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ON A POLITICAL SOLUTION TO THE NIMBY CONFLICT

by

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I. Introduction and Summary

Scale economy in the construction and operation of public facilities, such as landfills, call for cooperation among communities to build a common facility (O'Sullivan, 1993). Such a facility is a mixture of a public good and a private bad and, hence, leads to strong opposition by communities to locate it in their vicinity (Frey et.al, 1996). This is one of the most serious environmental concerns of recent years, and is known as **NIMBY**: "not in my back yard." In this paper we study the hypothesis that a democratic political process creates an adequate mechanism for the resolution of the NIMBY conflict. The intuitive explanation is simple. A NIMBY conflict is likely to induce lobbying and symmetric pressures by all threatened communities in the relevant region. As is well known (Grossman and Helpman, 1994), when subject to symmetric pressures, politicians stick firmly to principles and are functioning most efficiently.

The existing literature on the siting of noxious facilities has focused mainly on normative issues, such as an implementation of welfare-maximizing siting via decentralized community-based mechanisms (e.g., O'Sullivan, 1993; and Minehart and Neeman, 2002). However, it is evident that such mechanisms were seldom practiced (*e.g.* Swallow et al., 1992). The current study adapts a positive approach, integrating a political-economic framework with a model of a competitive real-estate market. In the theoretical section, a government of a linear two-city economy determines the location of a noxious facility, which affects the equilibrium in the real-estate market and induces the spatial distributions of price and population. The government is subject to political pressures by city-level lobbies of landowners (both landlords and homeowners).

In general, the political equilibrium and the socially optimal siting differ. However, the more equitable is the distribution of home ownership in the region, the smaller the difference. At the limit, when property distribution is perfectly equitable and all cities participate in the political arena, the government locates the facility at the socially optimal site. The analysis proceeds by identifying additional conditions, under which the political equilibrium siting coincides with the socially optimal location and by an empirical analysis.

In the empirical section, the theoretical framework is extended to account for a multiple-city region, and is calibrated to assess the prospects of the political system in resolving the NIMBY conflict in the context of landfills siting in Israel. It is shown that if all cities in the region form political lobbies and politicians are not extremely corrupt, the political siting is close geographically to the socially-optimal location, and the difference entails less than 0.1% reduction in social welfare. Moreover, even if the formation of lobbying in the region is incomplete, as long as the weight the politicians award social welfare is larger than 0.7, the proximity of the political and socially optimal locations is preserved. We interpret the above results as supportive of the hypothesis of an effective political solution to the NIMBY conflict.

II. The Economy

Consider a two-city, unit interval region, where the cities 1 and 2 are located at the borders, 0 and 1, respectively, and populated by N identical households. The economy is open trade-wise, but migration is domestic only. Landowners, either absentee or residents of the region, own land and are the suppliers of housing. Housing supply in each of the cities, S^i, is inelastic. A noxious facility like a landfill is located at a point $x \in (0,1)$. The environmental quality in each city, $0 \leq e^i(d^i) \leq 1$, is increasing, twice differentiable and concave function of the city's distance from the noxious facility, d^i $(d^1 = x,\ d^2 = 1 - x)$.

A. *Households' Behavior*

The utility of a representative household living in city i is defined over a composite consumption good, z^i, with a perfectly elastic supply, which is taken as a numeraire, and over his consumption of housing services: $q^i = e^i h^i$, which is proportional to one's housing size, h^i, with a proportion coefficient e^i (i.e. the environmental index). Utility is given by

$$U^i = z^i + u(q^i);\ i = 1, 2, \tag{1}$$

where u is increasing, strictly concave, and twice differentiable[1]. We assume linear transportation costs and that the amount of waste produced by each city is proportional to

[1] A more general formulation of the utility, $u(h,e)$, is possible, but do not change the main results and entails awkward arithmetics.

it's residential area. Therefore, total cost of transporting the waste of the i^{th} city is given by $tS^i d^i$, where $t > 0$, is the transportation cost per unit of housing area times a unit of distance. The cost is recovered via uniformly state/regional tax: $T = \frac{t}{N}(S^1 d^1 + S^2 d^2)$. Thus, a household's budget constraint is:

$$I = z^i + h^i p^i + T;\ i = 1, 2, \tag{2}$$

where I is an exogenously given income and p^i is the per unit housing price (including local taxes) to be determined in equilibrium.

A household will reside in a city with the lowest ratio $r^i = \frac{p^i(d^i)}{e^i(d^i)}$, which can be thought-of as the price of effective housing services in the i^{th} city. In addition, the household allocates its limited budget between consumption of housing services and other goods. Maximizing (1), subject to (2), yields the demand relations:

$$q^i = (\frac{du}{dq})^{-1}(r^i) \equiv D(r^i); \qquad z^i = I - T - q^i r^i, \tag{3}$$

and the household's indirect utility function:

$$V^i = I + u(D(r^i)) - r^i D(r^i) - T;\ i = 1, 2. \tag{4}$$

B. *Spatial Equilibrium*

The competitive equilibrium in the housing market is characterized by three conditions, which determine the spatial distributions of prices, population and dwellings. First, the housing supply in each city, equals demand:

$$S^i = n^i h^i \Longleftrightarrow S^i e^i = n^i D(r^i);\ i = 1, 2, \tag{5a}$$

where n^i is the equilibrium number of households residing in the i^{th} city. Second, in equilibrium, households will be indifferent between residing in the two cities (no migration condition):

$$r^1 = r^2 \equiv r. \tag{5b}$$

Finally, the two cities populations must add-up to the region's population:

$$N = n^1 + n^2. \tag{5c}$$

Substituting (5b) into (5a) and the resultant expression into (5c) yields a single equation,

$$S^1 e^1(x) + S^2 e^2(x) = N \cdot D(r), \tag{6}$$

which summarizes the equilibrium relations between r and x.

