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Analysis

Using Water Allocation in Israel as a Proxy for Imputing the Value of Agricultural Amenities

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ABSTRACT

This paper uses the water allocation economy in Israel as a proxy for imputing the value of agricultural amenities. A general equilibrium model is developed, and incorporates agricultural amenities as byproducts of agricultural production, water trade channels, and multiple water types. The premise is that until a decade ago, water policy in Israel was interlinked with agricultural land-use policy. Integrating a Monte-Carlo analysis, the model searches for a *baseline* minimum value of agricultural amenity that makes household, in the *counterfactual* scenario, indifferent between the administrative and market mechanisms. The minimum imputed value is around 109% agricultural output. The intuition is that the gains in *economic* welfare, from improved water use efficiency, are offset by the losses in *social* welfare due to a reduction in available agricultural amenities.

1. Introduction

Agricultural activities produce benefits above and beyond the market value of production because they provide non-marketed amenities, such as ecosystem services and farm landscape. Amenities also include less tangible, non-use value (such as existence and bequest) (Oglethorpe and Miliadou, 2000), and other aspects of cultural, social and heritage preservation (Chan et al., 2012).[1] They are typically not internalized by the sectors that create them, and are difficult to value in monetary terms (OECD, 2008).

The failure to account for the non-marketed value of agricultural amenities causes agricultural land to be undervalued and suboptimally allocated from society's point of view (OECD, 2005; Kan et al., 2009). For example, its loss to urbanization may be irreversible and costly to the well-being of society (defined as the economic and non-economic social aspects of welfare).

Therefore, it is highly important to measure the value of agricultural amenities in order to correctly assign property valuation, appraisals and taxation (Borchers et al., 2014), and design policies that support the agricultural sector through land subsidies, targeting and zoning (Engel et al., 2008).[2] To address this issue, the aim of this article is to impute *some* of the non-marketed value of agricultural amenities.

A large body of empirical literature has already attempted to quantify the non-marketed value of agricultural amenities using micro-level approaches. Examples include works on the external effects of farmland in the context of urban–rural land allocation (Borchers et al., 2014; Bergstrom and Ready, 2009; Bowker and Didychuk, 1994; Brunstad et al., 1999; Bergstrom et al., 1985; Bastian et al., 2002) and in Israel (Kan et al., 2009), on agricultural landscape value (Drake, 1992; Brunstad et al., 1999; Thiene and Tsur, 2013) and in Israel (Fleischer and Tsur, 2009), and on recreational value of open space in Israel (Fleischer and Tsur, 2000, 2003). As Chan et al. (2012) reports, fewer empirical studies have focused on the less tangible value. One relevant example is Becker et al. (2012) that examine the non-use value in water management in Israel.

In this study, the contribution is twofold. It uses a macro-level approach, not previously applied for valuing amenities: an economy-wide, general equilibrium model with Monte Carlo analysis. In addition, it uses the Israeli water economy as a proxy for the tangible and intangible amenity value that the public attributes to the agricultural sector. The model incorporates agricultural amenities as byproducts of agricultural production, and is based on the fact that when irrigation

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[1] The agricultural sector also produce negative externalities (e.g., non-point pollution, soil erosion). This study considers the net amenity value (positive minus negative) because of the functional form used.

[2] A notable example is through payments for environmental services (PES) programs (e.g., Sánchez-Azofeifa et al., 2007; Muñoz-Piña et al., 2008).

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water is a limiting factor in agricultural production, water pricing and quotas are effective in directing social, political and environmental objectives (Thiene and Tsur, 2013).

Water can be allocated by an administrative mechanism, market-based mechanism, or a combination of both.[3] This paper imputes the public's minimum *willingness to accept* an administrative mechanism, even though it creates distortions, because the rise in *economic* welfare generated by a hypothetical pure water market exactly offsets the lost *social* welfare from less available amenities. A pure water market improves economic welfare, when water inputs are used more efficiently, but reduces social welfare because the agricultural sector sells away its water inputs, reduces production, and therefore lowers the level of amenities available to households.

In Israel, the water allocation mechanism arises from a political arrangement of resources. The definition of agricultural amenities, therefore, covers a wide range of external benefits. de Groot et al. (2002) defines a topology of 23 ecosystem functions, which link with ecological, socio-cultural and economic value that make-up the total value of environmental goods. Hall et al. (2004) provide a review of the amenities that the public wants from agriculture and the countryside. In Israel, for example, beside the tangible amenities (e.g., food, landscape, and habitat) that the public attributes to the farming community, the public also views them as the "forefathers" of the State of Israel that gives them an intrinsic cultural, historical, and heritage value (Tal, 2007).

At the margin, this paper calibrates some of the agricultural amenities at around 109% its total economic output. However, the inframarginal value maybe much larger, suggesting that the administrative mechanism in Israel provides higher social–economic welfare compared to a pure water market. Furthermore, the findings indicate that desalination in Israel has been a cost-effective investment for alleviating the distortions made by the administrative allocation.

