] By substituting (12) into (13a) for $\overset{*}{n}$, we get an expression $\bar{R} = R(A, E)$. The same expression for R_e is given in Eq. (b) in footnote 20. From footnote 20, we know $\partial R(\cdot)/\partial A_e < 0$ and $\partial R(\cdot)/\partial E > 0$ by inspection. Thus if $E_e > E$, then $A_e \geq A$ for $R_e = \bar{R}$. From (13a) and Eq. (a) in footnote 20, where E does not appear explicitly (only implicitly in n), we know $\partial R/\partial A|_n < 0$. The sign of $\partial R/\partial A|_n$ is given by the sign $[\gamma(1+A)(\frac{1}{2}\epsilon A - 1) - \frac{3}{2}\epsilon A^2]$. It is sufficient that $A < 2$ and we have assumed $A < \frac{1}{2}$. Thus if $A_e > A$ for $R_e = \bar{R}$, we require also $n_e > n$. If the special circumstances of the city have $B_e < B$ (rather than $E_e > E$), the same statement applies. To prove that we would rewrite (13a) replacing $n^{1/2}$ by n^{ϵ} in evaluating Eq. (8a) to get new forms to (13a) or (a) in footnote 20.

expression for $\bar{V}$ for all other cities requires $A_e < A$, if $E_e > E$ and that $n_e > n$.[23]

In summary, in the mega-city democratic case, as opposed to the exclusionary city case, workers want their mega-city to be larger than other cities and to have relatively more entrepreneurs (or "high skill" people, given Comment 1). The term mega-city seems appropriate because small differences in E generate big differences in n. Note the elasticity of n_e or $\overset{*}{n}$ in (12′) or (12) with respect to E is around 2.5 for "typical" empirical values of ϵ of 0.1. The outcome accords with the image of mega-cities—unusually large and endowed with relatively more high-skill people. The relative abundance of high-skill entrepreneurs benefits workers, through factor proportion effects on factor returns. But even still the city is smaller than it would be with free migration. Having been endowed with special features, residents want to preserve their benefits, as opposed to having them dissipated by free migration of workers into the city. Favored cities run by local oligarchies will also be mega-cities. But now the oligarchy will want to enhance the relative number of workers, augmenting factor proportions in their favor. While city size will be relatively large, it will be also restricted. The enforced restriction is on the number of businesses or entrepreneurs, given now $R_e > \bar{R}$, while the equilibrium worker population will be self-enforcing. In viewing real world mega-cities, the issue is the ability of these cities to limit in-migration. While legal residents and population may be well regulated by zoning and licensing, squatter settlements are another issue.

5. CONCLUSIONS

In this paper we showed that, with freely functioning national land markets, either city formation by competitive land developers or having pro-active autonomous local governments in every self-organized agglomeration leads to efficient resource allocation. That result generalizes to a growth context, where new cities are formed by developers. Once a city is formed, developers dissociate from their cities, leaving existing cities as

[23] Optimizing in (20) yields

$$V_e = \left(\frac{1}{2}B\epsilon^{-1}\right) n_e^{1/2}(1 + A_e)^{1/2}[\delta(1 + A) - 3\epsilon] \tag{a}$$

$$V_e = \left(\frac{1}{2}B\epsilon^{-1}\right)\left[2B^{-1}\epsilon E A_e^{\gamma}(1 + A_e)^{-3/2}\right]^{(1/2)/(1/2-\epsilon)}(1 + A_e)^{1/2}[\delta(1 + A_e) - 3\epsilon]. \tag{b}$$

For all other cities, the expressions for $\bar{V}$ as functions of A, n, and E are identical to (a) and (b). If $E_e > E, V_e > \bar{V}$, for $A = A_e$. This is based on substituting for $\overset{*}{n}$ and n_e from (12) and (12′) in the relevant equation from (13b) to get $V = V(A, E)$. Evaluating $V_e = \bar{V}$ for $E_e > E$, we can show $A_e < A$ (using the same methodology in footnote 20). Then from (13b), because $\partial V/\partial A|_n > 0$, $n_e > n$.

potentially ungoverned (at least with respect to size and composition policy). The growth context with formation of new cities by developers is sufficient both to efficiently limit sizes of existing cities and to provide an economic basis for assignment of ownership of urban lands to entrepreneurs rather than workers.

If there are not freely functioning national land markets with developers and autonomous local governments, in general, self-organized cities tend to be oversized. In that context, any single city has an incentive to restrict its size and alter its composition. If a city such as a national capital has special advantages relative to other cities, with freely functioning national land markets, its size will be larger than other cities (although still restricted). If governed by a local democracy, its composition will be altered in favor of increasing the relative number of entrepreneurs. This is consistent with notions of mega-cities—large cities with relatively many high-skill people. However, if governed by an oligarchy of entrepreneurs, its composition will be altered in favor of more (low-skill) workers.

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