From (5b), and the definition of r, it follows that

$$p^i(d^i, x) = r(x)e^i(d^i); \quad i = 1, 2. \tag{7}$$

The above equation forms the hedonic price function, relating housing price to the city's distance from the facility, d^i, and the facility location, x. It can also be seen as the residents' demand for an increase of the distance. Differentiating (7) with respect to x yields:

$$\frac{\partial p^1}{\partial x} = r_x e^1 + r e^1_{d^1}, \quad \text{and} \quad \frac{\partial p^2}{\partial x} = r_x e^2 - r e^2_{d^2}, \tag{8}$$

where subscripts denote partials. Thus, the effect of shifting the facility location on housing prices is composed of two components. The first, $r_x e^i$, is a general equilibrium global effect; the change in x shifts the entire price distribution. Complete differentiation of (6) yields

$$r_x = \frac{S^1 e^1_{d^1} - S^2 e^2_{d^2}}{N D_r}, \tag{9}$$

and recalling that $D_r < 0$, imply that $sgn(r_x) \neq sgn(S^1 e^1_d - S^2 e^2_d)$, and that the general equilibrium effect in (8) may be either positive or negative.

The second term, $r e^i_{d^i}$, is of a local nature. A city located further away from the noxious facility enjoys a better environmental quality. The local effect is non-negative and decreasing. The range for which it is positive defines the NIMBY phenomenon. Empirical studies (e.g. Goren, 1997) suggest that in the case of a landfill, the NIMBY effect extends to a radius of about 10 miles. For the theoretical analysis, the NIMBY phenomenon is incorporated by assuming that $re^i_{d^i} > 0 \; \forall \; d^i \in (0,1)$. The observable inverse elasticity of the demand for distance from the landfill is $\eta^i \equiv \frac{d^i}{p^i}\frac{\partial (p^i)}{\partial d^i}|_{r=const}$. The NIMBY assumption implies that $\eta^i > 0 \quad \forall \; d^i \in (0,1)$. We denote $\hat{\eta}^i \equiv \eta^i - \tau^i$, where $\tau^i \equiv \frac{td^i}{p^i}$ is the share of transportation cost per unit of housing in the housing price. The elasticity $\hat{\eta}^i$ is the observable hedonic elasticity in economies where each household bears the cost of transporting its own waste.

III. Siting Decisions

The socially optimal site maximizes the total economic surplus in the economy,

$$W^S(x) = n^1V^1 + p^1S^1 + n^2V^2 + p^2S^2 = N[I + u(D(r))] + tx[S^2 - S^1] - tS^2, \qquad (10)$$

subject to the competitive equilibrium condition in (6).

Proposition 1: Optimal Siting. *Assuming an interior solution to the siting problem, the socially-optimal location, x^s, that would have been chosen by a benevolent government, is given by*

$$\frac{x^s}{1-x^s} = \frac{R^1\hat{\eta}^1}{R^2\hat{\eta}^2}, \qquad (11a)$$

where $R^i = p^iS^i$ is the property value in city i.

Proof: The first order condition for maximization of (10) subject to (6) is given by

$$\frac{\partial W^S}{\partial x} = t(S^2 - S^1) + NrD_r r_x = 0. \qquad (11b)$$

Substituting (9) into 11(b) and rearranging yield ($11a$). The second order condition, $r_x(S^1e^1_{d^1} - S^2e^2_{d^2}) + r(S^1e^1_{d^1d^1} + S^2e^2_{d^2d^2}) < 0$, is assured by concavity of $e^i, \; i = 1,2$, and (9). ■

Examining ($11b$), it is apparent that the siting decision leads to a trade-off between environmental quality and transportation cost. Shifting the facility from City 1 towards City 2 reduces the environmental externalities in the first and increases them in the latter, and at the same time the transportation cost increases in city 1 and decreases in city 2.

Optimal siting is achieved at a location where the two cost types are optimally traded; the marginal changes in aggregate environmental quality and total transportation costs are equal.

Equation ($11a$) characterizes the optimal site in terms of empirically observable quantities. It resembles Ramsy's inverse elasticity rule for optimal taxation. Like the introduction of a tax, the construction of a public facility serves to produce a public good, but creates a local loss of welfare that is proportional to the inverse of the (net) demand elasticity. The resulting rule for optimal siting is simple: the ratio of the distances should be equal to the inverse ratio of the net hedonic demand elasticities, each scaled by the corresponding housing value.