The imputed agricultural amenity is a *partial* value of its total because (*i*) there are many other instruments besides water subsidies that support the agricultural sector (some examples are tariffs, anti-trust exemption, permits for foreign workers employment, etc)[4], and using only one instrument underestimates the imputed amenities. (*ii*) The conservative parameters that are used *over*estimate the size of the water market (and therefore more welfare is gained), but *under*estimate the weight of the agricultural amenities in households utility (thus again giving more weight to the benefits of the water market). (*iii*) The estimates relate only to the effect of irrigated lands, while amenities associated with rain-fed lands are ignored. Finally, (*iv*) Water management policies are based on political processes (e.g., influenced by interest groups), and not only on welfare maximization (Finkelshtain and Kislev, 1997); but this is beyond the scope of this paper. Therefore, a portion of the imputed amenity value may represent also these distortions.

To capture the welfare distortions from water policy in Israel, the model is calibrated to 2006 — a period of severe hydrological deficit. Using more recent data would be an ineffective way to impute the value of agricultural amenities because the water economy and agricultural land-use policy in Israel today are much less interlinked compared to how they were a decade or two ago. Water subsidies to the agricultural sector have been dramatically reduced, and land-use policy is now mainly managed through regulation and direct subsidies, and much less through the water economy. In addition, the low cost of desalination, and high volume of purified wastewater for irrigation, have removed the acute resource constraint to a point where the Israeli water authority has had to curb the over-supply of desalinated water while being urged to lower water prices. Though water remains an issue of political power in the Middle East (Beltrán and Kallis, 2018), the general debate on the shortfalls of the administrative mechanism have largely subsided. Water has thus become less of a limiting factor in agricultural production compared to 2006.

In what follows, Section 2 provides a background on the distortions of the administrative allocation in Israel. Section 3 introduces the economy-wide general equilibrium model with agricultural amenities. Section 4 presents the data of Israel. Section 5 summarizes the empirical results with some further discussion, and Section 6 concludes. An online supplementary appendix is also available with further details.

2. Background on the Distortions of the Administrative Water Allocation in Israel

Israel is an example of a country which has historically developed an administrative water allocation mechanism to promote social and political objectives, such as settlement and land policies, food security, and equitable consumption (Just et al., 1997; Menahem, 1998). Prices and quotas are set by the Israeli Water Authority (IWA) — a governmental agency. It is illegal to resell water quotas, though some intra-regional reallocation has been permitted. The agricultural sector was the main beneficiary and obtained water inputs at subsidized rates, but to a lesser extent today.

By mid-2000s, the distortions generated by the administrative water allocation mechanism in Israel were said to be responsible for a severe hydrological deficit in the country — a *water crisis*. Various parliamentary investigative committees and researchers concluded that for decades, water allocation had been mismanaged by oversubsidizing the agricultural sector and underfunding water supply development. The system was subjective, politicized, and included various governmental bodies responsible for different objectives (Davidovich, 2008). The formation of unsolicited black water markets in various regions was seen as an indication of these inefficiencies.[5]

Leading up to the water crisis, suggestions were made to introduce various types of market mechanisms so that water would be consumed by those that valued it most (for a review, see Parker and Tsur, 1997). However, this never materialized. After 2010, water tariffs were updated to reflect the full cost of supply, and reorganization was made, but overall, the administrative mechanism did not change. Instead, extensive investments were made to extend the supply of water.[6]

In conclusion, by mid-2000s, despite clear evidence of distortions, the administrative mechanism continued to be the favored allocation system. The next section elicits the household's preferences for agricultural amenities by constructing a hypothetical water market that is compared to the administrative mechanism.

3. The Model

Applied, water-focused, computable general equilibrium (CGE) models have been developed to analyze many issues within the water economy (see detailed reviews by Dinar (2014) and Luckmann et al. (2014)). None, however, use CGE models to elicit the value of agricultural amenities.

Luckmann et al. (2016, 2014) and Baum et al. (2016) are recent examples of water-focused CGE models that focus on Israel. They develop a highly detailed breakdown of water types, production sectors, and households, and simulate counterfactual scenarios that include drastic reductions in Israel's water supply, an increase in desalinated water, and alternative water pricing. Diao et al. (2008) have studied conjunctive ground and surface water policy in Morocco. These studies,

[3] Zhao et al. (2013) provide a clear discussion of the cost and benefits of each.

[4] OECD (2017) provides an extensive review.

[5] Black water markets have been investigated by the State Comptroller in 2012, and deliberated by the High Court of Justice (*Bagatz*) and the IWA. In March 2017, the IWA reaffirmed this practice as illegal unless authorized by the state.

[6] By 2018, Israel operates five seawater desalination plants that provide more than two-thirds of the drinking water to households, and uses almost 90% of its purified wastewater for irrigation. See Haaretz (2014) and Rinat (2016) for a general overview.