The government in our analysis is, however, a political entity rather than a benevolent planner, and its utility is affected by both social welfare and political rewards. The ensuing location of the facility reflects the interests of the participants in the political arena and can be characterized as if it was maximizing a political support function; a weighted sum of social welfare and lobbies' welfare. The micro foundations for a political support function are provided by Zusman (1976) who describes policies as a solution to a Nash bargaining game between lobbies and politicians, by Grossman and Helpman (1994) who characterize policies as a perfect Nash equilibrium in a menu auction game, and by Finkelshtain and Kislev (1997) who portray policies as an efficient contract of politicians and interest groups. In all three studies, the lobby formation is exogenous, an approach that is adopted in the current analysis.[2]

Characterization of the equilibrium requires identification of groups in the economy, that are expected to form political lobbies. For at least two reasons, formation of a tenants' lobby is unlikely. First, since inter-cities migration is costless, an inherent conflict does not exist between tenants of different cities and efforts to form a tenant lobby are expected to be dampened by free riding. Second, lobby formation involves considerable fixed costs

[2] A formal analysis of lobby formation is presented by Mitra (1999) in the context of trade policies.

(Mitra 1999), while the effect of siting policies on tenants' welfare is minor (see Section IV). In contrast, those who own land in a specific city cannot rely on anyone but themselves to oppose the government's intention to locate a facility near their city that is expected to reduce the value of their property significantly. Thus, the free riding problem is much smaller in the landowners' case than in the tenants' case. Therefore, we adopt in the subsequent analysis the assumption that landowners will be organized in political lobbies.

Let $0 \leq \beta^i \leq 1$; $i = 1, 2$, be the proportion of land owned by landowners who are members of the i^{th} city lobby, and let $\nu^i \leq n^i$ be the *number* of *organized* landowners who reside in the region. The aggregate welfare of the lobby members, gross of the political contributions, is

$$W^i(x) = \beta^i S^i p^i(d^i) + \nu^i[I + u(D(r(x))) - r(x)D(r(x)) - T(x)]; \; i = 1, 2. \tag{12}$$

The political equilibrium siting, x^P, is the solution to

$$\max_{x \in (0,1)} \{W^P \equiv (1-\gamma)W^S + \gamma(W^1 + W^2), \quad \text{S.T. (6)}\}, \tag{13}$$

where $\gamma > 0$ is the weight that politicians place on political contributions. Assuming an interior solution to (13), the political siting is characterized via the first order condition:

$$\frac{\partial W^P}{\partial x} = (1-\gamma)\frac{\partial W^S}{\partial x} + \gamma \sum_{i=1}^{2} [\beta^i S^i p^i_x - \nu^i (r_x D + T_x)]. \tag{14a}$$

Introducing several notations, the political equilibrium site can be described in terms of observable quantities. Let $\nu = \frac{\nu^1 + \nu^2}{N}$ be the proportion of organized landowners who reside in the region, and $\alpha = \frac{\beta^1 n^1 + \beta^2 n^2 - \nu^1 - \nu^2}{N}$ be the proportion of organized but absentee landowners. We denote by $\eta^D = \frac{r}{q}\frac{\partial D(r)}{\partial r} \equiv \frac{p^i}{h^i}\frac{\partial h^i(p^i)}{\partial p^i}$ the price elasticity for the demand of housing services, which equals the observable price elasticity of housing demand.

Algebraic manipulation of (14a) yields proposition 2.

Proposition 2: Political Siting. *Assuming that the political equilibrium lies in the interior of* $[0, 1]$*, then the government's chosen site,* x^P*, is given by*

$$\frac{x^P}{1 - x^P} = \frac{[1 - \gamma + \gamma(\beta^1 + \frac{\alpha}{\eta^D})]R^1\eta^1 - (1 - \gamma - \gamma\nu)\tau^1 R^1}{[1 - \gamma + \gamma(\beta^2 + \frac{\alpha}{\eta^D})]R^2\eta^2 - (1 - \gamma - \gamma\nu)\tau^2 R^2}. \tag{14b}$$

Condition (14b) reflects the inherent conflicts between the interests of organized landowners and those of the whole society, and as γ vanishes Eq (14b) reduces to the optimal siting rule. To grasp the intuition of the result, suppose that transportation cost is negligible. In this case, the political siting formula is again an inverse elasticity rule, but now each elasticity is being scaled by $\gamma(\beta^i + \frac{\alpha}{\eta^D})$. Thus, *ceteris paribus*, in comparison to the optimal site, the city with better political organization (larger β^i) pushes the facility further away towards the other city, in order to protect its members' property values.

In addition to the local interest, all landowners' lobbies have a common global interest to raise housing prices in the economy. Getting the facility closer to a city diminishes significantly the environmental index in the city, and as a result it reduces the effective-housing supply in the economy, $e^1h^1 + e^2h^2$, which raises prices. The magnitude of this effect is inversely related to the absolute value of the demand elasticity η^D. This global interest may work in the same or opposite direction to the local one, and it is mitigated, if many of the landowners are residents of the region and care for the total economic surplus in the housing market rather than landowners' revenues. In the extreme case, when all residents are homeowners, α vanishes and only the local interest affects the political siting.

Since the focus of our analysis is the examination of the political process as a siting mechanism, we use the characterization of the political equilibrium in equations (13)-(14b) to study the circumstances under which the political and optimal locations agree.

Corollary

The following are alternative sufficient conditions for the coincidence of the political equilibrium and socially-optimal siting:

(a) The existence of a benevolent government ($\gamma = 0$)*;*

(b) A symmetry in political organization ($\beta^1 = \beta^2$) *and 1. all lobby members are residents* ($\alpha = 0$)*, or 2. housing demand is perfectly elastic, or 3. transportation costs are negligible* ($\tau^1 = \tau^2 = 0$)*.*

(c) All lobby members are residents ($\alpha = 0$)*, and either transportation cost is negligible* ($t = 0$) *or cities are of identical size* ($S^1 = S^2$)*.*

The corollary identifies several circumstances with *a complete political internalization* of the negative externalities. To examine further the plausibility of this later conjecture, we turn to an empirical assessment.

IV. Landfill Siting in the Center and South Regions of Israel

In this section we analyze the siting of a landfill in Israel, to assess empirically the main hypothesis of the paper concerning the capacity of a democratic political system to resolve the NIMBY conflict. The daily waste production in Israel amounts to 12,000 tons and is growing at an annual rate of 3%, which is larger than the Israeli growth rate of GNP. The waste-treatment system is in a transition process. In 1997, the base year for our analysis, the waste was disposed of in approximately 350 old and relatively small landfills, most of which did not meet western environmental standards and were located a short distance from the municipalities they served. In order to reform the aged system, the government instituted a national waste disposal plan ("TAMA 16"), designed to reduce dramatically the number of landfills and to dump the garbage in five (or less) large and modern ones.

However, due to intense protests of local landowners provoked by the NIMBY phenomenon, the government has failed to site most of these new waste facilities. The successful lobbying against the permanent siting of a central landfill in Duda'im, just a few miles south of the city of Be'er-Sheva, is a remarkable example (Shmueli and Gasul 1999). The lobby's members, composed of landowners, developers and representatives of all political parties in the city council, indicated the fear from reduction in the environmental quality and the value of the city's real estate as two of the prominent reasons for their opposition. Additional examples of landlord's campaigns against the siting of landfills in the vicinity of cities in the center of Israel are documented by Feitelson (2001).

The siting of a landfill that would serve the center and south regions of the country is the subject of the following analysis. In particular, we consider the major 33 cities in this area, as listed in Table 1. In 1997 those cities were populated by $980,065$ households (around 3.1 million people) accounting for more than 72 % of the national waste output.

A. *Calibration*

Calibration requires an adjustment of the theoretical model to account for a multiple-city region. Specifically, the equilibrium pricing conditions (6) and (7) can be rewritten as:

$$r = \frac{p^i}{e^i};\ i = (1, \ldots, 33); \qquad \sum_{i=1}^{33} s^i e^i = ND(r). \tag{15}$$

Data of the population and dwelling distributions in the region, as well as the local municipal taxes and the distance of each city from the nearest landfill are readily available and are reported in Table 1. Calibration requires also the specification of functional forms to represent preferences and environmental technology, taking into account inter-city variability. We commence with the latter. Let

$$\frac{e^i(d^i)}{\bar{e}^i} = \begin{cases} a + cln(d^i), & \text{if } d^i \leq \bar{d} \\ 1, & \text{otherwise,} \end{cases} \tag{16}$$

where a and c are positive constants, d^i is the distance between the center of the i^{th} city and the closest landfill and $\bar{d}$ denotes the maximum radius to which the negative environmental impact of the landfill extends. The maximal potential environmental quality in the i^{th} city is $\bar{e}^i$ as obtained in the absence of a landfill within a radius of at least $\bar{d}$.

The calibration of the parameters of $e^i(d^i)$ follows Goren (1997), who estimates the impact of landfills' proximity on housing prices in eighteen Israeli cities via hedonic price methods. The results were verified through a contingent valuation study. Goren estimates that $\bar{d} = 15,000m$ (m=meteres), $t = \frac{\$}{m^3}0.00005$, and that the ratio of the price of a house located at a distance of d^i meters to the price of an otherwise identical house situated at $15,000m$ from the facility is:

$$\frac{p^i(d^i)}{p^i(15,0000)} = \begin{cases} 0.0076 + 0.1032ln(d^i), & \text{if } 1000 \leq d^i \leq 15,000 \\ 1, & \text{otherwise} \end{cases}. \tag{17}$$

Equations (15), (16) and (17) imply that $\forall\ d^i \leq 15,000$:

$$\frac{e^i(d^i)}{\bar{e}^i} = \frac{p^i(d^i)}{p^i(15,0000)} = 0.0076 + 0.1032ln(d^i). \tag{18}$$

Thus, our estimates for a and c are 0.0076 and 0.1032, respectively. This specification implies that the hedonic price elasticity depends only on d^i and for $d^i \in [1000m, 15,0000m]$: $0.10 \leq \eta^i \leq 0.14;\ i \in (1, \ldots, 33)$. The (local) impact of a shift in the landfill location on housing values might be significant and on average, a kilometer of distance raises prices by 1.9%. This result compares with landfill effects in the U.S. (Farber 1998).

Continuing with the calibration, we note that equilibrium in the real-estate market entails $r = \frac{p^i(d^i)}{e^i(d^i)} = \frac{p^i(15,000)}{\bar{e}^i}$. We normalize $\bar{e}^1 = 1$, where the reference city, $i = 1$, is chosen to be Tel-Aviv, the city with the highest housing prices in Israel. Employing this normalization, we find the price of housing services: $r = \frac{p^1(d^1)}{0.0076+0.1032ln(d^1)} = \frac{\$}{m^2}3,715$.

Households' preferences are represented by a linear demand function for housing services: $D(r) = A - Br$. To estimate A and B, recall that $q^i = h^i e^i$, and hence, the price elasticity of demand for housing services equals the observable price elasticity of housing demand: $\forall i \in \{1, \ldots, 33\},\ \eta^D \equiv \frac{r}{q}\frac{\partial D(r)}{\partial r} = \frac{p^i}{h^i}\frac{\partial h^i}{\partial p^i}$. Employing structural econometric model of the Israeli housing market, Bar-Nathan et al. (1998) estimate $\hat{\eta}^D = -0.3$, implying $\frac{-Br}{A-Br} = -0.3$. Moreover, the equilibrium conditions in (15) yield a second equation in A and B, namely, $A - Br = \frac{1}{3.64 \cdot 10^9}\sum_{i=1}^{33} S^i(p^i(d^i) + T^i)$. Solving the foregoing equations we calculate $\hat{A} = 74.54$, $\hat{B} = 0.0046$.

To examine the plausibility of the calibration procedure, the predicted population distribution in equilibrium, $\hat{n^i}$, is compared with the actual one in the region, n^i; $i \in 1, \ldots, 33$. We find that the correlation coefficient between the two equals 0.97.

B. *Optimal Siting*

Following the declared goal of the Israeli government and the actual emerging policy, we consider the replacement of all the landfills that existed in the region in 1997 with a single, large and modern one. The optimal location of such a facility would maximize total economic surplus in the regional housing market:

$$W^S(x) = 980,065[600,060 - 0.0023r(x)^2] - 0.00005\sum_{i=1}^{33} S^i d^i(x). \tag{19}$$

Total social welfare, W^S, for every possible location of the landfill in the entire region is depicted in Figure 1a. The optimal siting is depicted in Figure 1a as point S, at longitude = 135.0 and latitude = 128.9. This is located in an open space, defined by the Israeli Ministry of the Environment as a "low-sensitive area" suitable for development, and at an approximately equal distance from Tel-Aviv and Jerusalem, the two metropolises in the region. Total annual economic surplus (net of the cost of transporting the waste) originating from housing services is then \$29.2 billion.

When the landfill is located at S, the only cities affected by its negative externalities are Qiryat Mala'hi and Bet-Shemesh, which are located less than 15 kilometers from the designated site. The landfill entails an annual total loss of \$0.9 million of economic surplus in the housing markets of those two cities. The location of the landfill in a relative vicinity to both metropolises of the region implies moderate transportation costs, which amount annually to \$4 million.

Thus, a carefully-situated landfill reduces environmental damages to a minimum, while transportation costs are kept low. On the other hand, inefficient siting in the proximity of populated residential areas may diminish welfare significantly. This is exemplified by a comparison of the optimal siting with the historic multi-facility situation in Israel, which reveals that the establishment of a single centralized landfill has the potential to increase the annual welfare produced by housing services in the discussed region by \$1.4 billion (5% of the region's surplus from housing services). In other words, the environmental damages caused by the 350 landfills which exist in Israel as of 1997 are huge, but most of them can be saved by a wise siting policy.

C. *The Political Arena*

First, we note that the above corollary concerning the coincident of the political and social locations remains valid in the current multi-city case. Unfortunately, however, non of the sufficient conditions, offered by the corollary, is met by the Israeli reality. This motivates the use of the Israeli data to assess empirically of our main hypothesis that the political siting does not deviate significantly from the socially-optimal one

We first simulate circumstances that are favorable for the political solution, under which all private landowners in the region form political lobbies. We then proceed with a more challenging test, examining a situation under which lobbies are concentrated in only one metropolis. In addition, we explore empirically the influence of equity in property distribution and of politicians' ethics on the siting policies.

Determination of the political equilibrium requires the knowledge of γ and the distributions of β^i and ν^i. To this end, we begin with the conceivable assumption that all private landowners participate in lobbies, whereas public housing companies are not engaged in the political arena. This implies that β^i; $i \in (1, \ldots, 33)$, equals the proportion of privately owned land in each city, and that ν^i; $i \in (1, \ldots, 33)$ equals the number of private landowners who reside in the region. Both types of information are published by the Israeli Central Bureau of Statistics and are reported in the last two columns of Table 1. The political objective function, W^p is then given by $W^p = (1-\gamma)W^s + \gamma \sum_{i=1}^{33} W^i$, where

$$W^i = \beta^i S^i p^i + \nu^i [600{,}060 - 74.54 r(x) + 0.0023 r(x)^2 - \frac{0.00005}{980{,}065} \sum_{i=1}^{33} S^i d^i]. \qquad (20)$$

Given the actual holding distribution in Israel, we find that the distance between the socially optimal and political equilibrium locations depends crucially on the politicians' ethical norms, γ. Governmental ethics are expected to vary considerably across countries and time. Accordingly, we simulate a variety of equilibria that correspond to a range of γs. The dark blue line in Figure 1a describes the trajectory of the landfill political-equilibrium location as γ ranges from 1 to 0. Figure 2a depicts the associated welfare consequences. Starting with the extreme case, where $\gamma = 1$, the politicians' objective function coincides with the lobbies' aggregate welfare and the single landfill is located at point L in the proximity of Tel-Aviv. This location near the largest city in the region diminishes annual welfare in about \$1.04 billion, or by 3.6% of the attainable economic surplus in the housing market. Yet, even from the society point of view, the establishment of a single landfill at point L is still favorable compared to the multi-landfills situation, by \$0.36 billion.

To explain the reason for this location (point L), we suppose first that all landlords are absentees. In this case, the lobbies care only about housing revenue, and the political objective function coincides with the aggregate profit of a hypothetical regional landlords cartel. Recalling that the demand elasticity, η^D, equals 0.3, it is clear that such a cartel would strive to reduce aggregate housing supply in order to increase housing prices and revenues. Since housing supply is fixed, the available technology to lessen "effective housing supply" is to locate the facility in the vicinity of concentrated residential areas. Such siting leads to a large negative environmental impact of the landfill and diminishes the effective housing services.

Indeed, as can be seen in Figure 1b, the aggregate annual housing rent reaches its maximum of \$6.4 billions, when the landfill is adjacent to Tel-Aviv, the largest metropolis in the region. In Israel however, about 70% of residents are homeowners. Therefore, in addition to revenue, they care also about consumer surplus, which is maximized in locations far from Tel-Aviv, as can be seen in Figure 1c. However, since the topography of consumer surplus (Figure 1c) is flatter than the terrain of revenues (Figure 1b), the latter is dominating and the maximum of the sum is achieved at point L. As the level of politicians' ethics increases, the landfill will gradually approach the socially optimal location along the dark blue line. Inspection of Figure 2a, which presents the associated welfare implications, reveals that social welfare is a decreasing parabolic function of γ. We find that the elasticity of social welfare in the politicians' ethical norms (measured by $1-\gamma$) is in the range of $0.004 - 0.05$.

The million-dollar question is where will the single landfill actually be located. To this end, we examine some plausible estimates of γ from previous studies. We have three relevant references. Zusman (1976) and Zusman and Amiad (1977) examine Israeli government intervention in the Sugar and Dairy industries and report γ in the range $0.4 \leq \gamma \leq 0.6$. Recently, Goldberg and Maggi (1999) analyze the U.S. federal government trade policies and estimate a smaller γ (by an order of magnitude), in the range $0.014 \leq \gamma \leq 0.019$.

Adopting the recent estimates from the U.S., we find that the political equilibrium site coincides with the socially optimal location. Furthermore, as can be seen from Figure 2a, as long as $(1-\gamma) \geq 0.7$, the annual welfare loss associated with the political process is negligible – less than 20 million dollars (about 0.06%). Even if we adopt Zusma's and Zusman and Amiads' extreme estimates ($\gamma = 0.6$), the political lobbying entails only a moderate loss of welfare of less than 1.2% of the maximal social welfare.

Zusman and Amiad infer estimates from data on the government support in Israeli agriculture during the seventies, an era characterized by domination of the agricultural sector in the Israeli political system, as is evident from the fact that 30% of government ministers were residents of agricultural communities, though their share in the population was only 8%. Thus, it is safe to infer that their estimates provide an upper bound to the actual weight that current politicians place on lobbies' welfare. Accordingly, we conclude that: *even if lobby formation among the affected communities is effective, unless politicians are extremely corrupt, the political equilibrium site would not significantly deviate from the socially optimal one.*

Higher moral standards among politicians increase the weight of social welfare in the political objective function. Below we demonstrate that equity in the regional holding distribution is another factor that can bring the political siting closer to the optimal one. The mechanism is simple. The higher the equity or equivalently the more landowners reside in the region, the larger the weight of consumer surplus in the lobbies' objective function, and indirectly, the larger is its weight in the political objective function. But, *ceteris paribus*, the larger the weight given to consumer surplus, the smaller the deviation of the political equilibrium site from the optimal one.

To quantify the impact of the distribution of land ownership on social efficiency of the siting policies, we assume $\gamma = 1$ (corrupted politicians) and simulate a sequence of political equilibria for a range of $\nu = \frac{\sum_{i=1}^{33} \nu^i}{N}$. In the extreme case of inequitable ownership, none of the region's residents are homeowners and all private homeowners are absentees, namely,

$\nu^i = 0 \; \forall i$. As aforesaid, in this case the political objective function coincides with the homeowners' aggregate revenues, and the landfill is located at point L in Figure 1a. As ν increases, the distribution of land ownership becomes more equitable and the landfill progressively shifts closer to point S, along the light blue trajectory in Figure 1a.

The consequent changes in social welfare, described in Figure 2b, exhibit positive parabolic relation between W^s and ν, and the implied elasticity is in the range of $0.03-0.20$. Currently, in Israel $\nu = 0.72$, and with $\gamma = 1$ the political equilibrium site is L. However, we find that if ν increases above 0.85, annual welfare losses diminish dramatically to \$83 million, which is 0.3% of the total surplus. An international comparison of developed countries reveals that the rate of home ownership ranges from 0.2 in Switzerland to 0.8 in Italy. Thus, we conclude that the levels of equity that are required to offset the wrongdoing of completely corrupt politicians are above those found in most developed countries.

However, the above analysis suggests an interesting insight concerning the possible trade-off between equity and morality in assuring an effective functioning of the political system. Figure 2c depicts the map of welfare isoquants in the (ν, γ) space. It can be seen that if $\gamma \leq 0.2$, then a moderate degree of equity of $\nu \geq 0.5$ will assure an efficent political solution with only minor annual welfare loses of less than \$50 millions (0.2%). Recalling that $\gamma = 0.2$ is larger in order of magnitude than recent estimates from the U.S., and that the condition of $\nu \geq 0.5$ is met by most developed countries including the U.S., we conclude that for the range of parameters that is found in many of the developed democracies, the political process provides a reasonable solution to the NIMBY conflict.

To examine the robustness of this conclusion, we conduct a sensitivity analysis with respect to variations in the value of housing price elasticity and the form of the demand function. We find that the larger $\hat{\eta}^D$ the closer is point L to S and if $\hat{\eta}^D \geq 0.6$, the two points coincide, implying that for any level of γ and ν the political equilibrium location is optimal. Moreover, Peng and Wheaton (1994) report that in many developed countries the housing demand is more elastic than in Israel, strengthening our conclusion.

To examine the restrictiveness of the maintained hypothesis of linear demand function we employ a Box-Cox transformation– $D(r) = A - B\frac{r^{\lambda}-1}{\lambda}$. Repeated runs of the model, where λ varies between 1 (a linear demand) and 0 (a logarithmic demand) reveals that the smaller is the value of λ the smaller is the deviation between points L and S[3]. Therefore, the linear demand function, employed in our analysis, appears to be the most challenging specification with respect to our hypothesis.

Note that the foregoing results demonstrate that although interest groups invest resources in lobbying, they create eventually only minor deviation of policies from the socially optimal ones. This is to say, that if interest groups in the various cities could operate cooperatively, they would probably decide to quit the political arena and save on political contributions. However, in reality, such a cooperation is unlikely. Therefore, each of the lobbies must be active and make a positive reward contribution to induce the government to choose this location rather than the one that would be worse from its own perspective. If a specific lobby were to become inactive, it may find the politically determined location of the noxious facility in its backyard, as demonstrated in the next simulation.

Specifically, we simulate a situation in which only private landlords at the city of Tel-Aviv and its neighboring cities (marked with $*$ in Table 1) are organized in politically active lobbies. The total welfare of the lobbies' members is maximized when the landfill is sited near the center of the other most populated city, Jerusalem (point T, Figure 1a). From the lobby's members' point of view, this is the best way to decrease supply of housing services and as a result increase r and their own revenues. The annual social welfare obtained in that location ,W^S, is lower by \$686 Millions (2.35%), than its level obtained under socially optimal siting. The location determined in the political arena however, is the one which maximizes the weighted sum of the lobby welfare and the social welfare. We find that if γ exceeds 0.7, then the political siting is still geographically very close to the optimal site, and the welfare losses are negligible. This result strengthens the confidence that the

[3] Values of λ greater than one results in housing-price elasticities which are smaller than any estimation reported in the literature

political process functions effectively, even if political organization is imperfect and lobby formation is incomplete.

Recently, while revising the paper, we have learned that the Israeli National Board for Planning and Building has decided to recommend the government to site the new central landfill at Kalanit, not far from the city of Qiryat-Gat. This site is only 10 km (6 miles) from the optimal location characterized in the paper.

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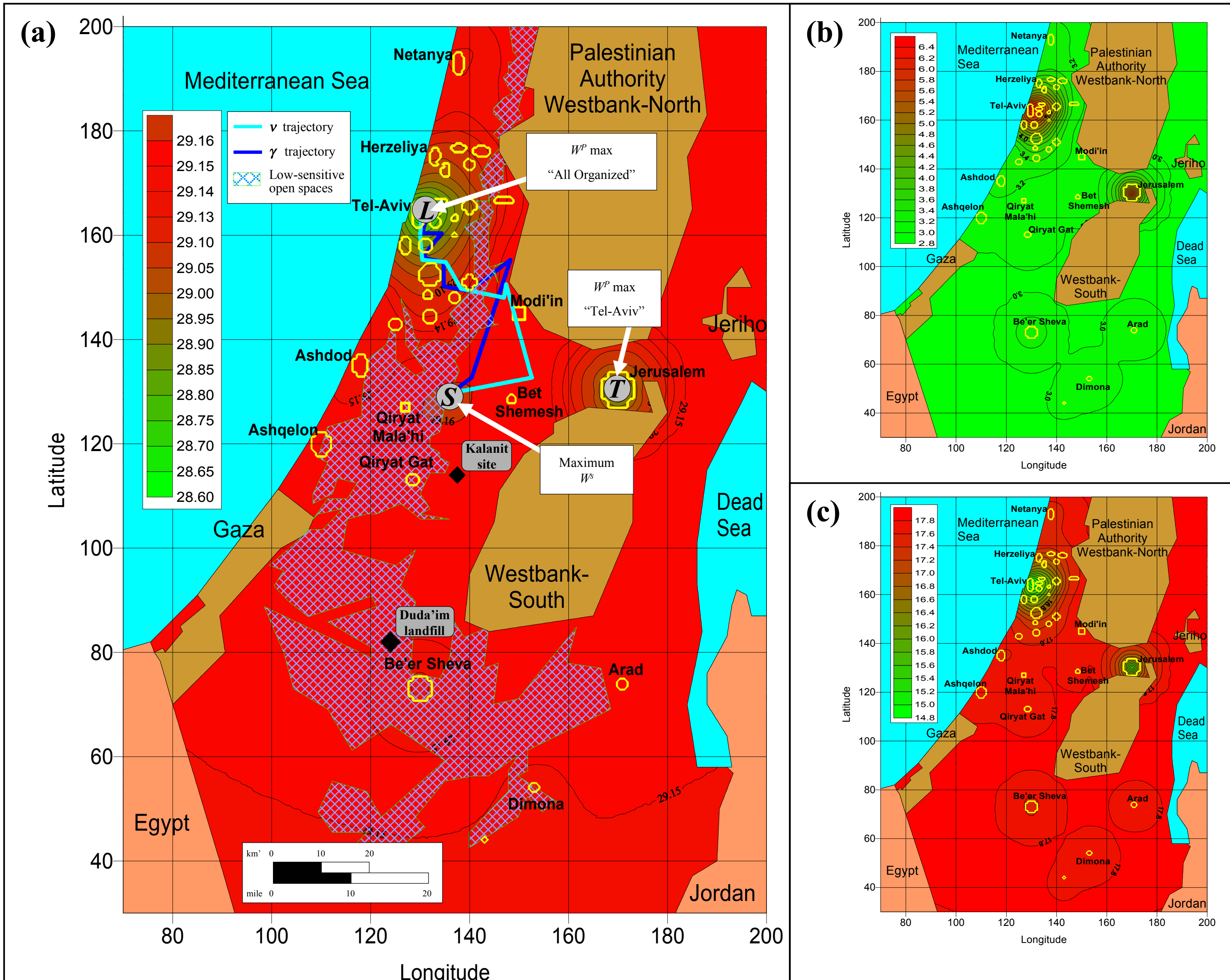

Figure 1 – Maps of (a) annual social welfare, (b) aggregate annual landowners' revenues, and (c) annual landowners' consumer surpluses (billions of U.S. dollars; in 1997 dollars)

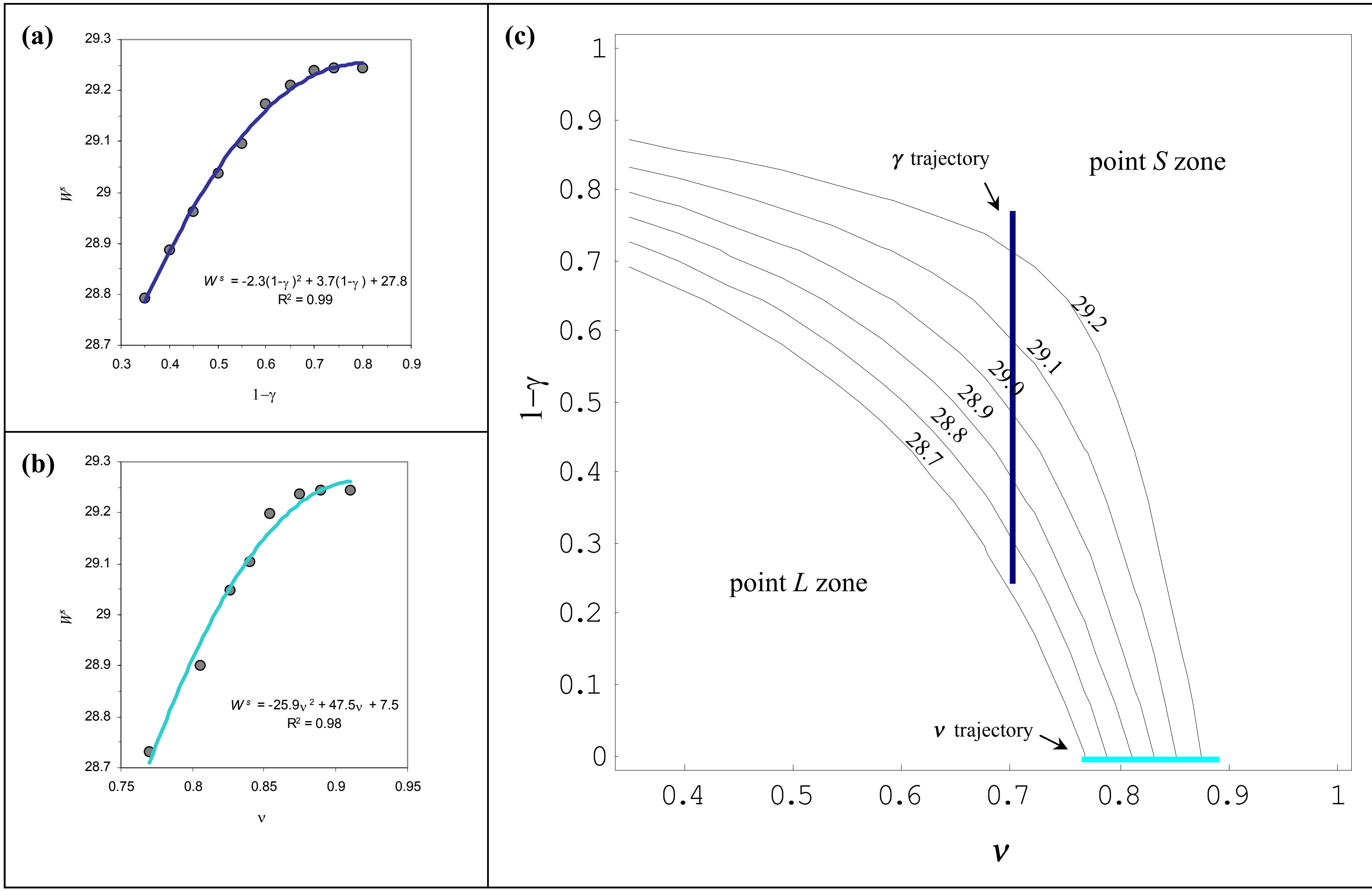

Figure 2 – Annual social welfare, W^s, under political equilibrium, according to (a) γ trajectory ($\nu = 0.7$), (b) ν trajectory ($1 - \gamma = 0$) and (c) isoquants of W^s in the $(1 - \gamma) : \nu$ plane (billions of U.S. dollars; in 1997 dollars)

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